

Copper switch-off, fibre take-up and ULL tariffs in France

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Abbreviations

ADSL	Asymmetric Digital Subscriber Line
ANO	Alternative Network Operator
AMII	Appel à Manifestation d'Intention d'Investissement - Call for Manifestation of Investments Intentions
Arcep	Autorité de Régulation des Communications Électroniques et des Postes – Name of the French NRA
ARPU	Average Revenue per User
BU	Bottom-up
C(P)S	Carrier (Pre-)Selection
CAPEX	Capital Expenditure
CCE	Coûts courants économiques; current cost accounting
CIS	Commonwealth of Independent States
CPE	Customer Premise Equipment
DE	Germany
DSL	Digital Subscriber Line
DTAG	Deutsche Telekom AG - Name of the German incumbent
EU	European Union
FAC	Fully allocated cost
FAI	Fournisseur d'Accès Internet – Internet Access Providers
FL	forward looking
FTTB	Fibre to the building
FttC	Fibre to the Cabinet
FTTH	Fibre to the home
FttP	Fibre to the Premise
GSM	Groupe Spécial Mobile; Global System for Mobile Communications
HD	Haut Débit – High Broadband Speed
HFC	Hybrid Fibre Coaxial
HNRA	High network reach area
HP	Homes Passed

i.a.	inter alia
i.e.	id est
IFER	Imposition forfaitaire sur les entreprises de réseaux
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IT	Italy
JT	Name of Jersey's incumbent Jersey Telecom
KPI	Key Performance Indicator
LER	Label Edge Router
LEX	Local Exchange
LLU	Local Loop Unbundling
LRAIC	Long Run Average Incremental Costs
LRIC	Long Run Incremental Costs
M2M	Machine to machine
mbps	megabits per second
MDF	Main distribution frame
MEA	Modern Equivalent Asset
MGW	Media Gateway
mln	million
(M)PoP	(Metropolitan) Point of Presence
MSAN	Multi-Service Access Node
MTF	Modulation Transfer Function
NBN	National broadband network; also name of the Austrian state-owned network operator
NGA	Next Generation Access
NGN	Next Generation Network
NRA	National Regulatory Authority
OCEN	Opérateur Commercial d'Envergure Nationale – Commercial Operator of Nationwide Scope
OPEX	Operational Expenditure

PIN	Public Initiative Network
PIN	less dense areas deployed on public initiative
PSTN	Public Switched Telephone Network
PTS	Name of the Swedish NRA
QoS	Quality of Service
RAN	Radio Access Network
RIP	Reseaux d'initiative publique – Networks of public initiative
RTC	Réseau téléphonique commuté; see PSTN
SBC	Session Border Controller
SIM	Subscriber identity module
SLU	Sub Loop Unbundling
SMP	Significant Market Power
SRIC	Short Run Incremental Costs
THD	Très Haut Débit – Very High Broadband Speed
UK	United Kingdom
ULL	Unbundled Local Loop
USO	Universal Service Obligation
VDSL	Very High Speed Digital Subscriber Line
VoIP	Voice over IP
VoIP	Voice over Internet Protocol
VULA	Virtually Unbundled Local Access
WACC	Weighted Average Cost of Capital
WLR	Wholesale Line Rental
WS	Wholesale

Management Summary

France is a country with a very ambitious fibre policy approach. The French government intends to achieve a nearly nationwide fibre network coverage by end of 2025 as it already laid out in 2013 in its "Plan France Très Haut Débit". This target is shared by many governments in Europe but only a smaller subset of countries is really showing actual deployments and deployment commitments of operators which realistically achieve this ambitious target, and France is one of them.

Currently more than 18 mln. households have the opportunity to subscribe for a fibre network. This is around 50 % out of 37 mln. households in France. Private operators as well as public Initiatives or Public Private Partnerships have committed another 16 mln. access lines to be deployed by 2025. Thus there are only 3 mln. of homes which are not committed by a fibre plan yet.

Demand for fibre based services started in France slowly, but increased over time. The take-up rate of FTTH/B has increased significantly from 22% in 2014 to 38% in 2017 and is now slightly above the European average of 35% / EU28) but below the leading EU countries which already exceeds 70% (Sweden: 76%, Finland: 78%, Bulgaria: 81%)

Effectively currently 7.1 mln. users subscribe to fibre while 18,4 mln. (Q4 2019) could do so. This in other words means that even where fibre is available the majority of users still satisfy their communications demand by using Oranges copper network and not the fibre networks.

We believe that this relationship between supply and demand for fibre in France can be characterized as a demand gap. A gap between demand and supply of fibre is not in line with the targets of the French fibre infrastructure policy and it is not in line with the economically efficient outcome. The full benefits of fibre only emerge if the whole potential demand for communications is in line with the actual deployment. There are supply side as well as demand side reasons why successful fibre policy requires that all customers migrate from the traditional legacy copper network to the new established fibre network. Only if all customers are connected to the fibre network innovative fibre based services can reach all potential customers and thereby exploit all relevant subscription externalities. For operators it is highly cost duplicative and inefficient to invest in and operate two network infrastructures in parallel if all potential customers could be served by one modern infrastructure. Such inefficiencies reduce the profitability of fibre networks and therefore the incentive to expand the fibre network in due time. As a result parallel legacy and modern infrastructures unnecessarily increase the cost of the communications systems and therefore the price level to the end customers.

Besides further managing the deployment process towards a nationwide fibre network it becomes a most important challenge for the French communications policy to solve the

demand gap and manage the transition of all customers and their access lines from the copper to the fibre network. While the deployment targets are well defined and in a successful implementation mode solving the demand gap is a less defined policy target from a strategic and an operational perspective.

Solving the demand gap is a strategic challenge for policy and regulation as it is for operators. Finally it is the end users who have to be migrated from the copper to the fibre networks by demand side, supply side and regulatory means. Operators currently already incentivise end users a lot to migrate with the success as reflected in the actual take-up rate. These incentive policies and their results indicate that there is a variety of impediments for customers to migrate. Because the incentive policies are mainly related to service pricing this indicates that demand side pricing measures have their limitations to foster migration. Supply side measures to foster migration (like degradation of Quality of Service for copper services and switching off the copper network are not defined yet and are not yet used by operators). Regulatory measures for fostering and supporting the migration process of customers are still under consideration and not yet strategically defined in a comprehensive way.

In the current 2020 public consultation, Arcep seems to propose to keep the ULL pricing approach of cost based pricing. Maintaining the current cost based methodology this approach would not imply wholesale price stability but would potentially lead to a price increase. As Arcep describes in their 2017 decision setting LLU prices for the years 2018 – 2020, relying solely on the BU LRIC cost model would have led to a price increase from 8.59 € in 2018 up to 10.71 € in 2020 which equals a 25 % increase over three years. This increase is mainly resulting from a decrease of active copper lines. Given the aim of a copper switch-off by 2030, this effect might even intensify resulting in an even harsher increase of prices, given that this cost model may give a realistic outlook of regulated prices. To foster migration to fibre Arcep discusses additionally and/or alternatively a variety of options. One option reflects the idea of giving up the regulatory remedy of cost based pricing for the copper ULL wholesale service in areas where fibre is already comprehensively deployed. No longer remedying ULL access – so Arcep's approach – could give Orange the flexibility to fix the wholesale price in a way which mostly reflects its own business interests. It is not realistic to assume that Orange will use such a pricing flexibility to reduce copper ULL prices below the currently regulated cost based level. Instead Orange has incentives to raise the ULL prices above the regulated cost based level. Arcep is not explicitly discussing of the outcome of the pricing flexibility of the incumbent but it is fair to say that Arcep would regard such pricing as coherent with its own regulatory policy intentions to incentivise ANOs to foster the migration of their end customers towards fibre.

Such a measure would intend to request an aggressive demand side policy to „motivate“ end customers to switch from using the copper network to using the fibre network by facing higher end user prices. In our assessment such a policy measure

would not be successful, would not be efficient, would distort competition and would in the end not support the fibre policy in France.

- It is doubtful in the competitive process that higher wholesale prices for ANOs would lead to higher end user prices, while higher wholesale prices increase unit costs for ANOs the network costs for the incumbent operator remained unchanged. He has the advantage of not responding to end user price increases of ANOs, instead he has the option to choose between receiving higher profits or increasing its market share. Thus wholesale price increases may simply compress the profitability of ANOs and reduce their ability to invest.
- For the above reasons a wholesale price increase has the potential to distort competition and to increase the asymmetries between the incumbent and the ANOs.
- According to market experience of operators in France only a smaller share of customers responds to price incentives resulting from variations of end user prices. According to Iliad only between 10% and 20% of customers may be addressable by price measures. Thus even if the intended wholesale retail price chain would work it would only generate effects for a small part of users.
- For different reasons wholesale price increases for ULL would reduce incentives to invest for the ANOs as well as for the incumbent.
- Although the approach of increasing wholesale charges is intended to be a demand side measure to foster migration it nevertheless would have major implications on the supply side: The incentives of the incumbent to switch-off the copper network, which are already low at the current price level will further be reduced by the additional margin which he would achieve by increasing wholesale prices. Wholesale prices which are already at the current pricing regime significantly above the actual cost would even generate more profits. This does not support any incentive to switch-off the copper network. Some NRAs nevertheless argue that the additional profits enable incumbents to make the necessary fibre investments. Since in France only 3 mln. of homes are not yet covered by plan this argument is not very strong. For an incumbent it is rational to still run the copper network as long as it generates contributions to cover fixed and sunk cost of the network. Why should an incumbent switch-off the copper network when he can on a per line basis earn more profits on copper than on fibre. In 2023 Orange still receives 75% off its wholesale revenues from copper network-related services. Finally there is rationale for the incumbent to run the fibre network as long as the wholesale prices allow for recovering the short run incremental cost represented by the operating expenses for running the network.

- Moreover, with Arcep's decision No. 2012-0007 of 17 January 2012 the cost assessment method to be used for the copper pair has been changed by progressively shortening the amortization period of copper cables from 25 to 13 years. The rationale for this change was to send a strong signal to the market concerning the transition from copper to fibre and to allow the copper cables currently in service to be fully depreciated by 2025. As of today it seems unrealistic to assume that the copper network will be completely switched-off by 2025. Thus Orange is now profiting from a fully depreciation of its copper network and could gain additional profits if the copper network is still in use after 2025 (given that the ULL price is not dramatically reduced after 2025). From today's perspective it seems that the pricing policy from 2012 is not in line with the current state of copper switch-off. If after 2025 wholesale profits are still generated through marketing the copper network the current ULL prices have to be evaluated as excessive.

Thus a regulatory pricing policy which would intend to foster migration would not have to increase but to decrease the wholesale price the incumbent is receiving from the copper network.

If the copper wholesale price is determined at the SRIC level the incentives of the incumbent to switch-off the copper network are maximised. Furthermore the decision relevant costs of the incumbent are covered. So he would have strong incentives to migrate all of its own end customers as well as wholesale customers towards the fibre network because he no longer earns contributions for operating the copper network.

Because of the theoretically well-known and well derived migration effect lowering the ULL prices to the SRIC level may cause downwards pressure on the end user prices on broadband access. Such an outcome would be counterproductive in front of the policy objective to motivate end users to migrate to the fibre network.

This dichotomy of effects running into different directions with regard to the migration target requires an intelligent solution to balance out the effects. The concept of wedge pricing is the approach which exactly defines the equilibrium between the two different effects. According to the basic idea of the concept there is a difference between the ULL price the access seekers are paying and the price (revenues) the access provider is receiving. As in the current regulatory pricing regime access seekers will continue to pay the regulated cost based wholesale price, the incumbent however no longer receives the whole revenues following from that price. Instead he receives revenues which represent the SRIC level of the copper network. The difference between the regulated wholesale price and the revenues he is receiving from wholesale – the wedge - is contributed to a fund whose proceeds are used in a competitively neutral way to further expand the fibre network. The basic concept of wedge pricing was already developed and proposed by WIK in its 2011 study "Wholesale pricing, NGA take-up and competition". The concept was further elaborated by Nera in 2017. The concept then

was introduced by Vodafone in the UK policy debate. Wedge pricing is attractive from a theoretical perspective because it rather perfectly balances out the contradicting effects relate to the level of ULL prices. The incumbent gets any incentives to switch-off the copper network and to migrate to fibre. There are no counterproductive effects from lower ULL prices to disincentivise end users to migrate to fibre. Instead access seekers and end users are subject to the economically most efficient pricing signals towards migration.

Before discussing the practicability and applicability of wedge pricing we want to highlight the basic building blocks and the requirements of the concept. The question is if the existing regulatory framework allows the regulator to distinguish between the wholesale price the access seekers are paying and the revenues the incumbent is receiving from wholesale. The revenues following from applying the wedge are flowing back to operators to keep the appropriate financing level for fibre investment as it has been before. The proceeds of the fund will be allocated to all operators investing in fibre in a competitively neutral way.

The implementation of the wedge pricing concept is not as easy as some proponents of the concept suggest. Any successful implementation of the concept faces the following challenges which requires to be solved:

1. Is the legal basis within the European and the French regulatory framework suited to introduce wedge pricing?
2. How can the SRIC be determined appropriately?
3. Is the legal basis to introduce the “Wedge Fund” available? Does its introduction require a specific new legislation?
4. How can it be aligned with state aid and/or universal service?
5. Can it legally be guaranteed that the proceeds of the fund will exclusively be used for extending the fibre network?
6. How to allocate the investment contributions of the fund in a co-investment framework between operators?

Because there is no practical implementation of the wedge concept in any country as we are aware of all questions mentioned above have to be solved in the French context on stretch. Although we are convinced that there are solutions available for each of the challenges mentioned above we are although aware of the legal and institutional complexity developing these solutions. In any case solving all issues may require more time than available than in the given time frame up to 2025.

In any case the wedge pricing concept very much confirms the view that pricing flexibility for the incumbent in setting copper ULL prices is not the right way to go. Also the British regulator OFCOM concludes from its critical reflection of wedge pricing that

pricing continuity is OFCOM's preferred approach. This would also be our conclusion for France. As further applying the current costing methodology would not generate pricing continuity we propose to freeze the current ULL price level for the relevant future.

Despite the economic fascination of pricing measures to optimise the migration path to fibre our overall conclusion is that other regulatory measures are more suitable and needed to develop an efficient migration path in France.

We propose the need for a regulatory masterplan which not only formulates measures to protect market players (operators, access seekers, end users) in the incumbent driven copper switch-off process but also sets targets and obligations for the switch-off process itself. The latter targets and measures in particular aim at fostering the migration process towards fibre. Such measures are in our view important because the operator driven switch-off process proves to be rather unambitious and slow. Regulatory action in this regard is necessary because the market dynamics of the last few years show that the competitive interaction of operators alone is not generating the migration of a switch-off process which exhausts all economic benefits inherent in the availability of fibre in France.

Setting migration targets

The following proposal is based on the assumption that Arcep is legally empowered to actively manage the copper switch-off framework in France. If that is not sufficiently the case we strongly recommend an appropriate legal initiative. Setting the targets of a copper switch-off first requires to manage the PSTN switch-off.

- Develop and agree a PSTN switch-off schedule aligned with the fibre roll out in a way that PSTN switch-off cannot delay copper switch-off.
- Orange shall be mandated to switch-off PSTN latest when fibre readiness is declared.
- For a small part of remaining PSTN customers the migration from PSTN to VoIP may be conducted together with the migration from Copper to fibre access lines in one step.

For copper network switch-off the following tasks have to be performed:

- Arcep should set a time plan for copper switch-off which is in line with the upcoming and existing fibre roll-out in France.
- Whenever an area is declared as fibre ready according to a relevant list of criteria migration and switch-off should be mandated in that area not later than 30 month. Within that period all customer would have to be migrated to fibre.

Removing regulatory constraints and facilitating migration

- Arcep should define USO network obligations technologically neutral. Currently the USO is ought to be provided by 99 % via copper and fibre and limited to 1 % via FWA (or mobile solutions). With the aim of a vast fibre roll-out, the number of accesses requiring FWA in rural areas may exceed 1 %. If 1 % is a fixed threshold per roll-out area, fibre roll-out in very rural areas might take longer as a 99 % fibre coverage will have to be achieved. Loosening this limitation towards an overall target will allow operators to decrease expenditures for a given area they would in other cases have to ignore due to unprofitability or an unduly high subsidy need.
- Change current access obligations (i.e. fault recovery process) such that they are in line with the copper switch-off plan
- Lift obligations to support special PSTN and copper dedicated services, which cannot be provided over VoIP. Remove any copper line power obligations.
- A not completed PSTN switch-off can be an obstacle for copper switch-off, even if an area is “full-fibre”. Therefore, notice periods for PSTN switch-off should be kept short.
- Take care that wholesale agreements regarding the PSTN or copper migration towards NGN respectively fibre do not foresee termination or migration fees for wholesale customers. If the regulatory framework allows to do so, to forbid migration and termination fees for end users could be supportive, as well.
- Regulatory or legislative support for operators to migrate customer contracts from copper to fibre based products in dedicated time frames consistent with the switch-off path (ability to terminate or change end user contracts)
- Remove copper line related quality obligations in fibre ready areas

Apply an active migration policy

- The copper switch-off process should start in an area of the network which has been declared of being fibre ready by Arcep based on transparent non-discriminatory criteria. The minimum size of such area can be the access area of the mutualisation points. Such small granularity supports quick migration progress compared to whole MDF areas where small segments could hinder or delay the migration as a whole.
- Relevant criteria for fibre readiness should be:
 - Fibre access line coverage by at least one fibre network within the whole area is given
 - The area is defined by operators committed deployment areas and at least should cover all homes addressed by a mutualisation point

- At least one active wholesale offer with at least comparable quality to those on copper in the same area must be available
- Furthermore customers should face competitive choice for fibre products by at least three operators present (building operator plus two coinvestors) in the mutualisation point, which have proved their market relevance by a certain market share or number of customers
- In a short period (i.e. 2-4 months) following the fibre readiness declaration operators should stop of commercially selling the copper access lines and related products (commercial closure).
- Existing copper access lines should be supported until they are switched off. Switch-off shall start after 24 month (begin of technical closure). Total migration should be terminated no longer than 30 months (end of technical closure)
- In case there is not yet a competitive market structure (less than three operators) Arcep may nevertheless declare the area as fibre ready but extent the period of commercial closure, begin and end of technical closure by six month each.

1 Issues at stake/ Introduction

In France the completion of the nationwide deployment of the new FTTH access network is in sight. Many areas are already deployed, for many areas the deployment has been committed by different operators. Only a few rural areas are still open to be served by whom and under which construct. Since operating the still existing copper access network in parallel to the new fibre network in the longer term is expensive and not efficient the discussion comes up how to incentivise and speed up the migration from copper to fibre access. This study tries to answer questions in the context of regulatory discussions coming up in the context of the French NRA Arcep' recent public consultations at first, but taking into account the discussions having taken place in Europe since 2011 and i.a. in the British NRA OFCOM's recent consultation. The study tries to respond to:

- What are the overall economic benefits of having full migration to fibre soon?
- What is the impact of copper switch-off on migration to fibre?
- Which pricing principle for ULL best optimises incentives to switch-off the copper network?
- What should be the proper pricing/costing principle applied to ULL in case of migration to fibre?
- Which pricing principle best optimises incentives to invest in areas where there is no fibre yet?
- Which pricing principle best optimises incentives to migrate customers in areas where fibre is available?
- What is the relevance and relative impact of pricing on migration to fibre compared to other measures?
- How to best balance pricing principles for (customer) migration to fibre and copper switch-off?
- How to support copper switch-off by other means than pricing?

The study first describes the actual market structure in France as starting basis (chapter 2) and continues explaining the technical requirements for copper switch-off and the requirement of a full PSTN to VoIP migration before, its overall benefits and the state of migration in relevant international examples (chapter 3). Describing the options and the history of price setting (chapter 4) forms the basis of an in depth discussion of an appropriate price setting in the context of incentivising copper switch-off in France (chapter 5). This leads to a discussion of regulatory options (chapter 6) and concluding recommendations (chapter 7).

2 Market structure, fibre roll-out and fibre take-up in France

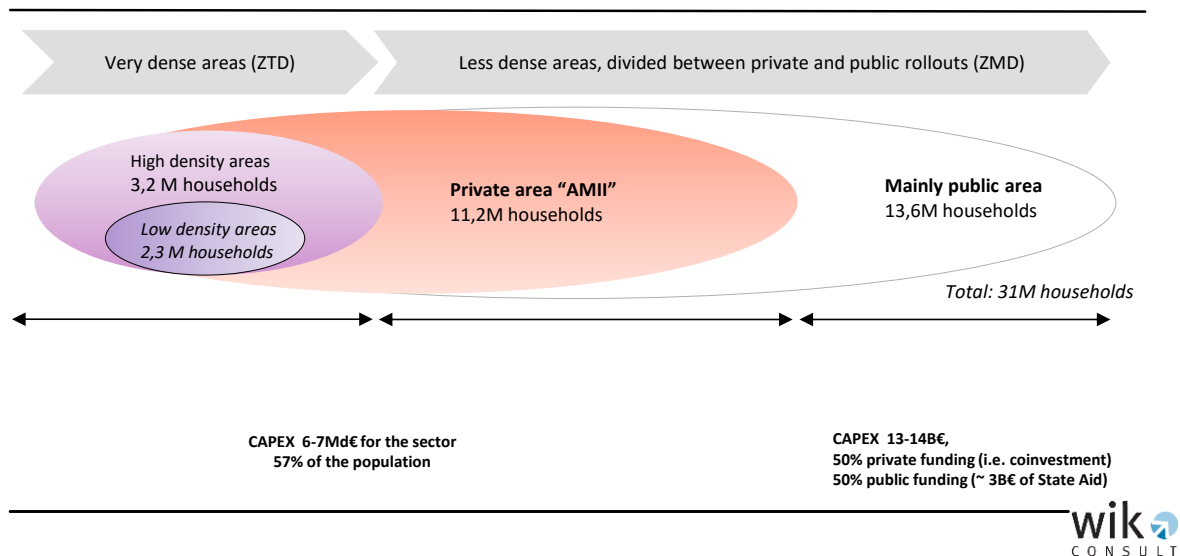
The preference for FTTH is supported by the French national broadband strategy. In early 2013, the French government set up the "Plan Très Haut Débit" which promotes the deployment of high-speed fibre based broadband networks throughout the country. A major target of the plan is to reduce the digital divide between rural and urban areas by providing equal broadband connectivity to the whole population. The Plan aims to connect 100% of households to high-speed broadband by 2022. Technologically, the Plan aims to achieve FTTH as far as possible. In areas where this is not economically viable, technologies like FTTC or radio technologies should be deployed.

The Plan has calculated a 20 billion Euro investment requirement to meet its targets over a ten year period. The Plan furthermore calculates the need of 3 billion Euro state subsidies to support rural broadband initiatives where private operators will not deploy their own network without it.

The Plan divides the French territory into subsidized and non-subsidized areas. Non-subsidized areas are those where FTTH has already been deployed and those for which operators have already committed to develop ultra-fast broadband. In these high- and medium density zones public funds and financing will not be granted to private initiatives because fibre deployment is regarded as profitable in those areas. The non-subsidised areas cover 57% of the population. A CAPEX requirement of 6 to 7 billion Euro is calculated for this area. Subsidised areas comprise of those parts of the country with lower population density where operators and other private actors did not show any investment initiative and interest. The Plan assumes that this area which represents 43% of population absorbs an investment requirement of 13 to 14 billion Euro.

Such areas are the scope of subsidised investments which can be pure public initiatives or joint public private partnerships. Figure 2-1 provides an overview on the structure of areas according to these dimensions.

Figure 2-1 Organisation of the FTTH roll-out and regulation



Source: Iliad

The numbers in Figure 2-1 also indicate that the number of premises (households) considered by Arcep to have natural monopoly characteristics in the fibre terminating segment is 27,8 million or about 90% of households. In contrast, 3,2 million households are considered to be viable for infrastructure competition to the base of the building.

In order to implement the Plan, the Government created the Mission THD in 2012 within the Ministry of Economics and Finance responsible in particular for determining the eligibility of broadband projects to receive public funds. From a regulatory perspective, the publicly funded networks have to offer wholesale services on an open access basis, ensuring that any operator or service provider can access the network on equal terms. There is also a requirement that the network has to be technologically neutral so that any standardised technology can be connected to the network.¹

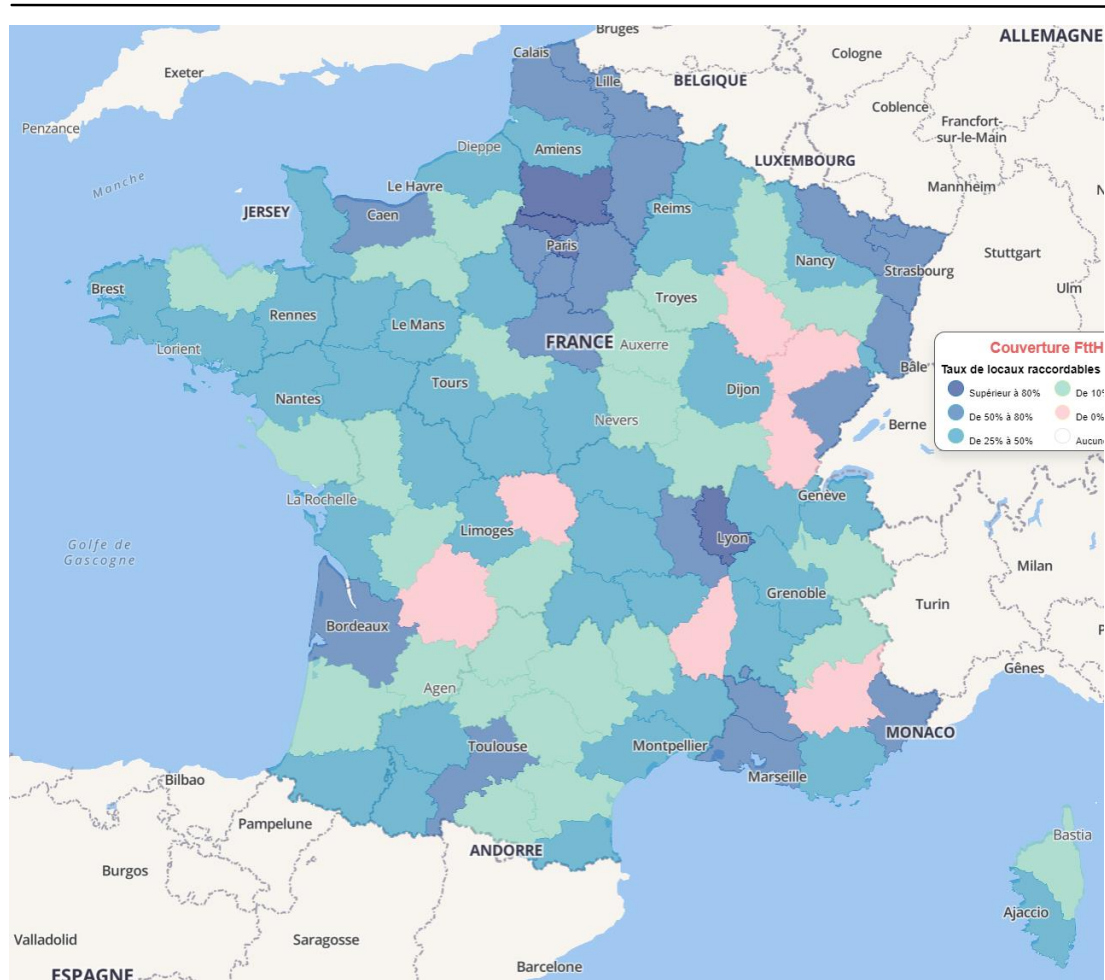
2.1 FTTH network roll-out

Figure 2-2 shows the availability of FTTH (coverage rate) in France. The overall (nationwide) coverage of FTTH in the fourth quarter of 2019 was 50 %². E.g. the map shows that in the region of Paris - with a coverage of over 80 % - the availability of FTTH is much higher than on the average level in France.

¹ WIK Consult (2016), p. 34.

² Arcep (2020d)

Figure 2-2 Map of FTTH network roll-out in France end of 2019



Couverture FttH

Taux de locaux raccordables

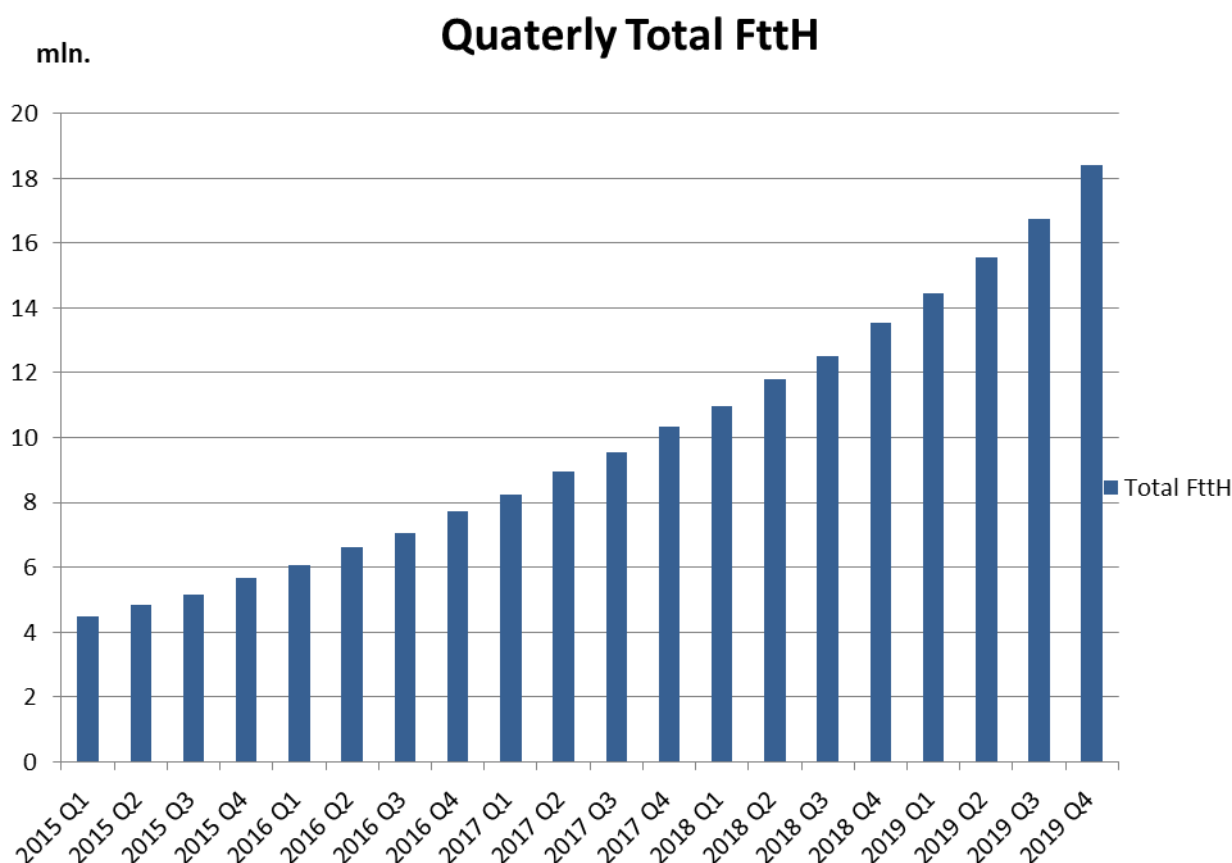


Source: Arcep (2020f)

Figure 2-3 shows the total number of homes passed with FTTH for every quarter starting in 2015 until the fourth quarter of 2019. The pace of fibre roll-out increases with a quarterly deployment of about 1 million access lines. In comparison to Germany the performance of France from one year (Q4 2018 – Q4 2019: 4,8 mln. of homes passed)

is higher than the overall performance in Germany until 2018 where around 3,6 mln. of homes were passed with FTTH.³

Figure 2-3 Total FTTH homes passed (mln.)



Source: WIK based on Arcep (2020d)

The following Figure 2-4 shows the progress of fibre roll-out in the three different types of areas: very dense areas (all privately financed), less dense areas where the roll-out is privately financed and less dense areas where the roll-out is partially publicly financed.

Figure 2-4 shows a) the premises already passed with FTTH, b) the progression in FTTH network roll-out made from the first quarter 2018 until the second quarter 2019, c) the commitments made by operators for 2020 concerning less dense areas with own

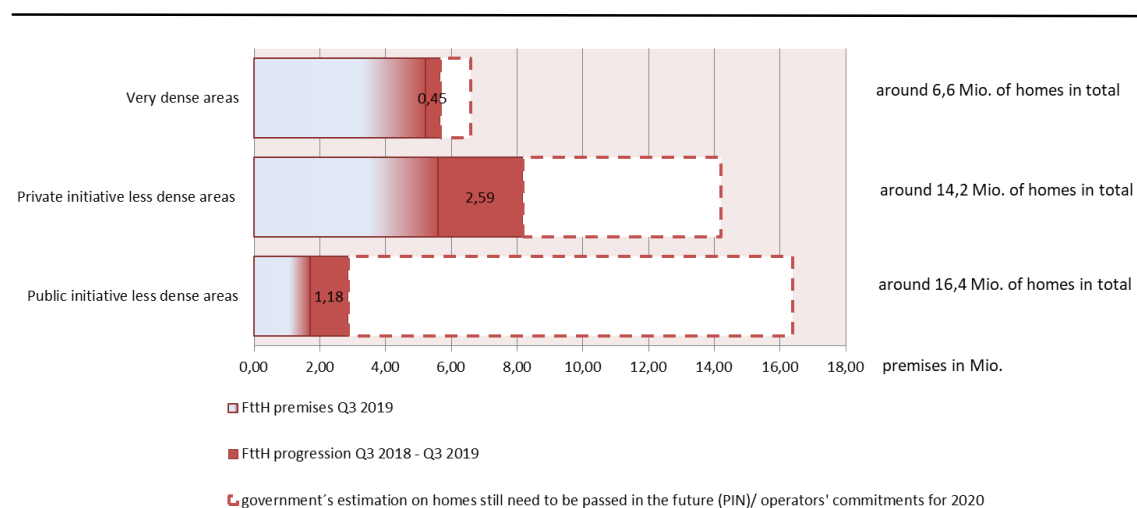
³ Statista, <https://de.statista.com/statistik/daten/studie/275118/umfrage/anzahl-der-per-glasfaser-versorgten-haushalte-in-deutschland/>, accessed March 30th 2020

investments as well as d) the government's estimation about FTTH network roll-out until 2022 concerning less dense areas on public initiative.

FTTH roll-out by area and financing

There are two forms of financing concerning FTTH, privately and publicly financed infrastructure whereas publicly financed infrastructure is defined as infrastructure that has been financed with help of public resources as well as private resources. Publicly financed in the following context stands for a mixture of public and private resources in order to roll-out the FTTH network. There is no definition to which share the financing is public or private.

Figure 2-4 FTTH network roll-out by area



Source: WIK after Arcep (2019b) and Gabla (2019)

Figure 2-4 shows the FTTH network roll-out in the three different types of areas. Moreover the figure gives information on the number of FTTH premises as of Q3 2019, the progress made in the last year (Q3 2018 – Q3 2019) and the government's estimation on homes which still need to be passed in the future regarding PIN areas as well as operators' commitments until 2020 regarding less dense areas on private initiative. In total around 21 mln. of all FTTH lines will be located in very dense and less dense areas on private initiative and around 16 mln. of lines will be located in PIN areas.

Until the second quarter of 2019 there are 15.6 mln. of FTTH homes passed in all three areas. This signifies an increase of 3,8 mln. of FTTH homes passed compared to the year before (Q3 2018 – Q3 2019). In total more than 25 mln. premises will be

(according to planning) served by FTTH in 2022 regarding all three areas⁴. From a total of 37,1 mln. homes to be passed in France three mln. of homes are not yet covered by a commitment or plan.⁵ The most critical achievements are related to public initiative areas. To pass the missing 3 mln. of homes not yet covered 5,7 bln. Euros of investments are necessary especially since the premises concerned are mostly hard to access.⁶ About 16 mln. homes are located in less dense areas which are deployed on a public initiative.

To sum up: There are only 3 mln. of homes missing from a total of 37,1 mln. Given the fact that only 8 % of homes in France are not yet covered by a plan or commitment in the next years, the question of optical fibre is not about investments anymore but about generating demand for optical fibre. Until Q3 2019 most FTTH lines (around 83 %) have been privately financed (around 13 mln. of lines from a total of 15,6 Mln. of lines already existing until Q3 2019).

Figure 2-5 shows the development of FTTH homes passed in the three different types of areas, namely: high density areas, less dense areas on private initiative and less dense areas on public initiative. All three bars show a constant growth but different growth rates over time. The number of homes passed with FTTH in high density areas grew constantly and now seems to be reaching a plateau which fits to the findings in Figure 2-4 that in very dense areas most of the existing premises are already passed (5,8 from 6,6 Mln. homes are already passed with FTTH). This is due to the fact that the deployment in those areas is more attractive (higher number of users and less deployment costs per user).

The bar sequence showing the number of FTTH homes passed in less dense areas deployed on private initiative surpassed the number of FTTH homes passed in high density areas in the first quarter of 2018 for the first time and continues to grow.

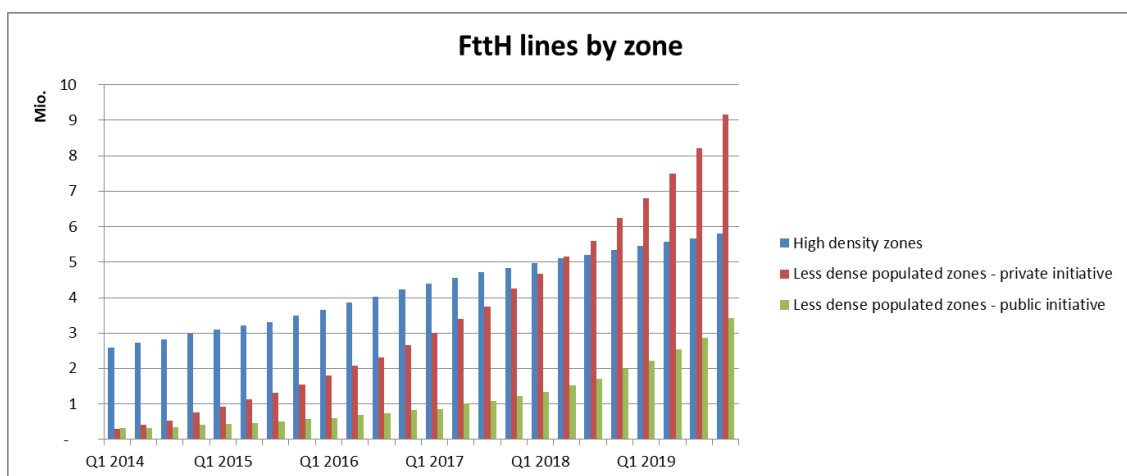
The number of homes passed with FTTH in less dense areas on public initiative is increasing with a delay compared to the growth in the other two areas. This reflects the fact that these areas are less attractive for private FTTH deployment.

⁴ The exact numbers vary from 25 to 30,7 Mln. total of homes passed by the end of 2022 depending on the source (see Infranum (2019), slide 7; Gabla (2019) slide 7)

⁵ Infranum (2019), p. 7

⁶ Gabla (2019)

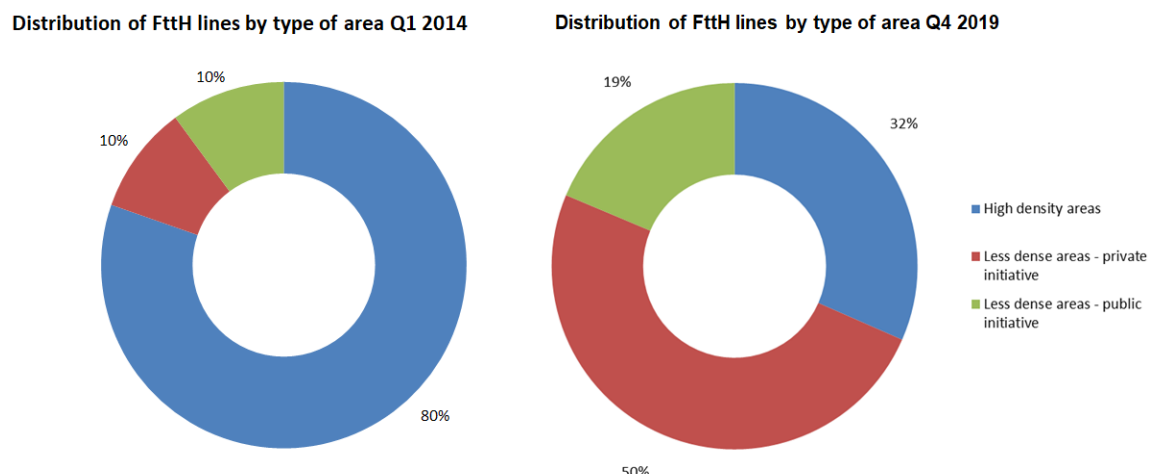
Figure 2-5 Number of FTTH homes passed by type of area



Source: Arcep (2020d)

The pie charts in Figure 2-6 show the distribution of FTTH lines in the different zones for two points in time: Q1 2014 and Q4 2019. The importance of FTTH outside high density areas is growing.

Figure 2-6 Distribution of FTTH lines by type of area Q1 2014 versus Q4 2019



Source: Arcep (2020d)

Having a closer look at PIN areas

Figure 2-7 shows the sales of FTTH lines in private areas in 2018 being significantly higher than the sales of the four network providers (Orange, SFR, Bouygues Telecom

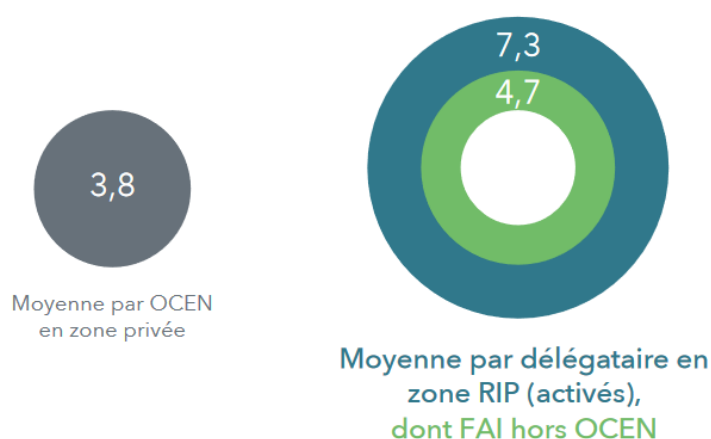
or Free) in private zones. Of 1000 homes passed the four operators sold on average 3,8 lines in private areas whereas in public initiative areas an average of 7,3 lines has been sold. 4,7 of those lines were sold by alternative operators.

Figure 2-7 Dynamics in PIN areas in 2018

COMMERCIALISATION

En 2018, une dynamique concurrentielle exemplaire dans les RIP

Ventes nettes mensuelles pour 1 000 prises commercialisables



Source: Infranum (2019), p. 15

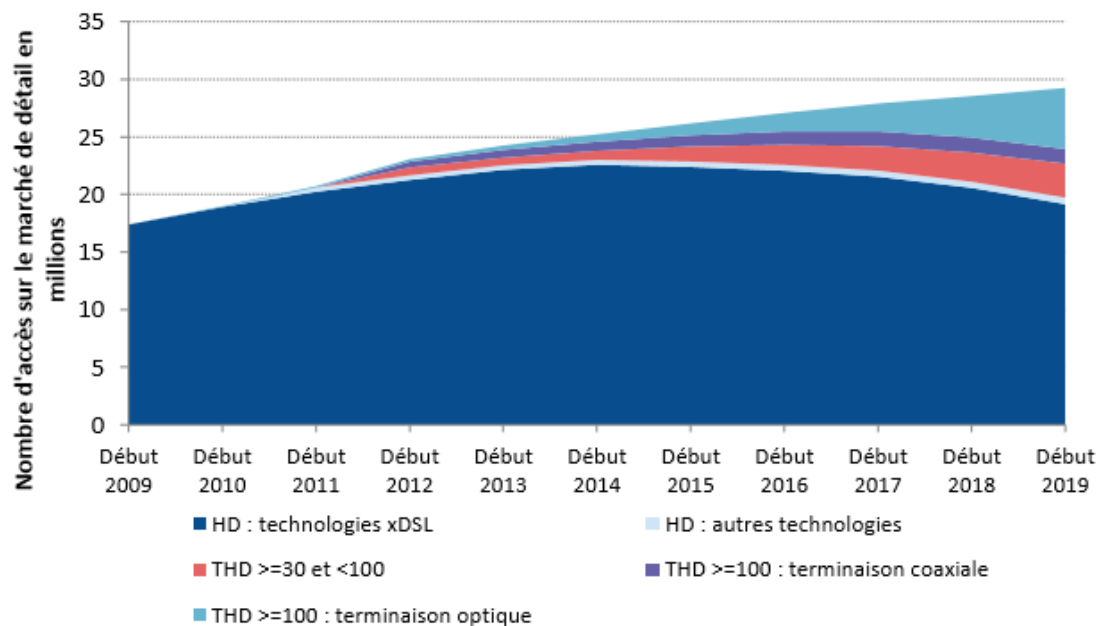
Gaining access in PIN areas for third parties is comparable to regulation in other areas. ULL regulation applies nationwide and pricing conditions are thus the same as for the other areas. Concerning bitstream access in PIN areas there is a differentiation between competitive area and non-competitive areas. Competitive areas are defined as areas where at least one alternative operator unbundles at the MDFs and already offers or would quickly be able to offer bitstream services. In these competitive areas there is an access obligation, but there is no cost orientation for tariffs. In non-competitive areas there is an access obligation and cost orientation for the tariffs. The ducts for the local loop are regulated on a national basis. The contracts are different concerning the rules on co-investment in PIN areas but the principles are similar to those in private areas (apart from subsidies). Arcep has issued pricing guidelines and validates the prices.⁷

2.2 Evolution of access technologies

Figure 2-8 shows the evolution of access technology by means of subscribers on the retail market.

⁷ Source: according to Iliad and Arcep (2015)

Figure 2-8 Evolution of the number of accesses, by technology, on the retail market



Source: Gabla (2019)

Access based on xDSL has been and still is the dominating technology. Since 2014 the share of DSL technologies is moderately declining. In 2019 there were around 19 mln. subscriptions registered for xDSL technologies. A similar development over time can be observed for cable customers, however on a much lower absolute level (about 3 mln. access in 2019). Starting in 2008⁸ access based on optical termination first increased slowly. It continued significantly increasing over time with 5 mln. fibre customers in 2019, which still represents a relatively small market share. Without major support measures it would take a long time until fibre will dominate xDSL.

There is no Vectoring used in the French VDSL2 deployments. Thus the VDSL2 signals interfere along the copper pairs with each other without correcting the distortions. The ports automatically adapt/reduce the transmission speed to a level which is still transmittable⁹. In some countries there is a threshold defined in the number of customers using an access line with VDSL2 in parallel, i.e. 50% of the copper pairs of a distribution cable. There is no such upper limit of VDSL2 usage in France. Thus the quality of VDSL2 for customers is decreasing with an increasing number of customers using this technology in the same access cable.

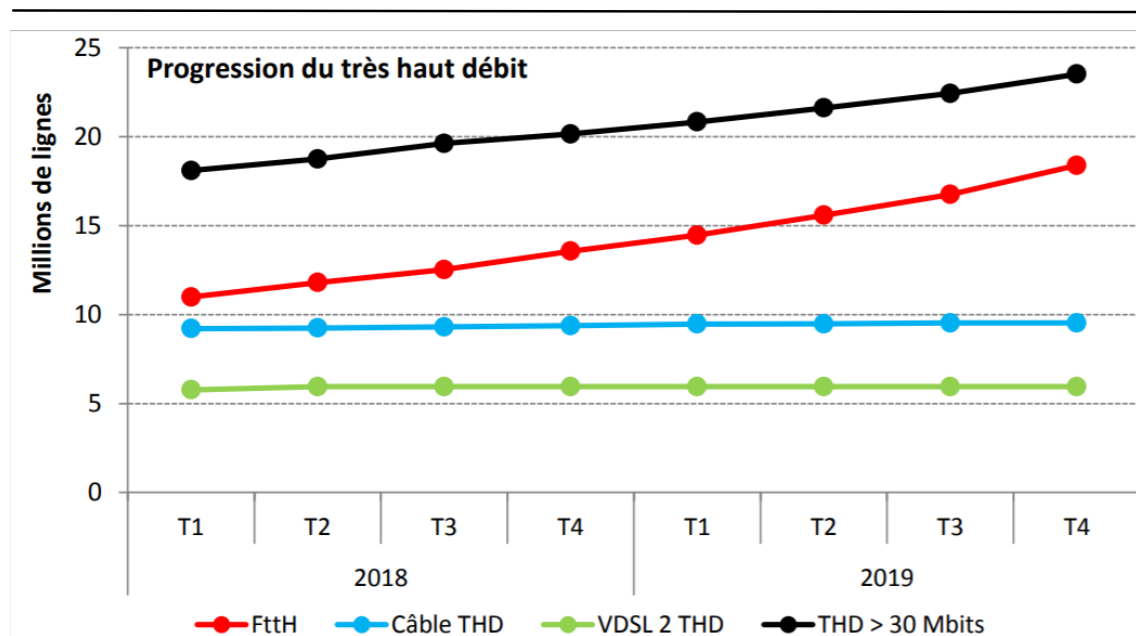
⁸ WIK (2016), p. 48

⁹ The transmission speed per copper pair is reduced, thus reducing cross talk/distortion effects down to a level at which the communication is without faults, thus can be "understood".

Very high speed network coverage

23,5 mln. homes were passed with very high speed internet (≥ 30 mbps) in France in the fourth quarter of 2019. This number is achieved by an overlapping provision of 18,4 mln. of homes passed based on FTTH, 9,5 mln. on cable and 6 mln. on VDSL2.

Figure 2-9 Very high speed internet coverage in France Q1 2018 – Q4 2019



Source: Arcep (2020e), p. 5

Table 2-1 shows on which access technologies the homes passed are based on. While cable and VDSL2 are relatively constant over time, overall coverage growth is generated by the growth of fibre with an annual growth rate of 35 %.

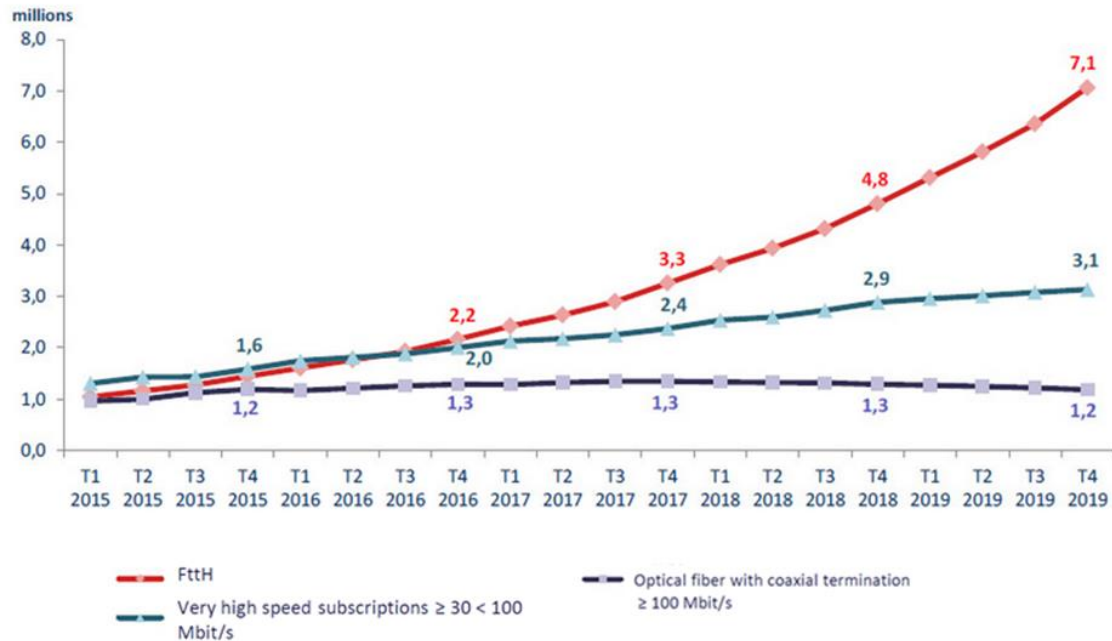
Table 2-1 Homes passed with very high speed internet by different technologies

Locaux éligibles au très haut débit :	31 Décembre 2018	31 mars 2019	30 juin 2019	30 septembre 2019	31 Décembre 2019	Évolution annuelle
sur les réseaux en fibre optique de bout en bout (FttH)	13 560 000	14 450 000	15 549 000	16 744 000	18 396 000	35 %
sur les réseaux à terminaison en câble coaxial	9 372 000	9 470 000	9 478 000	9 520 000	9 549 000	2 %
dont éligibles 100 Mbit/s (FttLA)	9 077 000	9 140 000	9 158 000	9 210 000	9 242 000	3 %
dont éligibles 30 Mbit/s (FttLA et HFC)	295 000	323 000	320 000	310 000	308 000	- 9 %
sur les réseaux en cuivre (VDSL2)	5 946 000	5 946 000	5 946 000	5 946 000	5 946 000	0 %
sur les réseaux en fibre ou en câble* * > 100 Mbit/s	15 967 000	16 680 000	17 532 000	18 460 000	19 740 000	23 %
tous réseaux confondus	20 143 000	20 820 000	21 610 000	22 420 000	23 521 000	17 %

Source: Arcep (2020e), p. 5

Regarding subscriptions Figure 2-10 shows the development from 2014 until Q4 2019. FTTH subscribers are accelerating with FTTH subscriptions exceeding fixed line very high speed subscription in the range of $\geq 30 < 100$ mbps already in Q3 2016. In Q4 2019 there were more than twice as much FTTH subscribers than very high speed fixed copper line subscribers in the range of $\geq 30 < 100$ mbps. Cable subscribers (≥ 100 mbps) were broadly stable over the last years with 1,3 mln., but decreasing in Q4 2019 to 1,2 Mln. subscribers.

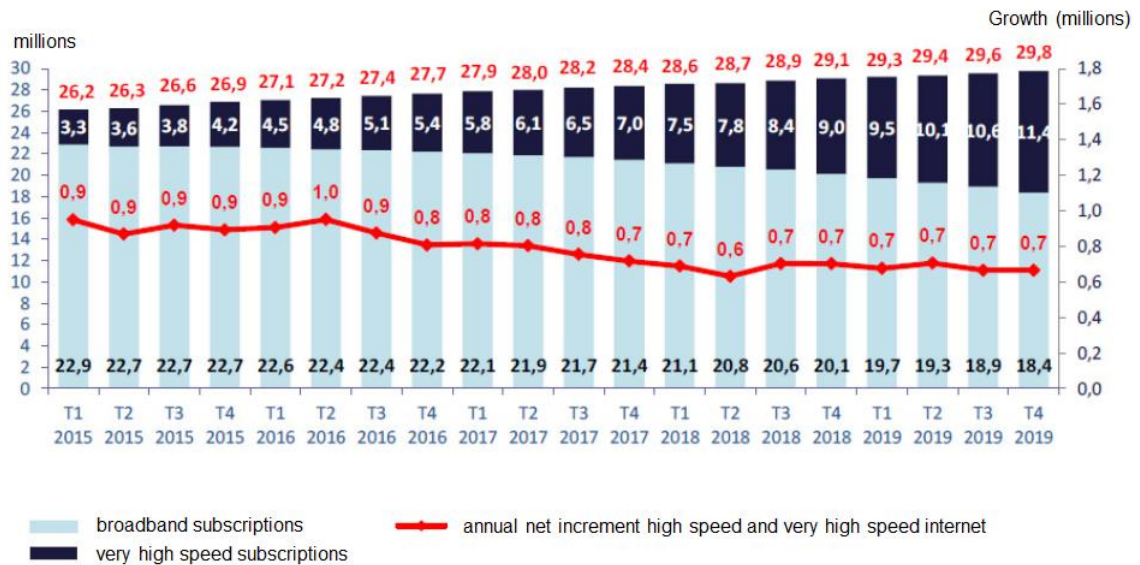
Figure 2-10 Subscriptions to very high speed internet access by different technologies in France



Source: Arcep (2020c)

Figure 2-11 shows the subscribers to very high speed internet access as well as high speed internet access (named in the figure as “broadband subscriptions”) from 2015 until Q4 2019. High speed internet is defined as a connection with a speed ≥ 30 mbps < 100 mbps and very high speed in this context is defined as ≥ 100 mbps. A steady growth of total broadband subscriptions up to 29,8 mln. in Q4 2019 can be observed. While the net annual increment (regarding 2018/2019) of the two speed classes of high and very high speed connections (≥ 30 mbps < 100 mbps, ≥ 100 mbps) is 0,7 mln., the internet access growth is driven by FTTH and VDSL2 is shrinking significantly.

Figure 2-11 Subscribers to very high speed internet access and net annual increment



Source: Arcep (2020c)

2.3 France in European comparison

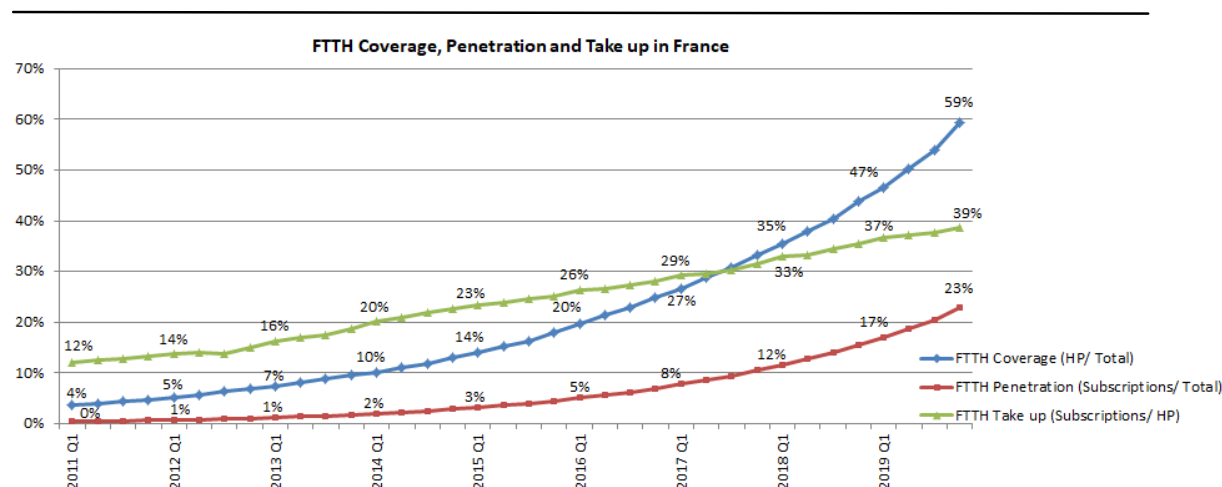
As of September 2018 the European average network coverage rate¹⁰ with FTTB/H was 36,4 %. In terms of network coverage with FTTH/B, France is one of the leading countries in Europe with a network coverage rate of FTTH/B of 45 % by September 2018).¹¹

As Figure 2-12 shows in France the FTTH (excluding FTTB) network coverage rate is strongly growing compared to the take-up rate. Nevertheless, the take-up rate of FTTH has increased in France significantly from 20% in 2014 to 39% in 2019.

¹⁰ Coverage means homes passed divided by the total of homes in France.

¹¹ Idate (2018)

Figure 2-12 FTTH coverage, penetration and take-up in France



Source: WIK based on Arcep (2019c), Arcep (2020c), Arcep (2020d)

The European average take-up rate¹² concerning FTTB/H is at 38,2 % (EU28) respectively 37,4 % (EU 39)¹³ (Sep 2018).¹⁴

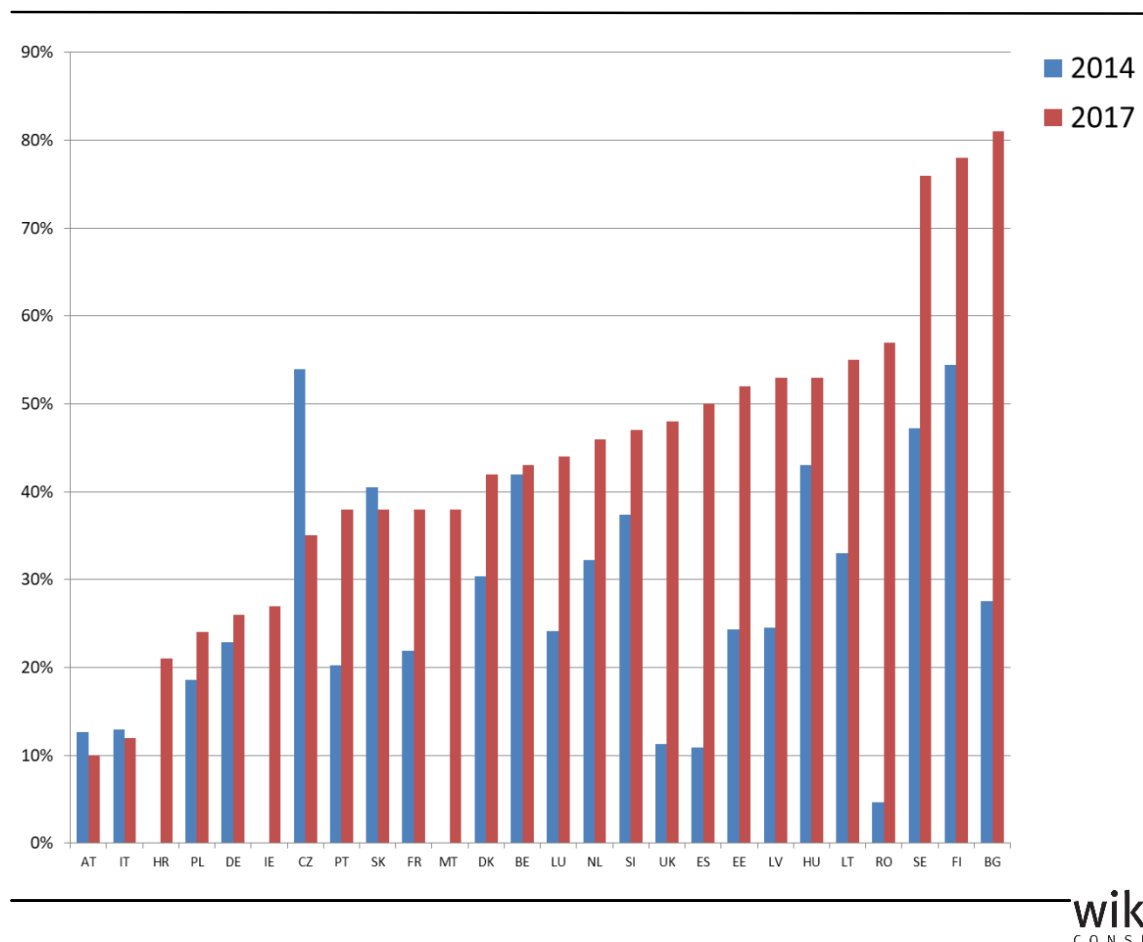
As Figure 2-13 shows the leading countries concerning take-up of FTTH/B in Europe are Bulgaria, Finland and Sweden.

¹² The take-up rate shows how many of the homes that already have been passed with FTTB/H internet access have a FTTB/H internet subscription.

¹³ EU39 = EU28 (excl. Cyprus) + 4 CIS countries + Andorra, Iceland, Israel, Macedonia, Norway, Serbia, Switzerland, Turkey

¹⁴ Idate (2018)

Figure 2-13 FTTB/H take-up in the EU in 2014 and 2017



Source: WIK Consult; Based on: EU-Broadband Indicators; EU, Broadband coverage in EU

A ranking with numbers as of September 2018 (no figure included here) shows that three countries (worldwide) achieved already a penetration rate¹⁵ of FTTB/H of 80 % (or more): United Arab Emirates, Qatar and Singapore (Sep 2018).¹⁶ The fibre (FTTH/B) penetration in France was 19,4 % and in European average 13,9 % in Sep 2018. Compared to Spain (44 %) and Portugal (37 %) the level of penetration is thus relatively low in France (see section 3.3.3).

In France, there is a significant difference between the penetration and the take-up concerning FTTH. Effectively, currently 7,1 mln. (Q4 2019)¹⁷ users subscribe to fibre while 18,4 mln. (Q4 2019)¹⁸ could do so. This in other words means that even where fibre is available the majority of users still satisfies their communications demand by using Orange's copper network and not the fibre networks. The relationship between

¹⁵ Number of subscriptions on the total amount of homes in a country.

¹⁶ Idate (2018)

¹⁷ Arcep (2020c)

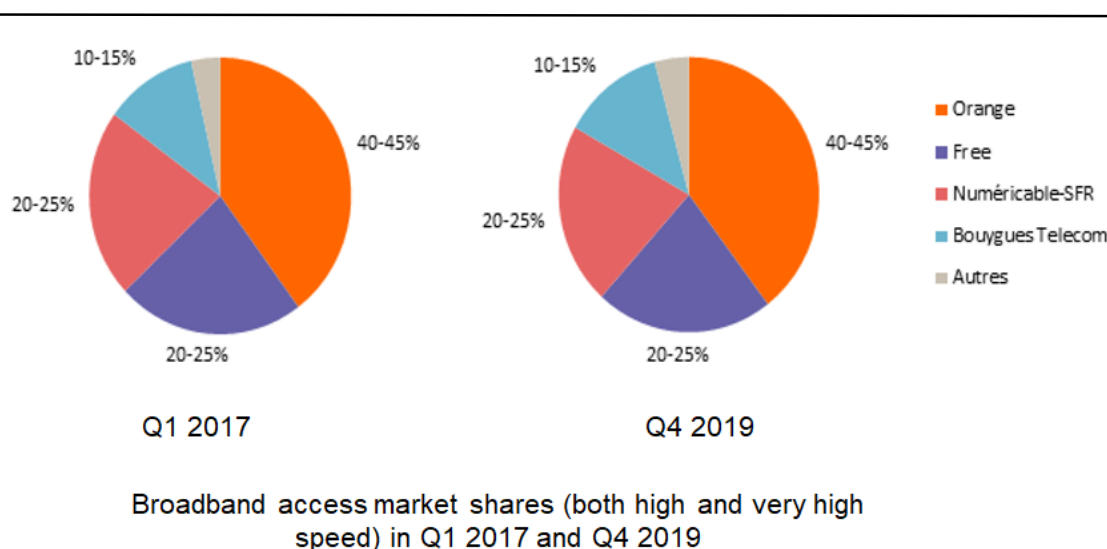
¹⁸ Arcep (2020d)

supply and demand for fibre in France can be characterized as a demand gap (further issues concerning the demand gap see section 3.3.3).

2.4 Market structure – broadband access market

As Figure 2-14 shows four major operators dominate the French broadband market for high and very high speed internet. The market structure has rarely changed between 2017 and 2019. For both years Orange dominated the market with a market share between 40-45 % followed by Free and Numéricable-SFR, each possessing a market share between 20-25% and Bouygues Telecom with a market share of around 10-15%, and finally small operators make up for 4% of the market.

Figure 2-14 Broadband access market shares (high and very high speed) in Q1 2017 and Q4 2019



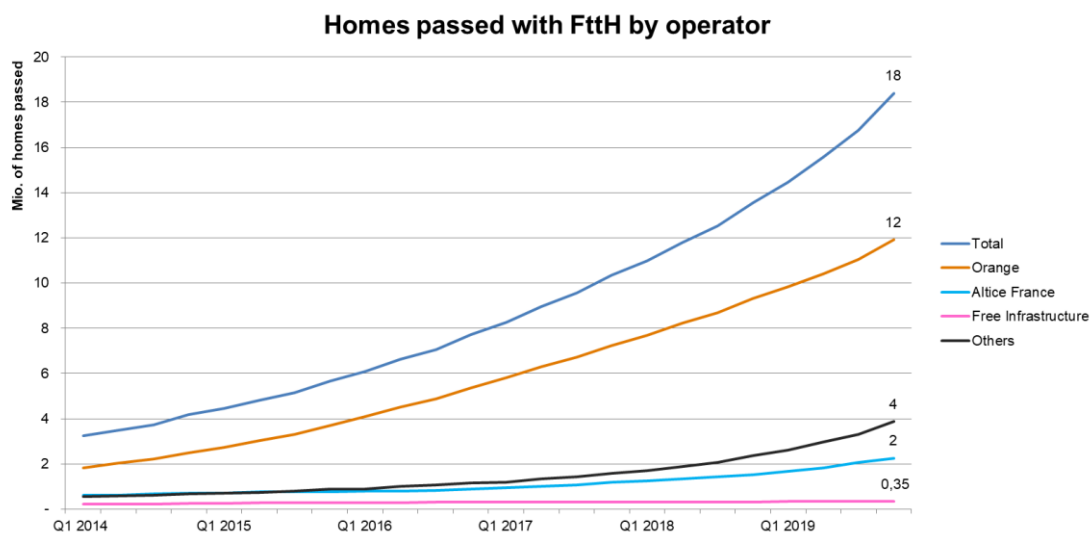
Source: Gabla (2019) supplemented by WIK

In Q3 and Q4 2019 Orange had a market share of 40%, Free 22%, SFR 21%, Bouygues Telecom 13% and other operators of 4%.

Market structure for FTTH internet access

As observable in Figure 2-15 Orange is clearly ahead concerning the amount of homes passed. In Q4 2019 from a total of 18 Mln. homes passed by FTTH in France Orange owns 12 mln. (66 %) access lines, Altice France 2 mln. (11 %), Free Infrastructure 0,35 mln. (2 %) and other operators 4 mln. (22 %).

Figure 2-15 Homes passed with FTTH by operator in France



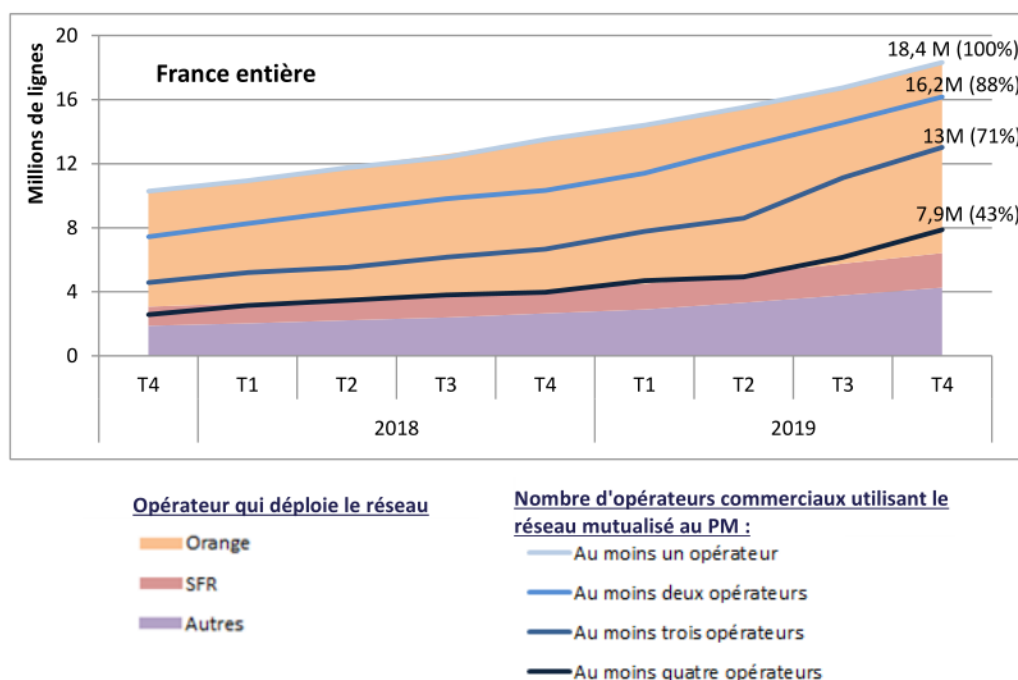
Source: Arcep (2020d)

As Figure 2-16 shows infrastructure competition and the mutualisation regime have provided a choice to customers in a major part of the fibre deployment areas. Only 12% of all households with access to FTTH could choose one single operator in Q4 2019. In 2015 that had still been nearly 40%.¹⁹ In Q4 2019 71% of all households already have access to three and 43% to even four operators. As of Q4 2019 88% of households served with FTTH had a choice between two or more suppliers under the passive access mutualisation regime. This share has relatively steadily increased over time indicating that infrastructure competition has expanded over time under the mutualisation regime.²⁰ While SFR and other operators cover about 6,2 mln. of homes, Orange is covering about 12.2 mln. homes in Q4 2019.

¹⁹ Arcep (2016a)

²⁰ Arcep (2019d)

Figure 2-16 Deployment and mutualisation of FTTH network



Source: Arcep (2020e), p. 6

Figure 2-17 informs on infrastructure competition and mutualisation in the three different types of areas (dense areas, less dense areas on private initiative and less dense areas on public initiative (PIN)). The market structure is different according to the area type:

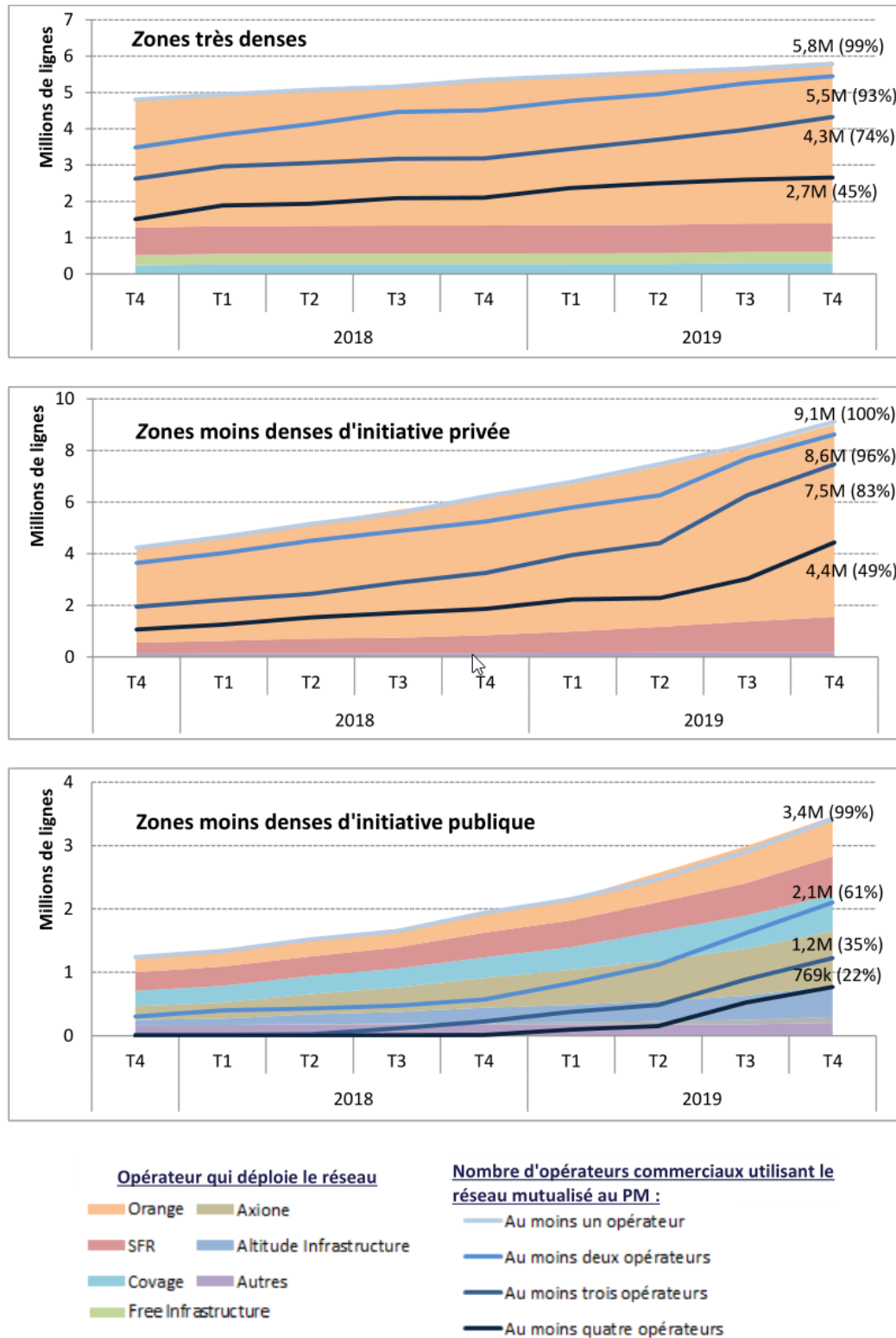
- In the very dense areas 45 % of homes have access to 4 operators. Only 7 % have access to just one operator.
- In the less dense areas on private initiative even 49 % of homes have access to 4 operators with a sharp increase over the year 2019. Only 4 % have access to just one operator.

As expected these relationships look quite different in the public initiative less dense areas.

- Here 22 % of households have access to 4 operators – which is surprisingly high, given the cost structure in these low density areas which was the basis for defining PIN areas in 2009²¹. 35 % of households have access to even three operators – which also is a surprising fact. 61 % of households have access to just one operator.

²¹ See Arcep (2009) and Arcep (2013)

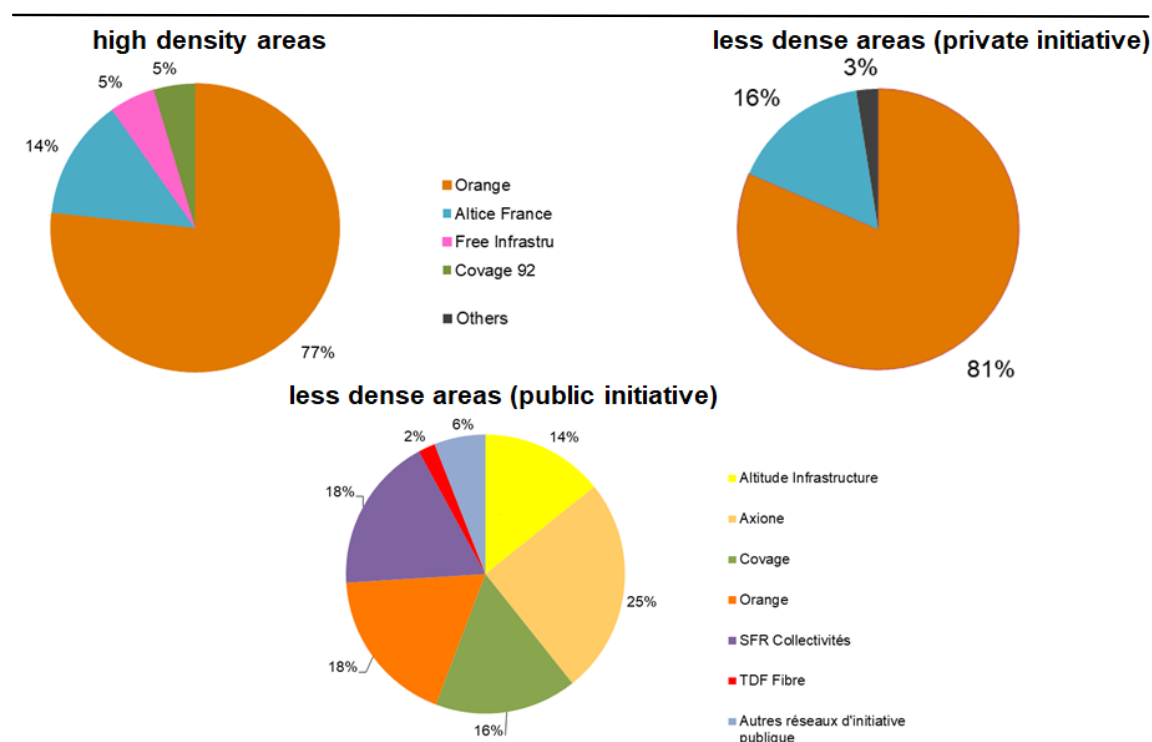
Figure 2-17 Deployment and mutualisation of FTTH network in the three different types of areas



Concerning the presence of the four big operators in France in the different areas there is no major difference between the distribution of market shares (Q4 2019) in high density areas and less dense areas on public initiative. Orange dominates in both areas with a market share of 77 % (high density areas) respectively 81 % (in PIN) followed by Altice France with a market share of 14 % respectively 16 % (in PIN). In high density areas 10 % of the market is captured to same portions by Covage 92 and Free Infrastructure whereas in less dense areas on private initiative “others” make up for only 3 % of all lines.

In less dense areas on public initiative (PIN areas) there is no domination by one market player. With 25 % Axione is leading the market followed by Orange and SFR Collectivités with a market share of 18 % each as well as Covage (16 %) and Altitude Infrastructure (14 %). “Others” includes alternative infrastructure operators led by local authorities.

Figure 2-18 FTTH lines by operator by type of area in France Q4 2019



Source: Arcep (2020d)

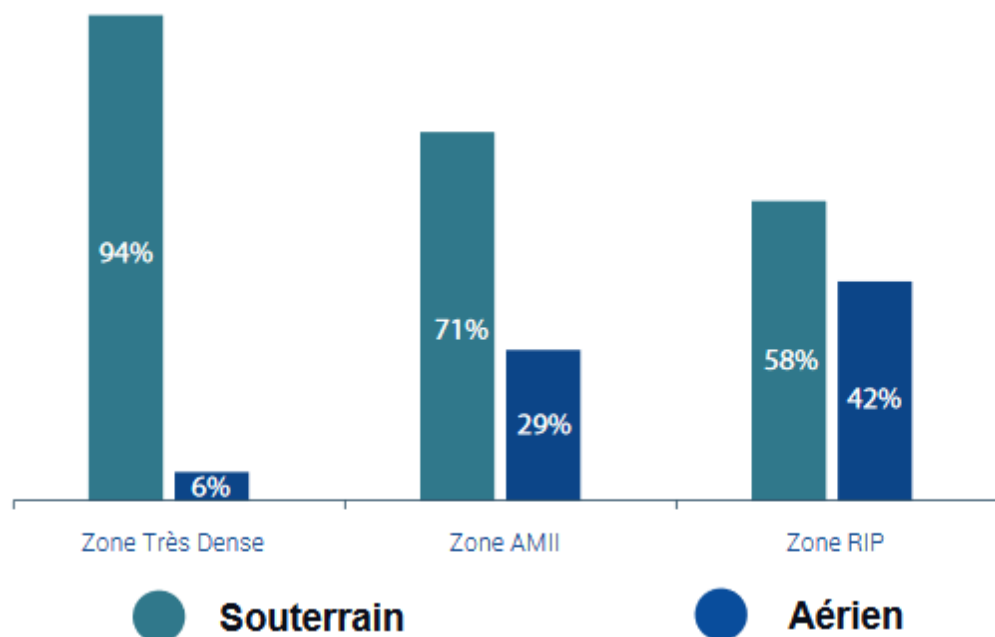
Type of installation in the different areas

In very dense areas 94 % of lines are deployed underground (souterrain) in trenches, ducts and sewers and only 6 % are aerial deployed (on poles). In the less dense areas on private initiative (zone AMII) 72 % of lines are installed underground and 29 % are

aerial deployed. In the areas on public initiative (zone RIP) 58 % of lines are installed underground and 42 % are aerial deployed.

Overall areas combined 90% of local loop lines are deployed with ducts²² and 10 % are directly buried cables.

Figure 2-19 Distribution of deployment type by area



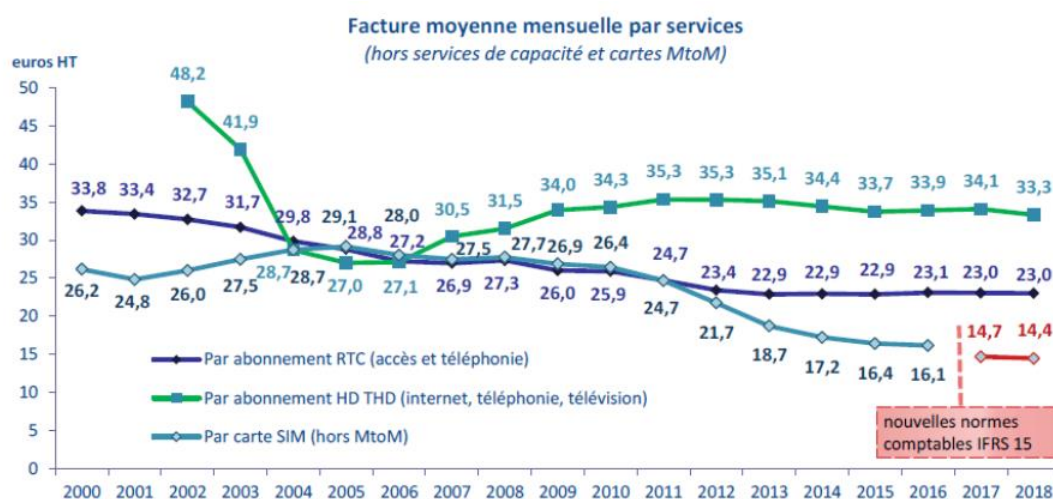
Source: Infranum (2019), slide 5

²² Arcep (2005)

2.5 ARPU and investment

Figure 2-20 shows the average monthly invoice (without tax) in Euros for different services, namely for a subscription based on PSTN (in French RTC, access and voice), a subscription for high speed or very high speed internet (plus voice and television) and for each SIM card (without M2M). Regarding the last seven years (2011 - 2018) average monthly invoice volume stayed relatively stable or has even fallen in the case of SIM cards. In 2018 for example the average monthly invoice was amounting to 33,30 Euros.

Figure 2-20 Average monthly invoice by service



Source: Arcep (2019h)

At the same time, as Figure 2-21 shows, operators' investments in electronic communication services increased continuously from 2015 on reaching close to 10 bln. Euros in 2018. In 2018 the growth was mainly driven by the deployment of very high speed fibre internet access lines (mostly P2P). Concerning investments in the RAN (named "boucle locale THD mobiles" in Figure 2-21) the amount of investments decreased from 2017 to 2018 (-0,1 bln. Euros) for the first time in more than ten years. With respect to the 5G rollout new investments in the RAN will take place and will thus change the latest downward trend of investments in the RAN.

Figure 2-21 Operators' investments in electronic communication services (without purchase of frequencies)



Source: Arcep (2019c)

Increasing investments at the one hand and constant income (ARPU) on the other hand are a challenge for the operators.

2.6 Intermediate conclusion

As sections 2.1 to 2.5 show the FTTH network roll out in France is gaining momentum with a network coverage rate of nearly 50 %.²³ Almost all homes in France are covered by an investment plan for or a commitment for the deployment of FTTH. Moreover, infrastructure competition and the mutualisation regime have provided a choice to customers in a major part of the fibre deployment areas. The network roll out progresses successfully.

However, France is facing a demand gap concerning FTTH with a take-up rate of only 38,6 %²⁴ which needs to be solved (see also section 3.3.3). Moreover, increasing investments at the one hand and constant income (ARPU) on the other hand remain a challenging situation for the operators.

²³ As of Q4 2019 Arcep (2020d)

²⁴ As of Q4 2019 Arcep (2020c)

3 Copper switch-off

3.1 Two forms of switch-off

Exchanging the old technologies for telephony has two elements: Exchanging the PSTN/ISDN switches and the copper wire pair access network and its signalling methods. Both are partially independent from each other, but interrelated. The Switch exchange is called PSTN switch-off, the copper access line exchange is called copper network switch-off. Both are motivated by supporting the increased bandwidth demand for end customers.

Replacing the copper lines by fibre links requires the PSTN signalling over the access lines being replaced by voice over IP (VoIP) communication. Converting this VoIP signalling into the PSTN signalling at the edge of the switching network (in the local exchange locations) is expensive and reduces transmission quality, hence this migration step from copper to fibre only makes sense when the switching network is already migrated to an All-IP network, also called Next Generation Network (NGN). Thus the PSTN migration is a precondition for migrating the access network towards a full fibre based network and for switching off the copper access lines.

3.1.1 PSTN switch-off

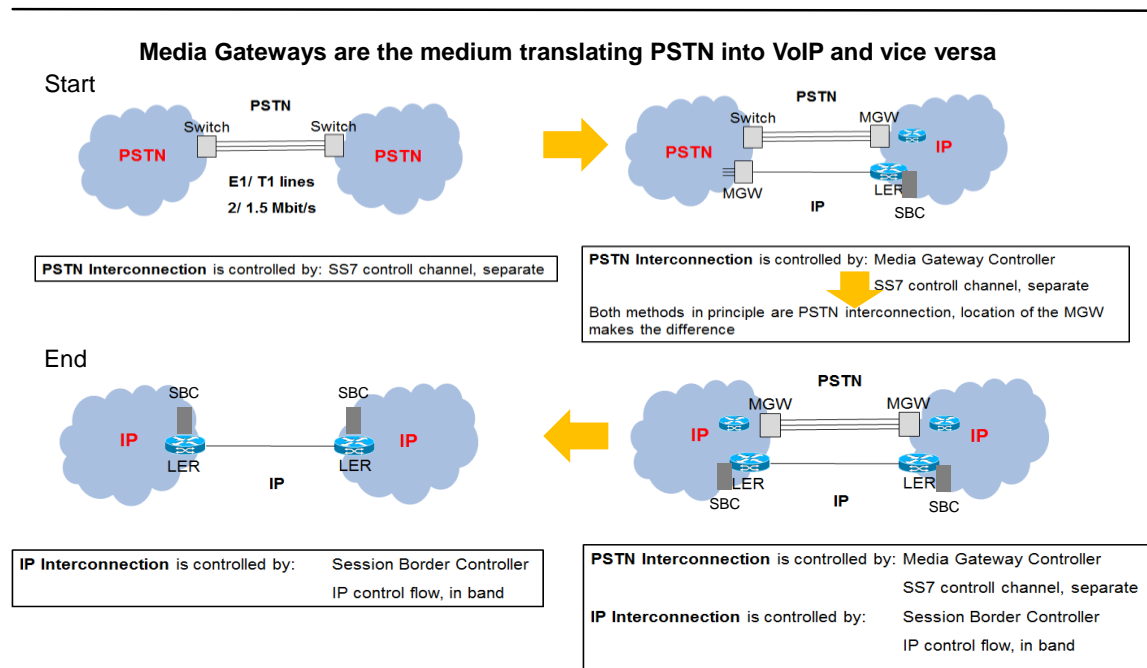
The PSTN-switch-off is motivated by two main reasons, first by the integration of all communication objects (voice, data, video/TV) into one switching and transmission network of high speed and capacity – the All-IP or Next Generation Network (NGN) - and second, by the need to exchange the PSTN switches because they are at their end of life and will no longer be supported by the suppliers. These reasons are interrelated. The PSTN switches and the technology are no longer supported because they could not provide the new services' demand. Integrating all communication objects into one single network platform based on packet switching increases flexibility in capacity use, service innovation and operation and by this decreases investment and operational costs. Thus there was no need to further develop and support the outdated voice dedicated circuit switching PSTN world. The NGN is the well accepted Modern Equivalent Asset (MEA) within the European Union for now more than 10 years.²⁵

Since the networks of the different operators are interconnected and each of the operators will migrate to VoIP at its own speed the interconnection technology had been made flexible by using Media Gateways (MGW) and their controllers technology. While interconnection today typically is based on IP interconnection there still remains the option of running a PSTN based fixed or GSM based mobile network. The protocol transformation between PSTN and VoIP can be performed by the MGW. The

²⁵ European Commission (2009)

interconnection in France today is regulated based on a VoIP interconnection as demonstrated in the end state of Figure 3-1.

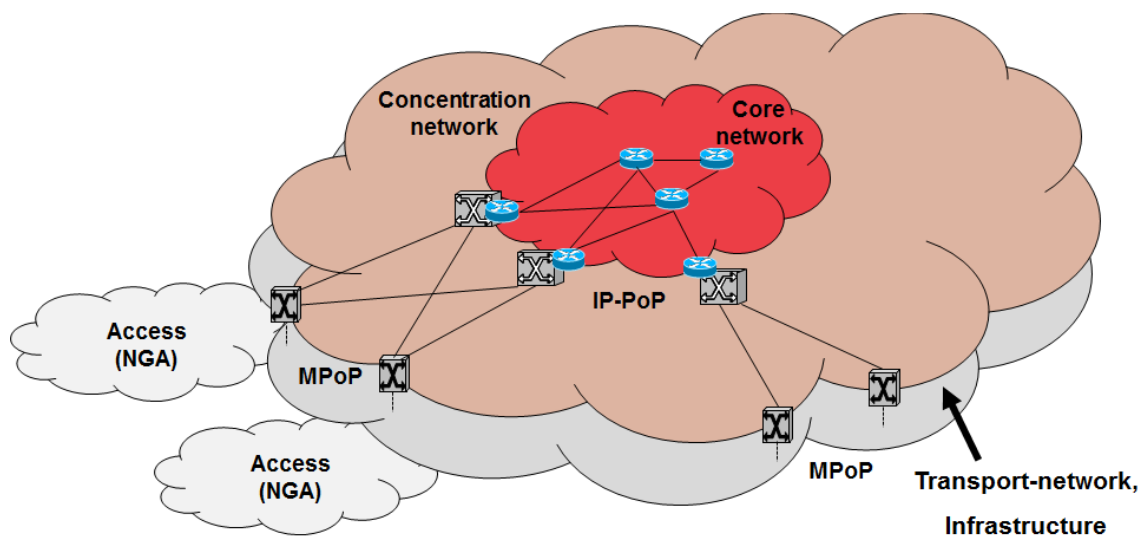
Figure 3-1 PSTN to VoIP interconnection migration



Source: WIK, LER: Label Edge Router, SBC: Session Border Controller

The migration of the switching network (PSTN) starts in the core network by providing NGN network nodes in parallel to the core PSTN network switches and then shifting traffic from PSTN to NGN. In a second step a second lower hierarchy PSTN switch level in the concentration network segment may follow, before region per region of the PSTN access switches at the edge of the concentration network are migrated.

Figure 3-2 NGN network Structure in core, concentration and access segments

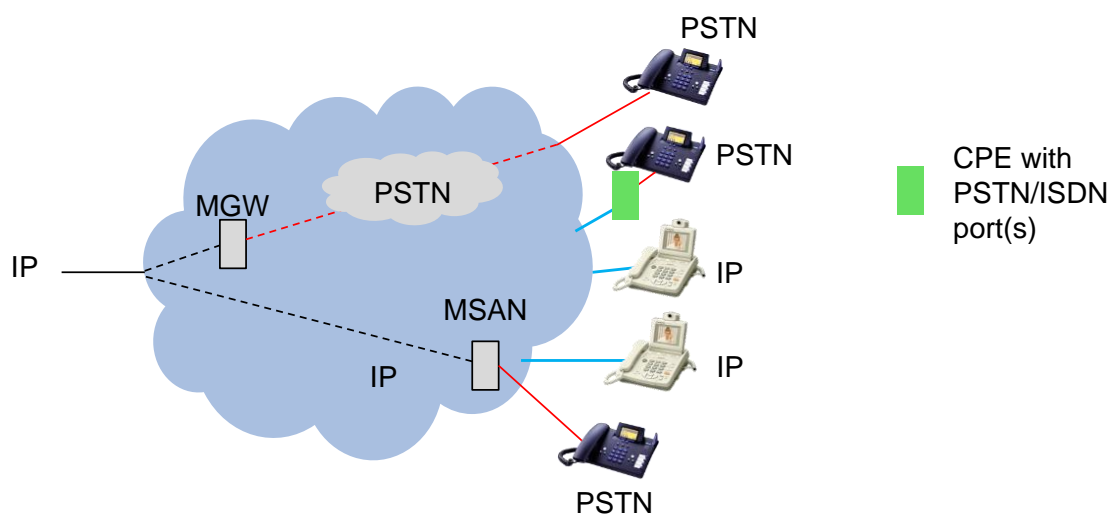


Source: WIK, MPoP: Metropolitan Point of Presence (Local Exchange)

As soon as the concentration network is capable aggregating higher bandwidth traffic from the access network the access lines may be upgraded to higher speeds and the end customers can be shifted to VoIP. This migration does not require the full exchange of the copper access by fibre, if the combined copper/fibre access like chosen in FttC or FttS provides sufficient bandwidth.²⁶

²⁶ This typically is given, if the copper subloop is not too long (< 1 km)

Figure 3-3 Coexistence of VoIP and PSTN end customers



Source: WIK, MSAN: Multi-Service Access Node, CPE: Customer Premise Equipment, blue links: fibre, red links: copper

During the migration process there may coexist both technologies, PSTN and VoIP on the switch level and among the access lines. A PSTN telephone may be connected by a copper access line to a PSTN switch, if it is a voice only customer. Alternatively it may already be connected to a FtH fibre access link, which is terminated at the end customer location by a CPE providing analogue or ISDN telephony interfaces. The CPE converts the PSTN signalling into VoIP. The CPE in parallel may be used to transmit data over the same fibre link. Another option often chosen in an FttC environment is the MSAN, providing analogue and/or PSTN interfaces in the street cabinet besides IP xDSL ports for data communication and/or fibre based Ethernet interfaces. The copper line in this case can transmit in parallel data signals over the same link terminating in a MSAN DSL port. Voice and data traffic are separated by a splitter. The voice traffic is terminated at the MSAN at a PSTN/ISDN voice port, the data traffic is terminated at a IP/Ethernet data port. The MSAN then converts the PSTN voice into VoIP and vice versa. Towards the core network the MSAN only communicates in the IP protocol, thus all voice is transmitted in VoIP. By this all PSTN switches may be switched-off over time and some (or theoretically even all) end customers still use copper PSTN access.

Thus it may occur that the VoIP migration is performed to 100%, while the copper switch-off still is on a lower level. It may become clear that a copper switch-off, the full migration to a fibre link, requires a VoIP switching platform supplying telephony services, hence the VoIP migration is a prerequisite for the access fibre migration or copper switch-off, at least in those areas where the copper lines shall be switched off.

3.1.2 Practical aspects of PSTN-VoIP customer migration

The PSTN-VoIP customer migration is needed latest when the access network is migrated to an all fibre access network. According to international practice the migration typically can be performed in three levels:²⁷

- **Voluntary (natural) Migration:** Stop PSTN –technology related product offerings by replacing them by new broadband products in all IP-ready areas
- **Active Migration:** The end customers are actively addressed with new broadband products and have the change to change in a voluntary way and at a time agreed upon with the operator
- **Forced Migration:** The existing contracts will be actively terminated or will no longer be continued when they run out of term. Since in France in many cases the contracts do not have a fixed term (i.e. two years) this kind of termination may require additional legal tools.

VoIP is not 100% compatible with PSTN and does not support all features and characteristic which have been developed over time. Typical problems arising may be i.a.:

- D-channel use for POTS (X.35 and other protocols)
- D-channel use for alarm monitoring (burglar, fire, air condition control, ...) and other control applications²⁸
- Charging pulse of POTS gets lost
- Network power for emergency phones (even in case of el. power failure), especially for escalators
- Fax transmission, data transmission, modem connections (compression)
- Voice codex
- Dialling methodology (MTF, impulse)
- Who pays for the new equipment?
- **How to discover all migration relevant special applications?**
 - No (central) documentation
 - Collect experience with a hard switch over of a sample city (France)
 - Working groups of private (in-house) network installation companies, moderated by NRA (Germany)

²⁷ Dornheim (2015)

²⁸ In 3Q2019 Orange still operated 2.2 million PSTN/ISDN business lines (RNIS in France). Since November 2019 no longer can sell new RNIS access lines.

During the transition process and thereafter one might observe a couple of typical problems, which have to be addressed and solved. These will not prevent migration towards the future network platform. Observations i.a. are:

- Voice quality is reduced (especially for cross border calls between different networks and to foreign countries)
 - Different voice codices used, transformation loss, delay and jitter to high
- Network availability decreases, i.e. number of customers affected by a single fault increases (lack of redundancy in the access and aggregation network segments)
- Porting numbers (PSTN -> IP) is additional source of faults
- Provisioning problems
- Customer-CPE poorly prepared, no customer information
- Missing skill while migrating customers and during failure repair („We cannot find your telephone number any more“), no competence in failure fixing
- Poorly skilled field service
- In some cases loss of customer access for months, caused by migration, **no** mobile substitute was made available

From a regulatory point of view some of the so far regulated products are affected:

- WS line rental: not affected, alternative bitstream product
- Carrier selection: may be obliged also, if required
- Universal Service: unaffected
- On net el. power: not really relevant, can be provided by customer power and batteries
- Line sharing: no longer possible in solutions without MSAN PSTN
- Customer protection: actions might be taken (see examples above)

Regulators typically observe a negligible number of end customer complaints during volunteer migrations, but significantly more when migrated in a forced manner. An issue of debate especially in the latter cases is who shall have to pay for the new or additional equipment. The NRA actions observed in Europe are moderation rounds and round tables with the stakeholders, not only between the operators but with interested business and residential customer groups too. Clear market communication rules have to be determined. A successful migration can be also supported by defining measurable and clear KPI (Key Performance Indicators) per end customer combined with appropriate flat compensations if they are not met.

3.1.3 Copper network switch-off

When the PSTN-VoIP migration is completed in an area at least to the extent that the PSTN access switches are replaced or can be replaced during the switch over from a copper access line to a fibre based access port by port respectively end customer access by end customer access the copper switch-off can start in a physical manner.

The substitutes for the copper line have to be developed and agreed before migration. This typically is performed well already during the PSTN-VoIP migration for the retail customers, but also has to be considered for the wholesale access products. These can be physically unbundled duct spaces, fibre links or VULA products instead, accompanied by the Layer 2 and Layer 3 bitstream products.

The copper switch-off then can be performed area by area and customer per customer, as long as the fibre links have been provided in parallel. (A switch-off of the copper line first, followed by replacing it by fibre i.e. in the same duct is a theoretical option, but takes the customers out of service for a longer time than just changing from the copper access link to a parallel provided fibre link, which has already been checked before for proper operation before. The switch over to the fibre access has to be coordinated with each end customer and typically requires on site visits for fibre and CPE installation.

When all customers of a MDF access region are migrated, not only those of the incumbent but also all those having been operated by ANOs using copper ULL/SLU the decommissioning of the MDF and the appropriate cabinets can start. Finally the copper cables can be removed, at least as they are using duct systems or aerial poles. Recycling them can result in a significant kickback of the migration cost, and the ducts may be used as spare or for additional retail or wholesale services.

3.2 Behaviour of an efficient operator

An efficient operator is an operator who has efficiency as a major goal, using efficient tools, processes, topologies and equipment in order to perform adequate products at high quality for an affordable price, also taking its own profitability into account. Thus such hypothetical efficient operator is the operator equivalent a regulatory authority is comparing the real operators with.

One can assume that an efficient operator would not run two fixed access networks in parallel, at least not beyond a reasonable migration period. That would lead to a duplication of cost, i.e. for operation, documentation, maintenance, repair, skill, spare parts, additional complexity (two instead of only one infrastructure) etc. So a cable which is only used by few customers still required maintenance as a whole cable, and dedicated skill for repair and operation incl. documentation. Thus an efficient operator will gradually migrate the whole access network, region by region, retail and wholesale

end customers together, probably starting in the most profitable areas first. The gradual approach would work area by area in a complete manner whenever an area is completely ready for service. The efficient operator would not leave a long period between finally deploying its fibre network and switching off the copper network.²⁹ An efficient operator makes best use of its existing duct and pole infrastructures by releasing and dismantling the copper cables as soon as possible (new free duct and pole space/ capacity for upgrade and repair).³⁰

3.3 Overall economic balance of copper switch-off

The PSTN and copper network switch-off cause relevant costs:

- System and service development cost, parallel deployment of fibre
- Operational cost to manage the switch-over
- Information and handling cost with customers
- Direct or indirect payments to incentivize customers to migrate
- De-commissioning cost of cables, MDF, street cabinets

On the other side one can expect a copper metal sales income from recycling the old copper cables. Estimations for France (based on a valuation of the copper network in UK) state that the resale of copper from Oranges' local loops would bring in more than 700 mln. Euro.³¹ Reusable duct space in addition can generate additional values.

3.3.1 Benefits and rationales for network operators

The copper switch-off brings a range of different benefits for network operators. They vary for individual cases (depending on the operator, country etc.) but from different examples some general conclusions can be drawn:

Saving the (inefficient) operational cost of a second and parallel access network

The OPEX for maintaining the copper network shouldn't be neglected. Some components of the OPEX do vary depending directly on the number of customers while others do not necessarily decrease proportionally to the decreased number of customers. Still being variable costs these cost tend to a fixed cost character. The so called repair maintenance cost, e.g. for a loose connection, decrease with the decreasing number of customers showing a truly variable cost character. The OPEX independent of an active line can be costly because they do not depend on the number

²⁹ Unless it is overcompensated for still operating copper

³⁰ E.g., the small Channel Island of Jersey has completed a full copper and PSTN switch-off between 2012 and 2019 (see section 3.5.5).

³¹ Iliad (2020), p. 14

of customers still using this line or part of the network, e.g. changing a cable. Both maintenance cost components typically increase over time in line with the cable's age.

Maintaining Orange's copper network costs about 500 Mln. Euros per year. This number is relatively stable over the years with a slight increase in absolute terms. On the contrary the cost per line increase about 10% per year shedding a different light on the stable amount of maintenance cost.³²

Benefits related to technical aspects of fibre networks

The US operator Verizon has noted that overall, operating a fibre network is 60 % cheaper compared to operating a copper network due to savings in required buildings (60-80 %), energy (40-60 %) and maintenance (40-60 %)^{33,34} Moreover, fibre has proven to be 70 % to 90 % more reliable than copper depending on the typology.³⁵

The use of fibre networks as opposed to copper networks results in a more efficient use of ducts and poles by thinner and lighter fibre cables. A fibre PoP covers the equivalent of 3 copper switches concerning the number of accesses.³⁶ At the same time access technology equipment for fibre occupies (only) 15 % of the space occupied by copper access equipment.³⁷ Thereby sought-after space especially in urban areas previously occupied by copper becomes available and could be offered for sale. In addition, operators can generate additional income by selling the copper itself.

Rationales and motivations for network operators

A higher fibre take-up caused by a copper switch-off increases the profitability of fibre investments and strengthens the business case for fibre. This is of great importance since deploying fibre is associated with high sunk costs which occur upfront due to civil works and the purchase of passive and active equipment. An increasing take-up rate is thus crucial for supporting a positive business case.

Generally internet access based on FTTH leads to higher customer satisfaction (due to lower fault rates etc., see above) and therefore to lower churn.

For example, bottom-up cost models prepared by WIK³⁸ indicate that a penetration rate of 40% or more may be required to support a positive business case, even in cities, and this penetration rate has to increase in less dense areas – implying that fibre in these areas may have the characteristic of a natural monopoly.

³² Dumoulin (2019)

³³ due to 60% fewer costly truckrolls and savings of 40-60% on maintenance

³⁴ Chirgwin (2015)

³⁵ Thomas (2015)

³⁶ Source Iliad

³⁷ Telefónica (2018)

³⁸ Elixmann et al. (2008); Jay & Plückebaum (2011); Braun et al. (2019)

3.3.2 Benefits for customers

Although interest and willingness to pay for fibre-based services varies in different countries, from a technical point of view customers benefit from a better service reliability, a wider range of services, higher bandwidth and from symmetric products.

Information on the customer's personal view on benefits of FTTH is provided by a representative survey of consumers in the fibre-rich Swedish market conducted by WIK in 2017. The survey confirmed that the technical advantages lead to a higher customer satisfaction: 82 % of FTTH customers stated that they are happy with their service compared to 50% of DSL customers. Furthermore, 87 % of the FTTH users highlighted the high bandwidth itself as a benefit of FTTH based services. Further advantages of FTTH named were the wider range of services and value for money.³⁹

3.3.3 Facing a demand gap

As shown in section 2.3 the relationship between supply and demand for fibre in France can be characterized as a demand gap. A gap between demand and supply of fibre is not in line with the targets of the French fibre infrastructure policy and it is not in line with the economically efficient outcome. The full benefits of fibre only emerge if the whole potential demand for communications is in line with the actual deployment. There are supply side as well as demand side reasons why successful fibre policy requires that all customers migrate from the traditional legacy copper network to the new established fibre network (see sections 3.3.1 and 3.3.2).

Solving the demand gap is a strategic challenge for policy and regulation as it is for operators. It is the end user who has to be migrated from the copper to the fibre network by demand side, supply side and regulatory means. Operators currently already incentivise end users to migrate (e.g. no migration fees, fibre proposed as soon as possible, same price for fibre for first year or longer) with a certain success as reflected in the actual take-up rate. These incentive policies and their results indicate that there is a variety of impediments for customers to migrate. Because the incentive policies are mainly related to service pricing this indicates that demand side pricing measures have their limitations to foster migration (see section 5.7). Supply side measures to foster migration like degradation of Quality of Service for copper services and switching off the copper network are not defined yet and are not yet used by operators.

In the scope of another project WIK⁴⁰ conducted interviews concerning copper switch-off. Some network operators stated not yet seeing any need for a migration to FTTH since transit technologies, e.g. vectoring, would be sufficient in order to meet customers' needs. Operators from countries with a high network coverage of FTTB/H

³⁹ Arnold et al. (2018)

⁴⁰ Tenbrock, Knips, & Wernick (2020), p. 20

were of a different opinion. Countries identified which are also facing a demand gap are for example Denmark⁴¹, Austria⁴², the Czech Republic and Greece⁴³. In Austria as well as in the Czech Republic the NRA sees the lack of end-customer demand for FTTB/H as the main obstacle to copper switch-off. On behalf of the Austrian incumbent A1 a study has been conducted investigating the demand deficit.⁴⁴ In some areas of Austria and Germany fibre roll-out only starts if there is an upfront commitment of subscriptions of 40% of the homes passed. In the Czech Republic the NRA sees the stimulation of demand as a potential vehicle in order to promote the copper switch-off. In Greece a voucher program shall boost demand. In contrast, in Latvia the NRA does not expect any problems concerning the take-up of FTTH given the presence of infrastructure competition.⁴⁵ Luxembourg expects lacking demand to be a medium-size problem which could be handled by making selected services (e.g. IPTV) available on FTTB/H accesses only.⁴⁶ The NRA of Slovenia emphasis on the importance of incentivising demand for fibre products. which could for example be achieved via information events.⁴⁷

3.3.4 Net balance

The operator behaviour of countries with advanced fibre deployment indicates that the balance is positive. This has been confirmed in many interviews.⁴⁸

3.4 Status of copper switch-off in France

In 2013 the French government initiated its' "Plan Très Haut Débit" which names three milestones:

1. Guarantee 100% coverage with high speed internet (> 8 mbps) by 2020.
2. Establish a nationwide coverage with very high speed internet (> 30 mbps) by 2022 thereof 80 % via fibre.
3. Achieve 100 % FTTH coverage in 2025.⁴⁹

⁴¹ Ibid, p. 25 seqq.

⁴² Ibid, p. 35

⁴³ Ibid, p. 29

⁴⁴ Österreichisches Institut für Wirtschaftsforschung (2018)

⁴⁵ Ibid, p. 33

⁴⁶ Ibid, p. 34

⁴⁷ Ibid, p. 42

⁴⁸ Godlovitch et al. (2019)

⁴⁹ République Française (2020a), République Française (2020b)

PSTN switch-off

Orange has started with the technical PSTN switch-off but is facing delays according to the original planning.⁵⁰ The switch-off is divided in two stages: firstly no new lines based on PSTN are sold⁵¹ and in the second stage existing lines will be technically closed. This is shown in Figure 3-4 on the upper level; under “Arrêt de production” (stop of marketing) one can see the planned timeline for the stop of opening new lines and in the lower part of the figure the planned timeline for the technical closure is stated. They stop to market analogue lines by the 15th of November 2018 in mainland France. Marketing of ISDN lines was stopped exactly one year later in mainland France. For the overseas departments the marketing stop of analogue lines is scheduled for November 2020 and for ISDN lines in November 2021.

5 years after the stop of commercialisation of analogue and ISDN lines the technical closure starts following a continuously updated plan⁵² which shows the cluster listed by department and their exact closing date. The technical closing is stated with a starting date but has no definite end date. Starting in October 2023 Orange indicates to close around 150.000 access lines per year in the first years.⁵³

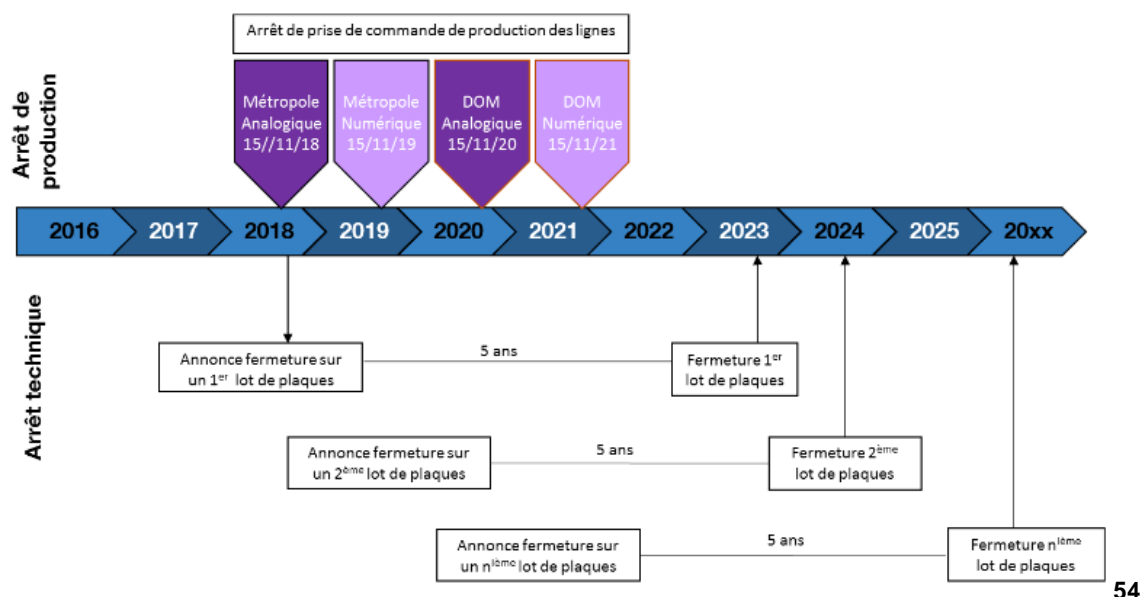
⁵⁰ The relatively long notice period for a switch-off of five years could be one reason.

⁵¹ Orange (2019)

⁵² See <https://reseaux.orange.fr/projets/modernisation-telephonie-fixe> and <https://www.fftelecoms.org/nos-travaux-et-champs-dactions/reseaux/plaquette-se-preparer-arret-rtc-vers-tout-ip-4eme-edition-octobre-2019/>, accessed March 30th 2020

⁵³ Orange (2019), p. 4

Figure 3-4 Orange's timetable for closing of the PSTN network



54

Source: Orange (2019)

Figure 3-5 shows the municipalities which Orange will fully transfer to VoIP classified by migration date. Prior to the first announced PSTN closures in November 2023, in October 2023 several geographic areas will be completely switched to the IP technology. Those will be the first areas where all PSTN fixed telephone lines are switched to IP technology and thus are prepared for a copper switch off in a consecutive step. The portion of customers concerned in 2023 represents 3% of the lines in the PSTN.⁵⁵ Another 3% will be closed in October 2024.

Even though Orange did not close down whole connection areas Orange did already start with PSTN switch-off as well as the migration of customers to VoIP. The PSTN technology is on the decline. The number of subscribers decreased by around 10 % per year in the last years. By December 2019 approximately 75 % of telephone subscriptions for French households and businesses use voice over IP technology.⁵⁶

In December 2010 Orange's technical director stated that already for several years large copper cables have been removed, already representing nearly 80.000 tons of this metal.⁵⁷

⁵⁴ „Plaque“ means a cluster of municipalities.

⁵⁵ Orange (2019), p. 3 seq.

⁵⁶ Arcep (2019e)

⁵⁷ Subtil (2019)

Table 3-1 demonstrates that Orange has already in 2018 provided 73 % of its' voice lines over VoIP. By 2023 more than 97 % of voice lines will be provided by VoIP.

Table 3-1 Status of incumbent's voice lines provided through VoIP in different European countries

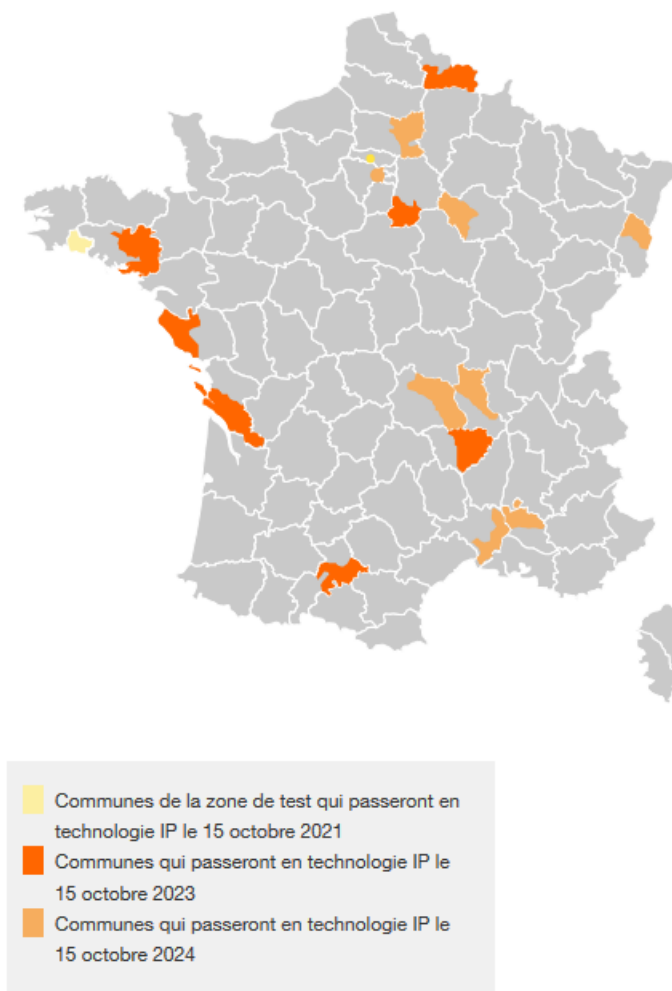
		% incumbent voice lines provided through VoIP													
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Estonia							100%								
Germany						50%		100%							
Netherlands	2006					85%		100%							
Portugal								44%		100%					
Spain	2009					20%		75%							
France								73%				>97%			
Poland								27%						100%	
UK								0%						100%	
Sweden								50%							
Italy								21%							

Source: Godlovitch (2019), slide 8

Concerning the question how many people are by the closure of the PSTN Arcep states that the number of subscribers to this network has been decreasing by around 10 % per year for several years. The closure of the first cluster in 2023 will concern a territory affecting only less than 1 % of the total telephone subscriptions.⁵⁸ This is roughly in line with interviews conducted in another WIK study and the numbers from the table above (see Godlovitch et al., 2019).

⁵⁸ Arcep (2019g), <https://www.arcep.fr/demarches-et-services/utilisateurs/consommateurs-arret-rtc.html>

Figure 3-5 Orange's plan to fully replace PSTN by VoIP in different municipalities with starting date



Source: Orange (2020)

Copper switch-off

In December 2019 Orange's CEO Stéphane Richard announced that the copper switch-off shall start in 2023 and be completed by 2030.⁵⁹ The final step of migration from copper to fibre is the switch-off of the copper access network and the de-commissioning of MDFs and street cabinets. In France no copper network switch-off started yet.

There is an on-going policy debate on copper switch-off in France since 2012 without relevant outcomes so far.

⁵⁹ Dumoulin (2019)

In 2014, encouraged by French Government and Arcep, Orange already performed a pilot trial to copper network switch-off in the municipality of Palaiseau in the Hauts-de-Seine area including 16.000 homes (thereof 4.500 one family houses) and 1.000 enterprises. Orange cooperated with the municipality to inform inhabitants and businesses about the project by organising information meetings and supplying information through municipal publications.

The trial has delivered several encouraging outcomes. For instance, the plan was well accepted by the users concerned and Orange had already migrated more than 90% of its residential retail subscriber base to fibre in early 2015. Furthermore, the switch from ADSL to fibre led to a significant increase not only in down- and up-stream traffic but also in the take-up of services such as pay-TV and catch-up TV.

However, the project has also faced a number of obstacles. For instance, the negotiations with alternative operators about closing down MDFs where the latter have installed their equipment ahead of schedule were unsuccessful and Orange was obliged to maintain these until 2018.

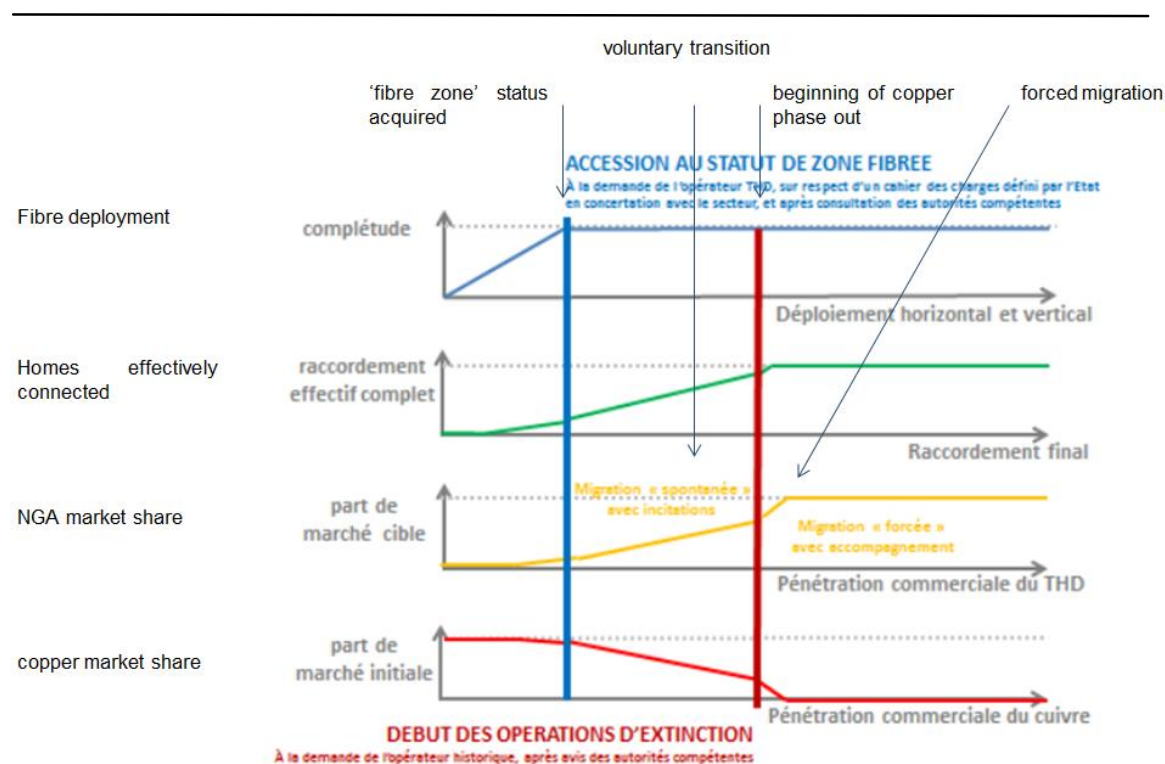
From the formal regulatory conditions, Orange is required not to de-commission its MDFs and street cabinets until a shared fibre network has been deployed in the respective area and allows the provision of services to all end-users which could be served through the copper network. Unless an agreement is closed between Orange and the access seekers on an appropriate migration plan and path, closure of MDFs or street cabinets will be subject to a prior notification five years in advance. It includes as a prerequisite of copper switch-off that there have to be at least two fibre based operators present operating on a shared fibre infrastructure – on may be Orange.

It is also not yet clear in the trial when and how the remaining users of legacy services will be migrated to fibre. While the vast majority of users has migrated to fibre already, a low number of subscribers has preferred preserving a traditional access line. Another question that has not been solved is how to handle certain legacy non-voice services, for which no substitutes exists on an NGA network so far. Amongst others, this concerns a number of applications in the energy sector, tele-surveillance and tele-alarm systems, remote control of domestic appliances or elevator emergency lines . The fact that these issues have not been tackled for the moment is partly related to the limited scale of the project. Businesses have shown only limited interest in getting involved in the process and have been reluctant to invest in developing new solutions, as long as the issue is limited to a small geographic area.⁶⁰

⁶⁰ Neumann et al. (2016), p. 57

To further investigate the question of how to implement the transition from copper to fibre, the French government requested former Arcep president Paul Champsaur to conduct a study, which was published in February 2015.⁶¹

Figure 3-6 Transition to fibre networks and copper switch-off (recommendation from the 'Champsaur' report)



Source: Mission on the transition to ultrafast broadband and switch-off of the copper network (2014), p.33

The Champsaur report advocates a gradual transition rather than a hard deadline for the switch-off of copper infrastructure, due to the perceived financial and technical challenges associated with a switch-off obligation, including the potential need for compensation. It also suggests that the switch-off of the copper network should be organised by geographic areas, whereby the process begins after a given area has been defined as 'fibre area'. According to the report for being recognised as a fibre area, the network should

- meet the requirements of completeness as defined by French regulation,
- commit to quality of service, notably universal service obligations over fibre,
- provide wholesale access on non-discriminatory terms,

⁶¹ Available at http://www.economie.gouv.fr/files/files/PDF/rapport-final-paul-champsaur_2014.pdf.

- respect requirements in terms of engineering and information systems to ensure inter-operability.

Lastly, the Champsaur report advocates mechanisms to incentivise operators and users to migrate to fibre within fibre zones, noting that increasing wholesale prices for copper could make the infrastructure less attractive to alternative operators and users relative to fibre in circumstances where both infrastructures operate in parallel.

The law for the growth, activity and equal economic opportunities, also called “Macron law”, promulgated in mid-2015, takes up these proposals. Among three measures to accelerate the “Plan France Très Haut Débit” contained in the text is the creation of a “fibre area” status. The attribution of this status to an area is set to trigger measures to facilitate transition from copper to FTTH. This status can be obtained as soon as the establishment and operation of an FTTH network open to all ISPs is sufficiently advanced, at the request of the network operator or the local authority. This status is assigned by the Minister responsible for electronic communications, after consulting Arcep.⁶²

3.5 International developments and best practice

In this chapter international experience from the copper switch-off is being summarised. As the NGA strategies and roll-out plans vary strongly between countries they thus have far differently progressed. Therefore incumbents and NRAs choose different approaches towards the switch-off of the legacy network which is in many cases intended as a partial copper switch-off of the feeder segment in cases where FttC was chosen to be the NGA technology. In all cases the copper switch-off was not initiated by the NRAs or by law but on the incumbents’ initiatives which in some cases are being accompanied by wholesale pricing strategies of the NRAs. The country comparison shows that a complete PSTN switch-off and VoIP migration, like happened in Estonia already by 2017 as well as a far NGA roll-out in combination with a high NGA retail take-up, like observable in the Spanish broadband market, are efficient triggers for a fast copper switch-off.

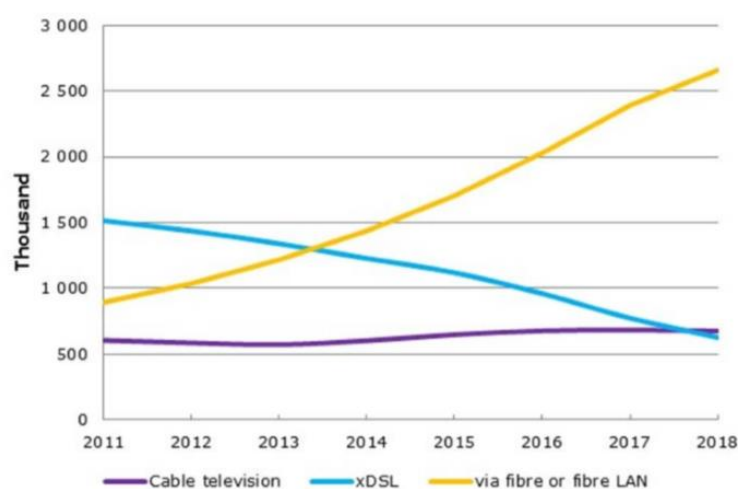
3.5.1 Sweden

Sweden in its copper switch-off process strongly profits from its end customers strong demand for fibre access. The switch-off process by the incumbent’s own initiative had commenced by 2011 and is being observed by the Swedish NRA PTS which keeps publically informing on the dismantling process.

⁶² Neumann et al. (2016)

The following graph shows the fast take up of fibre subscriptions and decline of copper based xDSL services in Sweden since 2011:

Figure 3-7 Number of subscriptions in the Swedish fixed broadband market 2011-2019



Source: BEREC (2019)

Thus far, mostly rural and suburban MDFs have been closed, amounting to ca. 50 % of all Swedish copper MDFs. Closed copper lines are not solely being replaced by fibre but also by FWA solutions, which facilitates the switch-off particular in rural areas.

By the end of 2020, Telia plans to switch-off further 461 MDF locations. When switching off copper at an MDF location, Telia has to inform collocating operators 5 years in advance and end customers 12-16 months ahead. It is subject to current consideration by the Swedish NRA to reduce the notice period from 5 years to 18 months.

There are no obligations implemented in Swedish regulation that would oblige Telia to deploy alternative infrastructure in the case of dismantling its copper network.

3.5.2 Spain

Unlike many other European countries, the VDSL(2) presence in Spain is rather limited, therefore customers have to switch towards FTTH or HFC based products in order to achieve very-high speed connectivity. A high rate of homes passed, ca. 77 % of the total Spanish population have potential access to FTTH infrastructure, facilitates the copper switch-off. The absence of copper based alternatives for fast broadband speeds has led and is continuously leading to a fast progressing migration of end customers from copper to fibre. Particularly in densely populated areas this roll-out is accompanied

by fierce competition on the end customer market, as several operators have deployed FTTH infrastructure. This infrastructure based competition is again an enhancer for copper switch-off, as notice periods for shutting down MDF locations might be kept short, in cases where no competing operator is relying on copper based services, but is already able to serve end customers by its own FTTH network.

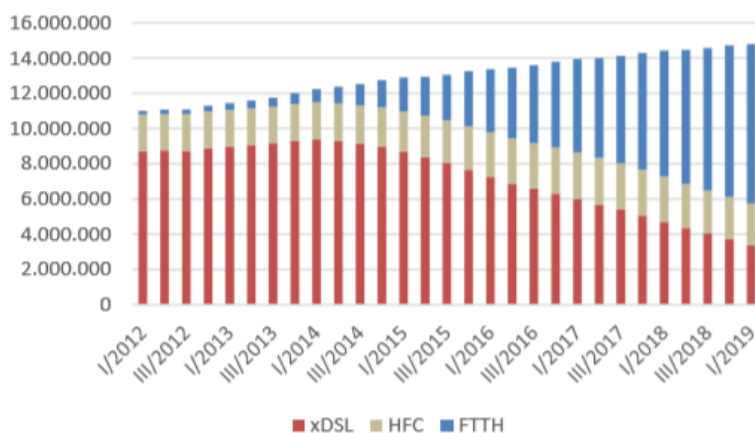
Given the state of deployment of fibre, the copper network in wide parts of the country is not any more competitive in Spain, so the incumbent has a strong interest in switching off the legacy network and closing copper MDFs. The closing process had begun by end of 2015. Following a national decommissioning list copper MDFs are being switched off in accordance with their respective order of priority. By mid-2019, 1614 copper exchanges were notified to be closed (18 % of total). The list is continuously growing and by end of 2019 402 (5 % of total) were effectively shut down. The incumbent's plan foresees a closure of all MDFs by 2025 which is in coherence with its plan of a full fibre coverage before 2025. The notice periods for the closure of MDFs are:

- 5 years for ULL,
- 1 year for bitstream, and
- 6 months in case of no active wholesale subscriber.

After this notice period, no new customers are allowed and existing copper clients have to migrate within a guard period of 6 months. After this period, no customers are allowed to be served by copper for any operator and the dismantling of equipment may begin.

The following figure shows the decline of xDSL provisioning vs a quick take up of FTTH and a quite constant demand of HFC.

Figure 3-8 Broadband Access Evolution in Spain from 2012 - 2019



Source: BEREC (2019)

3.5.3 Estonia

Of all countries investigated and presented, Estonia has made the most progress towards a complete copper switch-off with 100 % of the incumbent's voice subscribers already migrated to VoIP by 2017 and 70 % of all copper exchanges decommissioned at the end of 2018.

The incumbent is migrating customers of switched off PSTN exchanges towards Vectoring (VDSL2) and FttB/H infrastructure with about 2/3 of the current access network being fibre-based and 1/3 copper-based. After the notice of the decommissioning of a copper MDF, the migration of the end customer is not allowed to take place within 6 months after notice. The SMP regulated operator is obliged to provide regulated wholesale services in cases of decommissioned copper access lines including passive services of duct access, unbundled fibre, shared fibre as well as bitstream.

The migration process is being managed by the incumbent with the NRA only stepping in in cases of disputes.

3.5.4 Netherlands

The Netherlands may be seen as pioneers in the field of copper and PSTN switch-off as they had initiated the all-IP programme already in the year 2007. By 2018 85 % of Dutch PSTN customers had been migrated to VoIP with a completion of the migration being achieved by the end of 2019.

Despite the well organised and fast migration of the telephony services, the process of copper switch-off shows a rather slow implementation progress. The Netherlands have yet not introduced a formal programme for the switch-off and thus far it is taking place in 6 defined pilot areas in which the decommissioning was tested in November 2018. Not only the results from these pilot areas have shown that the legacy equipment of the end customers is an obstacle for a faster progress of the switch-off.

In 2018 the NRA had reacted to the slow migration process by setting a 1 year notice period for closing of a copper MDF, which is a rather short term in European comparison.

3.5.5 Jersey

The small Channel Island of Jersey has completed copper and PSTN switch-off on 31st December 2019 by a programme in which, by three steps, all copper premise connections were completely replaced by fibre and the copper network was shut down. The main driver of this programme were the expected benefits of a full fibre accessibility. The implementation of this programme was possible by an easy decision making process as the local Telecommunications company JT is 100 % government owned. Furthermore, the fibre was easily deployed because the legacy network was entirely ducted with sufficient duct capacity.

The three phases of the programme were:

- 1) Start in 2012 to replace all broadband connections with full fibre by Q2 2018
- 2) By Q1 2019 replacement of all non-broadband lines (i.e. voice only lines) with full fibre
- 3) By Q4 2019 services have moved off any remaining copper lines in use to the installed fibre.

By the completion of this programme, Jersey became the first full fibre jurisdiction after all customers were switched from copper to fibre within 12 weeks.

Figure 3-9 Jersey full fibre programme



Source: Daragh McDermott, Jersey Telecom , WIK Conference, October 2019, Brussels

3.5.6 Australia

In Australia the copper switch-off forms part of the state-owned nationwide (quasi-)monopolistic broadband network operator's (NBN: National Broadband Network) policy. The copper switch-off plan has started in 2014 but was intended to switch-off copper from the beginning on. The NBN-Co was founded by the Australian government because the existing Australian incumbent operator Telstra resisted rolling out fibre in line with the political will. Goal was covering 93% of the Australian homes by FTTH, 4% by a terrestrial FWA network and the remaining very remote homes by satellite connections. NBN-Co took over the complete copper access network of Telstra and thus was able to use the existing duct network. With changing governments the strategy has been adapted over time and today NBN-Co is rolling out a broadband network combined of FTTC VDSL2 and FTTH. Because NBN-Co owns all the assets it may decide to roll out fibre and to migrate from copper to fibre by its own, controlled by the governmental will or pressure.

Whenever NBN declares a certain area "ready for service", the incumbent Telstra who is the user of the copper network has to switch-off the respective part of the copper network within 18 months or has to transfer it to NBN, if NBN intends providing FttC service in the respective area.

Within the same period of 18 months Telstra, as well as any other ISP, has to migrate their customers to the new NGA infrastructure deployed and provided by NBN-Co.

3.5.7 Portugal

The Portuguese broadband market, like the Spanish one, shows a broad roll out of existing FTTH infrastructure with ca. 50 % of homes passed, which was not only achieved by the incumbent's but also by other operators' investments. In coherence with this state of FTTH roll-out, the demand for copper based wholesale services has been declining over the past years. Yet, the full copper switch-off has not far progressed and by the end of 2019 only 6 copper MDFs were switched off.

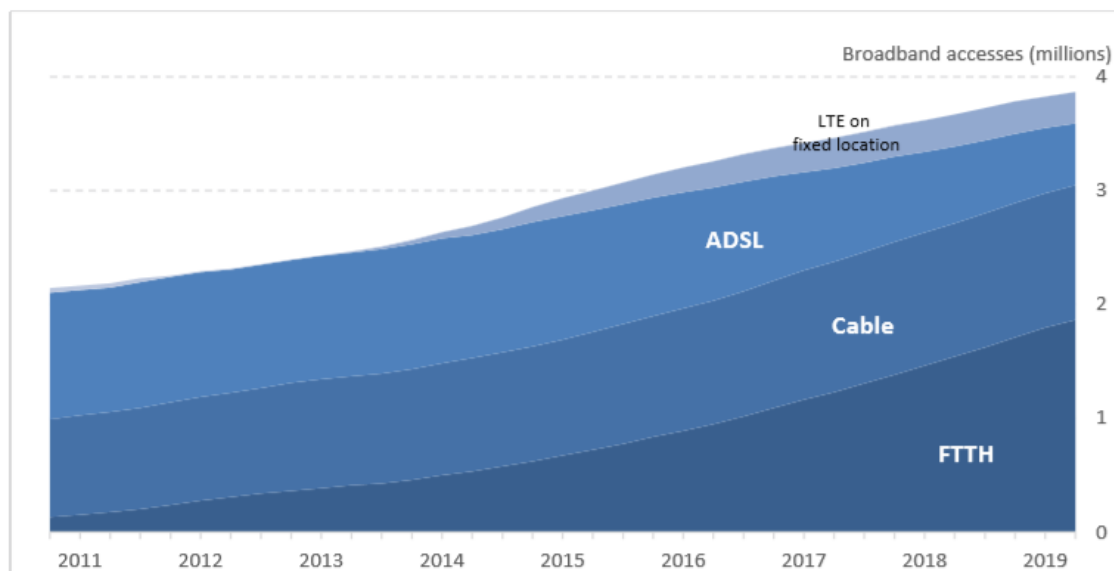
The notice periods for an MDF switch-off are:

- 5-year for total switch-off of a MDF, a local exchange or an access point/connection with co-located operators, and
- 3-year notice period if equivalent wholesale access products are available.

The switch-off process is being managed by the incumbent following the rules for this procedure which were outlined in the NRA's 2017 market analysis of market 3a.

As the illustration shows, the take up of FTTH infrastructure has accelerated over the past years with the consequence of a decline of active ADSL clients. As in Spain, because of the absence of a broad vectoring roll-out, copper based ADSL services are not able to keep competition with the fibre based services. Like in Spain this creates favourable conditions for a copper switch-off, which just has not yet been implemented by the incumbent on a broad basis.

Figure 3-10 Evolution of number of broadband accesses by technology in Portugal from 2011-2019



Source: ANACOM (2019), p.9

3.5.8 Italy

In Italy thus far, no MDFs have been closed. The incumbent is pushing forward the FTTC/Vectoring roll-out with some exceptions of FWA for customers located in “white areas” and has therefore suggested a plan for decommissioning (switching off) the legacy network of Local PSTN Exchanges (LEX). This plan involves three scenarios:

- The first scenario foresees switching off 65 % of LEXs by 2023. The notification period of LEX switch-off is allowed to start if the incumbent (TIM) has achieved a 100 % NGA roll-out by this time and a NGA retail take-up of 60 % in the areas affected. Depending on the level of competition, the notification period for the LEX switch-off may be 12 months (if only bitstream is available), 18 months (if copper LLU, copper SLU and VULA are available) or 24 months (in white areas). After the respective periods the migration itself must take place within 12 months and each individual customer must be informed about the switch-off three months in advance.
- The second scenario involves switching off the primary network with a migration towards FttC.
- The third scenario focuses on the switch-off of the local network with a migration towards FTTH.

The available wholesale services in a decommissioned legacy network in Italy are planned to be mostly VULA, as well as FTTC-based bitstream and SLU while wholesale services of LLU, shared access, WLR, CS/CPS, analogue leased lines and DSL copper bitstream will not be available.⁶³

The Italian NRA incentivises the migration by regulatory price setting, e.g. by setting the prices of the wholesale access product based on NGA infrastructure the same as the copper based access products.

In almost all parts of Italy ENEL Open Fibre is mandated to roll out an FTTH network. This wholesale only network is under construction, but there are not many access lines available yet, except in the area of Milan, where open fibre has taken over the already existing ca. 2.2 mln access line large FTTH network of the former Metro Web. One can expect that the copper fibre migration like in the area of Milan will be driven by demand of bandwidth, richer content and improved quality of service. Regulatory migration approaches do not exist to our knowledge.

3.5.9 Intermediate Conclusion

The international benchmark analysis on copper switch-off of the eight countries selected show that the prerequisites in terms of existing fibre roll-out and notice periods were different and thus the anticipated path of the decommissioning evolution is different. The analysis yet also shows that countries that actively addressed copper switch-off by regulatory means, were able to achieve a faster evolution of the switch-off.

The necessary technological precondition for a copper switch-off is a PSTN migration of customers to VoIP. Favourable prerequisites for a fast copper switch-off are firstly a fibre roll-out with a large footprint, both in terms of geography as well as in terms of population and secondly a copper access line which is limited in broadband, which is particularly the case if ADSL lines have not been upgraded by Vectoring. Thirdly, it is in favour of a migration if the end customers show strong demand for very high broadband.

Spain is an example meeting these preconditions resulting in a fast copper switch-off. VDSL(2) vectoring spread is limited in Spain while various operators have deployed FTTH. Therefore, an end-customer who is in need for higher bandwidth than ADSL can provide has to migrate to either HFC or FTTH, and he can only migrate to FTTH in those areas, where HFC is not available. Furthermore, in the densely populated areas, various operators have rolled out fibre infrastructure which thrives price competition on fibre-based products. This price competition leads to relatively small price differences between the copper- and fibre-based products which again melts down burdens for end customers to migrate. While the Spanish end-customers' behaviour seems to be

⁶³ BEREC (2019), p.5 et sqq.

majorly driven by prices, the Swedish case reveals that end-customers' intrinsic demand for higher bandwidths can be another catalyser for migration.

The success of a far progressed PSTN to VoIP migration for the success of the copper switch-off becomes evident in the Estonian case, which was the first country to complete VoIP-migration and now faces the favourable situation of a far progressed copper MDF decommissioning. Comparably, the Netherlands who were one of the first European countries to initialise VoIP migration in 2007, were not able to turn this success into a comparable copper switch-off result despite of a large FTTH footprint. As a result, the Dutch NRA took action and set a one year notice period for the decommission of a copper MDF, which is a very short period in European comparison. Just like in the Netherlands, also the Swedish NRA is considering tackling notice periods in order to achieve further decommissioning of the legacy network. Sweden has reached a 50 % switch-off rate and plans to reduce the 5 year notice period to 18 months in order to sooner achieve a full switch-off.

These observations indicate, that PSTN switch-off is a necessary yet not sufficient prerequisite for copper switch-off. Given a PSTN switch-off and comparably slow copper switch-off, the NRAs tend to foster migration by implementing short notice periods for the decommission of copper MDFs. France just like Spain may take advantage of a large FTTH footprint of multiple operators which thrive price competition. Secondly, just like in Spain, France has early concentrated on fibre-based infrastructure and therefore the copper-based broadband offers are often not capable to compete. PSTN switch-off may be regarded as an obstacle for copper switch-off in France which may be tackled by shortening notice periods for both. Given the Swedish example, the five year notice period (as currently implemented in France) should be reduced to 18 months.

On a smaller scale, the observations from Jersey show, that a parallel migration may as well be possible. By the best practice from Jersey, it may be implementable for France as well on the scale of areas, to conduct a PSTN switch-off in parallel to the fibre switch-off.

Copper switch-off is being conducted by the incumbent in all observable cases but as the examples from particularly Portugal and Sweden show, the NRA should monitor this process well, set milestones and grant full transparency of it. In Portugal the incumbent is obliged to follow the publically stated rules for the decommissioning the NRA has postulated in their market analysis in 2017. The Swedish NRA constantly accompanies the switch-off process of the incumbent and steadily informs the public about the dismantled MDF locations. The effect of transparency is not directly measurable in terms of decommissioned MDFs but will certainly enhance customers' and other operators' understanding of the process and therefore prevent conflicts.

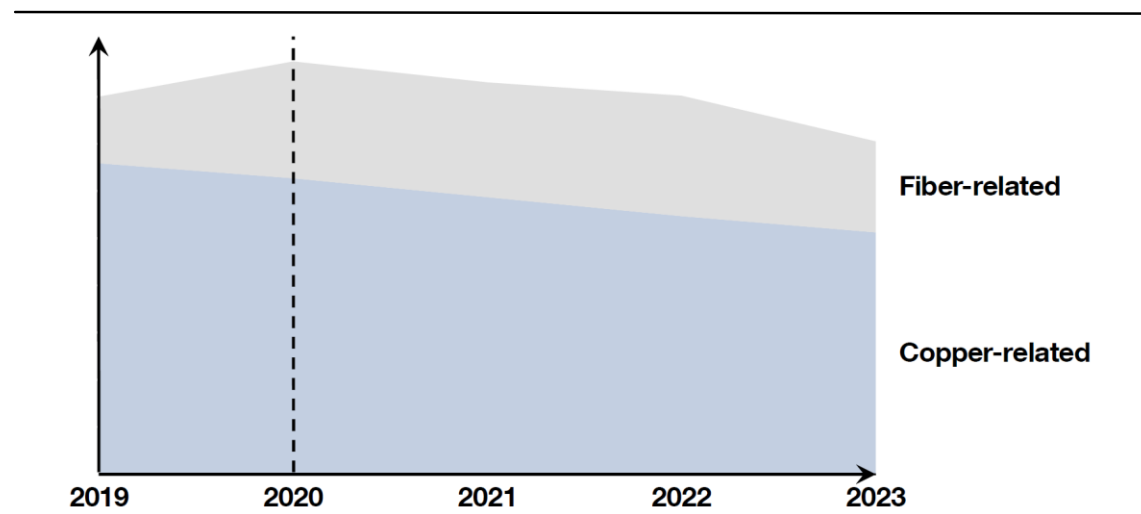
3.6 Why does Orange not follow an active switch-off strategy?

As shown in section 3.4 and 3.5 a gradual pace of the incumbent's FTTH deployment and reliance on copper upgrade technologies are not relevant factors for delaying switch-off in France compared to UK, DE and IT.

There are still about 8 mln. PSTN lines in France. Orange has a market share of close to 100% in this segment. A PSTN and copper network switch-off would motivate users to choose alternative offers. Thus Orange can only lose market share in this segment. Each operator which forces customers to migrate will lose some of it. The in-house cabling is in many cases a constraint for customers/operators to migrate. Another barrier for migration could lie in the connection costs which operators charge from end customers for migration. As shown in Figure 3-11 in 2023 Orange still receives 75% off its wholesale revenues from copper network-related services. Fixed wholesale revenues in France should peak in 2020 with revenues in 2022 at approximately the same level as in 2019. Since Orange can still receive excessive profits from copper wholesale services it is understandable that it does not follow an active switch-off strategy.

The structure of revenues Orange is receiving from its copper assets will change when migrating to fibre. Most of the fibre is financed in co-investment models which reduce the monthly recurring rental charges of Orange. In many cases Orange is the leading investor, in other cases competitors or even Public Private Initiatives have the lead. Thus all such structures affect and change Orange's cash flows in a negative sense compared to today's situation. Thus it is the natural interest of Orange to keep the copper income as long as possible, at least in all those areas where they do not lead the fibre investment.

Figure 3-11 Orange's fixed wholesale revenues



Source: Orange (2019c), p. 36

4 ULL costing and pricing

4.1 Arcep's development of ULL pricing principles over time

Backed by corresponding European regulation, the French regulator Arcep applies a price regulation remedy on copper ULL according to cost based pricing. The basic principles of the cost standard and cost calculation approach date back to an Arcep decision of 2005.⁶⁴ Based on a cost model Arcep simulates the so called "coûts courants économiques" (CCE) to determine ULL cost.

In its Decision No. 2012-0007 of 17 January 2012, Arcep amended its Decision No. 05-0834 of 15 December 2005, changing the cost valuation method to be used for the copper pair, by progressively shortening the amortization period of copper cables from 25 to 13 years⁶⁵ while at the same time progressively increasing the amortization period of civil engineering assets from 40 to 50 years between now and 2021. This scheduled increase should result in a decrease in France Télécom's (now Orange) full unbundling tariffs after 2012.

In November 2010 Arcep published a decision regarding the economic conditions that would give access to ducts in France Télécom's access network.⁶⁶ The decision in particular determines how the relevant cost of ducts is to be shared by the copper and fibre loops. The relevant cost is determined from the normal regulatory accounts as it relates to the local loop. It apparently excludes costs that are explicitly incurred to enable roll-out of FTTx that would not have been necessary if one had used a less volume consuming technology.⁶⁷

⁶⁴ Arcep (2005)

⁶⁵ Because the French government is striving for 100% coverage with high speed broadband by the year 2025, Arcep decided to "send a strong signal" and assumed that all copper cables currently in use should be fully amortized by 2025. Hence the (remaining) lifetime was set at 13 years. See Arcep (2012), p. 5

⁶⁶ See Arcep (2010)

⁶⁷ Ibid, p. 8.

Table 4-1 Monthly LLU prices in France from 2000 to 2020

Date	11-2000	07-2001	06-2002	06-2005	01-2006	01-2009	01-2011	01-2012	01-2013	01-2014	01-2015	03-2016	01-2017	2018	2019	2020
LLU price	17.10€	14.48€	10.50€	9.50€	9.29€	9.00€	9.00€	8.80€	8.90€	9.02€ ¹⁾	9.05€	9.10€	9.45€	9,31	9,41 ²⁾	9,51 ²⁾
Cost base	LRAIC				FAC ⁶⁸			New allocation of ducts						BU-LRIC+ model & regulatory accounting		
Asset valuation	Successive replacement cost (les Coûts de Remplacement en Filière (CRF))				Current cost with economic amortisation (~tilted annuity)									Considering Reusability and RAB		
Basis of cost calculation	100% of lines		~70% of lines		~95% of lines									55 % of lines FTTH PtMP; 45 % of lines Copper		
WACC	>12.1%	12.1%	10.4%	?	?	10.7%	10.4% ^[1]	8.9% ^[2]				8,7%	8.7%	7,6%		

1) This price was retroactively reduced to 8,78 Euro because the proven OPEX by Orange was much lower than originally forecasted for the pricing decision.

2) Because of a tax (IFER) decrease the price applied by Orange in fact was 9,27€ in 2019 and 9,46€ in 2020.

Source: Bouygues, WIK

⁶⁸ See p. 8 of the decision.

[1] Arcep (2010)

[2] Consulted in November 2011. http://www.arcep.fr/uploads/tx_gspublication/consult-projdec-taux-remu-fixe-mobile-151111.pdf Arcep states that the decrease of the WACC results from revision of market risk premium, coefficient of specific market risks and ratio of debt to equity, all of which have now been evaluated in a long-term view.

These three decisions are still the basis for ULL price regulation of the last years and those for 2016 and 2017. The last decision from 2017 and the current consultation are discussed in section 4.2.1 and 4.2.2. In 2017 Arcep introduced a BU LRIC+ model.

In its 2005 Decision Arcep decided to use the Fully Allocated Cost Standard to determine ULL charges. In its former pricing decisions Arcep had used the LRIC cost standard. At that time Arcep had used a bottom-up cost model to determine the relevant cost. Table 2-1 provides an overview of methodological aspects and the outcome of ULL price determination in France. The ULL price was steadily reduced starting from a high level of 17.10 Euro in 2000. The turning point is marked in 2014 when the upwards pricing trend started.

The most prominent price change is the one related to the 2002 decision⁶⁹ which reduced the number of lines taken into account for determining the cost of unbundling (see below) and reduced the WACC from 12.1 % to 10.4 %. Since 2005 Arcep has not determined the LLU prices ex ante, but has verified ex post that France Télécom complies with its obligation to set “non-excessive” tariffs. France Télécom dropped the price from 9.50 € in 2005 to 9.29 € in 2006. France Télécom explained that productivity gains allowed it to reduce the wholesale price from 9.29 € to 9.00 € in January 2009.

In France copper access line costs were initially determined on the basis of all lines. In 2002 Arcep took note⁷⁰ that alternative operators tended to apply for unbundled lines primarily in denser populated areas and that the average copper local loop costs depend on the density of the area. Arcep decided to distinguish two areas: (1) one densely populated area where it is likely that alternative operators will invest in unbundling within two years; and (2) a lower density area where it is highly unlikely that such investment will occur. At that time Arcep considered about 70% of total lines for determining the LLU cost. Therefore the cost of LLU was predominantly derived from the average copper cost in denser populated areas (about 21 million lines of a total of 34 million).⁷¹

In 2005 Arcep noted⁷² that the footprint of unbundling had enlarged significantly (also due to activities of local authorities) bringing the average cost of unbundled lines closer to the average cost of all lines. However, Arcep also noted that the existence of the compensation fund for Universal Services was likely to conflict with a LLU price based on all lines. It was decided that the LLU cost should not consider the cost of the (relatively long) lines in those unprofitable areas with low population density for which France Télécom is compensated for by a Universal Service fund. This Universal Service regime compensates France Télécom for a part of the cost of lines in remote and therefore otherwise unprofitable areas, so that the operator can offer users there also a

⁶⁹ ART (2002)

⁷⁰ ART (2002), p. 15-16.

⁷¹ In the 2005 Decision 05-834 Arcep quantified this share still as 70% of all lines.

⁷² Arcep (2005), p. 31-32.

subscriber line at an affordable price. If we then assume the cost of the LLU was based on the average cost of lines - that also include the lines in these remote areas - this cost estimate would turn out to be unduly high and the corresponding price for the LLU might disadvantage alternative operators in their competitive position. These areas make up 5% of all lines so that the new regime extends its copper pair average cost base to 95% of all lines.

Up to 2005 the cost of unbundled local loops in France was based on a Long-Run Average Incremental Cost methodology⁷³ with asset valuation using "Successive Replacement Cost" ("les Coûts de Remplacement en Filière"). This approach was originally proposed by France Télécom and supposed to emulate a "make or buy" decision of either renewing or maintaining an asset.⁷⁴

4.1.1 The pricing and costing principles of Decision No. 05-0834

In 2005 Arcep launched a "consultation on copper local-loop costing methods" which was followed by Decision 05-0834. In its consultation, Arcep proposed four possible cost methodologies for the local loop: 1) Historic Cost Accounting - HCA, 2) Current Cost Accounting - CCA, 3) an economic amortization method and 4) the successive replacement cost method.⁷⁵ Actually, Arcep decided to use current cost accounting with economic amortization in the form of applying a tilted annuity. According to Arcep, this methodology has three main advantages:⁷⁶ non-discrimination (in particular between the different offers of France Télécom), creation of an incentive for FT to invest efficiently in the copper local loop, and an incentive for alternative operators to invest efficiently in unbundling.

Arcep pointed out that it envisaged that its cost accounting methodology used for the provision of ULL still is in line with the same guiding principles as the LRAIC standard it applied before. The choice of this methodology implies that the only cost taken into account are the ones directly linked to the activity, including costs of future investment and taking into account the evolution of prices.

The other options were discarded; the reasons for deciding against historic cost accounting were primarily that it does not take the evolution of prices into account. In addition Arcep stated that historic cost accounting does not allow moderating the impact on LLU prices from changes in the annual investment rate of France Télécom. Arcep

⁷³ European Commission (2005)

⁷⁴ Successive Replacement Cost determines the asset value as the difference between 1) the cost of renewing the asset immediately at its market value and 2) the cost of maintaining the asset until the end of its lifetime. See Arcep Decision 05-0834, p.8.

⁷⁵ During the consultation process stakeholders also proposed a price-cap approach and the Infrastructure Renewal Accounting method. Both were discarded by Arcep for being a mechanism for tariff control rather than asset valuation (price-cap) and too theoretic (Infrastructure Renewal Accounting).

⁷⁶ European Commission (2005)

states that successive replacement cost does not encourage efficient investments by France Télécom and would lead to high LLU prices.⁷⁷ To put it in our words, the amortization of assets is carried out using a tilted annuity formula applied to the historical investment path.

4.1.2 Amendment of Decision No. 05-0834 in 2012

In this Decision⁷⁸ Arcep changed the lifetime of copper cables and ducts (civil engineering) in its cost model.

In the first half of 2011, Arcep carried out a public consultation on annualized investment cost methodologies for France Télécom's copper local loop and on changes resulting from the switch from copper to fibre. In the wake of this consultation, Arcep considered that its method, which is based on economic amortisation of the incumbent carrier's actual costs, does not induce either excessive compensation or provision for replacement of fixed assets, and appears to comply with the ruling from the Court of Justice of the European Union against Arcor (Germany) and with the European Commission recommendations.⁷⁹ Arcep nevertheless believed it necessary to take into account, first, the increased longevity of the civil engineering assets, which is an essential infrastructure that can be reused for the deployment of optical fibre networks, and second, on the contrary, the accelerated obsolescence of copper cables which are due to be replaced by fibre optic cables.

In its Decision No. 2012-0007 of 17 January 2012, Arcep amended its Decision No. 05-0834 of 15 December 2005, changing the cost assessment method to be used for the copper pair, by progressively shortening the amortization period of copper cables from 25 to 13 years⁸⁰ while at the same time progressively increasing the amortization period of civil engineering assets from 40 to 50 years between 2012 and 2021. This scheduled increase should in Arcep's expectations result in a decrease in France Télécom's full unbundling tariffs after 2012.

Pursuant to the publication of this decision, and in accordance with its regulatory obligations, France Telecom amended the tariffs subject to cost-oriented pricing obligations imposed by market analysis decisions and the price for full unbundling has decreased from 9.00 € to 8.80 €.

⁷⁷ Arcep (2005)

⁷⁸ Arcep (2012)

⁷⁹ Arcep (2011)

⁸⁰ Because the French government is striving for 100% coverage with high speed broadband by the year 2025, Arcep decided to "send a strong signal" and assume that all copper cables currently in use should be fully amortized by 2025. Hence the (remaining) lifetime should be 13 years. See Arcep (2012), p.5.

Accordingly, there has been a regime change: The previous regime⁸¹ used a lifetime of 40 years for civil works (manholes, ducts, cable tunnels) and 25 years for copper cables and poles. The new decision⁸² increased the lifetime of civil works by 1 year, every year from 2012 to 2021, that means 41 years in 2012, 42 years in 2013, etc., till reaching 50 years in 2021. The lifetime of poles will remain 25 years. The lifetime of copper cables is reduced to 13 years.

From our point of view it is useful and important to shed some light on the considerations which led Arcep to its final conclusion in the decision. The authority launched a public consultation on 29 March 2011 on the criteria for choosing a method of annualized capital costs and the transition from copper to fibre. The results of this consultation were published on 7 September 2011.⁸³ They were followed up by a deeper analysis by Arcep published in November and the decision itself in January 2012⁸⁴.

Among the most relevant comments on the initial consultation, according to our opinion, is the view that copper cable lifetime should be shorter than 25 years and that the 40 years lifetime of civil engineering was underestimated in the relevant baseline decision of 2005. Competitors argued that France Télécom's current investments are at a significantly lower level than those 40 years ago and hence no corresponding reinvestment of these original investments can be observed. This observation is shared by Arcep and visualized in Figure 4-1.

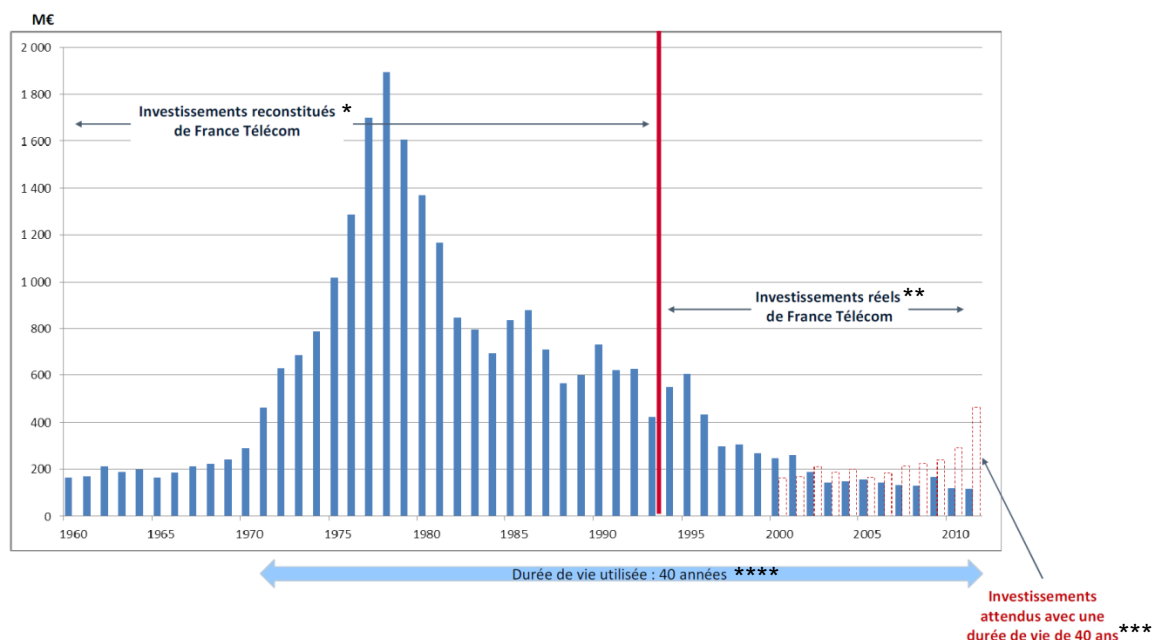
⁸¹ Arcep (2005)

⁸² Arcep (2012)

⁸³ Arcep (2011a)

⁸⁴ Arcep (2012)

Figure 4-1 France Télécom's annual investments in civil engineering (in Euro at the end of 2010)



* Approximated investments of FT

** Actual investments of FT

*** Investments expected with a lifetime of 40 years

**** Considered lifetime: 40 years

Source: Arcep (2011a)

Furthermore, because of the ongoing fibre deployment all stakeholders agreed that copper will become obsolete eventually and hence will not be considered an essential facility some when in the future. Even though this conclusion is shared by practically all players the responses have been diverse. One suggestion was to differentiate by geographical area since in high density areas an FTTH roll-out is likely to replace copper at a quicker pace than in low density areas where it might remain the only sustainable landline infrastructure.

Arcep concluded that as long as the copper network is still in use the declining demand for copper would lead to constantly rising access charges and therefore a mechanism needed to be put in place to ensure relative pricing stability for products based on copper during the transition period to fibre.

Arcep published a follow-up report with a more thorough analysis of the issues of this consultation in November 2011.⁸⁵ In this report Arcep decided to gradually extend the civil works lifetime by one additional year every year from 2012 to 2021 (hence extending the lifetime from 40 to 50 years at the end of this period).

⁸⁵ Arcep (2011a)

Regarding copper cables Arcep decided to reduce the lifetime in order to accelerate the repayment of copper network cost while there are still large numbers of users utilising the copper network. This is based on the assumption that by 2025 almost all French users will be served by very high speed broadband (i.e. fibre). Arcep wished to "send a strong signal to the market" and permit a full amortisation of copper cables by the year 2025. Lifetime of copper cables was therefore reduced from 25 to 13 years.

Arcep described in detail how the changes to lifetime should be implemented in the calculation of annuities by increasing the remaining lifetime by the difference of the previous lifetime and the new lengthened lifetime. For example, an asset invested in 1990 with an amortisation period of 40 years, would have a residual life of 18 years in 2012. Increasing the duration for amortization by one year in 2012 means that for the calculation of the annuity in 2012 a remaining lifetime of 19 years would be used for that asset.

Arcep provided tables for both copper cables (with shortened lifetime) and civil works (with increased lifetime). Each line of those tables indicates investment of a given year; each column indicates the remaining lifetime for this investment the future (2011 and beyond).⁸⁶

Regarding the decrease in amortisation time for copper cables Arcep decided to apply the following rules:

- For assets whose residual life is less than 12 years, the remaining life is unchanged;
- For assets whose residual life is greater than or equal to 13 years, the remaining life time is equal to 13 years in 2012;
- New assets acquired after 2012 are amortized over a lifetime of 13 years.

4.1.3 Allocation of duct cost between copper and fibre

In November 2010 Arcep published a decision regarding the economic conditions that would give access to ducts in France Telecom's access network.⁸⁷ The decision in particular determines how the relevant cost of duct is to be shared by the copper and fibre loops. The relevant cost is determined from the normal regulatory accounts as it relates to the local loop. It apparently excludes costs that are explicitly incurred to enable roll-out of Fttx that would not have been necessary if one had used a less volume consuming technology.⁸⁸

⁸⁶ See Arcep (2012).

⁸⁷ See Arcep (2010)

⁸⁸ Ibid, p.8

Arcep considered four indicators that could be used for determining the shares of the costs of the duct network to be allocated to copper and fibre. These were:

1. The relative lengths of copper and fibre cables,
2. the relative volumes that copper and fibre cables occupy in the ducts,
3. the relative volumes of cables effectively in use, and
4. the relative number of customers that obtain access over copper or fibre.

Arcep decided to use the last of these approaches reasoning that allocating the cost according to the number of customers using either technology would better reflect the needs of long-term transition from copper to fibre. It would allow a progressively increasing share of the relevant duct network cost to be charged to fibre as it would be proportional to the corresponding revenues. It would also not disturb the equilibrium of current services using copper as a technology.⁸⁹

The approach towards duct costs has the effect of allocating these costs from copper to fibre in a dynamic manner over time, which reflects the state of maturity of fibre uptake. Three stages are involved in the costing process:

1. Civil engineering costs are allocated between local loops installed in ducts and local loops which are directly buried.
2. Costs are allocated between local loop access and core network according to the lengths of cable infrastructures deployed in these segments.
3. The costs of local loops installed in ducts are allocated between copper and fibre according to the number of retail access lines based on copper and fibre (i.e. the respective take-up) using the duct network. Such retail access lines include those used for residential and business purposes as well as other types of access such as mobile base stations.

Arcep reports that all respondents in the public consultation expressed themselves in favour of this approach.⁹⁰ Arcep's approach does in our view not reflect any cost-based pricing rule but represents a "value of service" pricing. Over time the cost allocation approach brings the allocation of costs closer to the actual capacity used by each technology. In the first years when the penetration of fibre still is low, fibre will be allocated a (much) lower share of duct space than a capacity based approach (based on the duct space required for deployed fibres) would dictate. In this way Arcep's allocation approach lightens fibre from costs and reduces the risk of fibre investment to some degree. This method of allocation, however, also implies a cross-subsidization of fibre by copper compared to a capacity based allocation approach, as the share of the

⁸⁹ Arcep (2010), p. 10f.

⁹⁰ Arcep (2010), p. 10

actual use of duct space by fibre presumably is larger than the share of customers currently getting access over fibre.⁹¹

4.2 Arcep's current costing and pricing approach

4.2.1 Arcep's latest decision number 2017-1570 in 2017

In several public statements Arcep and its President have reasoned their LLU pricing decision and provided some indication on the future LLU price path.

In an interview with Le Figaro at 6 April 2016⁹² Chairman Soriano highlighted that regulation cannot accept a market outcome of a network duopoly, “the worst of all systems”, between the incumbent Orange and the cable operator Numericable/SFR. It is essential in his view that the other two operators heavily invest in fibre, too. The increase of LLU charges shall motivate these ANOs to invest in their own fibre network instead of further using Orange's copper access network via unbundling. The regulatory emphasis is to incentivise further investment instead of getting lower retail prices.⁹³ The level of prices is acceptable. There is no need for further downward pressure.

Before the latest ULL pricing decision Chairman Soriano pointed out that the upcoming price decision shall provide a strong and precise signal to the market that the copper access charges shall support the migration to fibre.⁹⁴ Therefore, Arcep intends to progressively increasing the copper LLU charge. Instead of lowering the recurring monthly copper ULL charges, Arcep will reduce the non-recurring charges, in particular the termination charge to make the migration from fast to superfast broadband easier.

In its detailed roadmap of the “revue stratégique” Arcep announced, that it will formulate an LLU pricing strategy still in 2016 which will cover the period 2018 – 2020.⁹⁵ This strategy will formulate economic conditions for a further migration to fibre and provide security for the investors, especially for the operators using LLU access.

The latest decision⁹⁶ from Arcep about LLU price caps is from December 2017. It sets price caps for copper local loop access charges (LLU and bitstream) for the period from 2018 to 2020. It says that the recurring monthly wholesale charge for full unbundling could be capped at €9.31 a month starting on the first of January 2018, at €9.41 a month starting on first of January 2019, and at €9.51 a month starting on the first

⁹¹ Neumann, Plückebaum, & Held (2016), p. 8 seqq.

⁹² Bembaron (2016)

⁹³ Interview of M. Soriano by Europe 1, April the 4th 2016.

⁹⁴ Nextinpact, 2015 Interview of Soriano, NetInpact (2015): <https://www.nextinpact.com/news/97302-interview-sebastien-soriano-si-arcep-etait-inventee-aujourd'hui-que-devrait-elle-faire.htm>

⁹⁵ Arcep (2016), p. 5 seqq.

⁹⁶ Arcep (2017a)

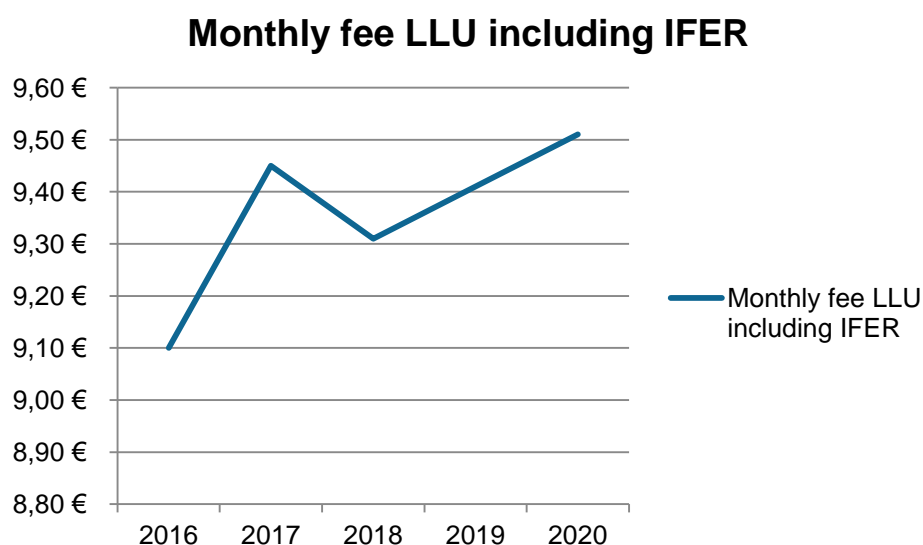
January 2020. As Figure 4-2 shows this means a reduction from 2017 to 2018 by 14 Euro Cent but from 2018 until 2020 a constant increase.

Table 4-2 Price caps for market 3a

		2016	2017	2018	2019	2020
Full unbundling	Monthly fee net of all taxes ²⁰	8.20 €	8.32 €	8.17 €	8.21 €	8.23 €
	Monthly fee including IFER ²¹	9.10 €	9.45 €	9.31 €	9.41 €	9.51 €
	Installation fee	50 €	50 €	50 €	50 €	50 €
	Contract termination fee	15 €	15 €	5 €	5 €	5 €
	SAV ²²	105 €	105 €	105 €	105 €	105 €
Partial unbundling	Monthly fee	1.77 €	1.77 €	1.77 €	1.77 €	1.77 €
	Installation fee	66 €	66 €	66 €	66 €	66 €
	Contract termination fee	35 €	35 €	35 €	35 €	35 €

Source: European Commission (2017), p.5

Figure 4-2 Evolution of price caps for market 3a



Source: European Commission (2017), p.5

For the current valid pricing Arcep introduced a BU LRIC+ model in accordance with the “Commission Recommendation on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment”⁹⁷ which had been published by 2013 and was ought to be implemented

⁹⁷ European Commission (2013)

by the European member states' NRAs three years after its publication. Therefore, Arcep in its decision by 2017⁹⁸ was obliged to implement a BU LRIC+ model for cost determination of the local copper loop. Throughout the respective decision, Arcep stresses its aim to be in accordance with the recommendation⁹⁹. The EC approved the 2017 decision without commenting. Together with the cost model, Orange's regulatory accounting form the basis for the LLU pricing. Before this 2017 decision, LLU pricing was solely based on the methodology of Orange's regulatory accounting¹⁰⁰.

The recommendation being the external reasoning for the implementation of a cost model, the internal reasoning by Arcep is the desire to implement a methodology of cost finding that in the long run will be able to produce stable and predictable outcomes given the technological transition towards fibre. This predictability shall provide security for investors and the market participants¹⁰¹.

With a view on the technological transition and parallel to the increasing recurring LLU fees, one-off charges, in particular the termination fee were reduced from 20 € to 15 € in the 2017 decision¹⁰². By this means, an incentive should be put in place to switch-off the copper and migrate towards fibre local loops.

Other incentives set by Arcep (implemented in its 2012 pricing decision and approved by this 2017 decision) apply to the depreciation of the legacy cables which was reduced from 25 to 13 years¹⁰³. The lifespan of buried cables in the BU cost model was applied with 25 to 40 years and 20 to 25 years for aerial cables. Therefore, the expected lifetime of the fibre cables of the BU cost model far exceed the lifetime of copper cables which form the basis for the pricing approach by Orange's regulatory accounting.

Besides the lifetime of cables, Arcep has identified the following main steering parameters of the cost model:

- The evolution of fixed copper access lines,
- The incumbent's investments in civil engineering and copper local loop,
- Orange's OPEX for operating copper,
- Taxation of the copper pair,
- Specific costs of unbundling, and
- Specific costs of activating the respective services.¹⁰⁴

Based on the French fibre roll-out plans the model simulates the evolution of active copper pairs and in accordance with Orange's projections, Arcep estimates the following decline of number of copper pairs in service from 2018-2020:

⁹⁸ Arcep (2017a)

⁹⁹ Ibid. p.1, p.3f, p. 7, p. 19

¹⁰⁰ The methodology of the regulatory accounting was in detail described in chapter 1 of WIK's 2016 report for Iliad.

¹⁰¹ Arcep (2017a), p. 19

¹⁰² Ibid, p. 21

¹⁰³ Ibid, p. 7

¹⁰⁴ Ibid, p. 10

Table 4-3 Number of copper pairs in service 2018 - 2020

	2018	2019	2020
Number of copper pairs in service	- 1.4 M	- 1.8 M	- 2.2 M

Source: Arcep, Décision 2017 – 1570, p. 12

The incumbent's investments into the copper local loop also take into account an estimation of future investments. The investments in copper cables are expected to be proportional to the evolution of active copper pairs determined before. In terms of reusability of civil works for the deployment of fibre cables, Arcep anticipates an increase of reusable assets of 7 % p.a.

The OPEX decrease proportionally with the number of active copper pairs.

In France a specific taxation on the operation of the copper pair ("IFER" – Imposition sur les entreprises de réseaux) increases the LLU fee. Arcep regards the LLU fee including IFER its target figure and therefore might adapt the pre-tax LLU fees in the case the IFER shall change.

The specific costs of unbundling appeal to after-sales service, marketing, and billing react proportionally to the number of active copper pairs.

In case of bitstream or VULA the costs of activating the access consist of the costs of the DSLAM which are expected to decline due to technical progress and Ethernet migration.

The costs of the LLU resulting from the BU cost model range from 8.59 € for the year 2018 till 10.71 € for 2020¹⁰⁵. The final determination of LLU fees is based on Orange's regulatory accounting "taking into account" the results from the BU cost model¹⁰⁶. Given the results of the model compared to the LLU fees that have been announced which range from 8.17 € in 2018 till 8.23 € in 2020 (see Table 4-2) which are far below the cost model results in 2020, the decision seems to have been fairly based on the regulatory accounting.

4.2.2 Arcep's current consultations for the next market analysis

Until today two consultations took place regarding the current market analysis with at least one more consultation coming before a new decision will be published at the end of 2020. Table 4-4 shows the consultation process for Arcep's current market analysis and the main points in the receptive consultation.

¹⁰⁵ Arcep (2017a), p. 19

¹⁰⁶ Ibid.

Table 4-4 Consultation process for Arcep's current market analysis and main points

1 st Consultation (June-September 2019)	2 nd Consultation (February – March 2020)	3 rd Consultation (probably around May 2020)
General aspects of how to best support the migration from copper to fibre	Details concerning commercial and technical closure (notice periods and perquisites etc.)	Presumably about the cost methodology
Possible differentiation of regulation by different types of areas and potentially loosening of obligations on Orange	QoS parameters for services based on copper in areas where fibre is absent	
New decision by the end of 2020		

Source: WIK

In the context of its current market analysis Arcep launched two consultations as a preparation. The first consultation¹⁰⁷ was running from 11th of July 2019 until the 27th of September 2019. Arcep received 24 responses to this consultation. The second consultation¹⁰⁸ was running from the 6th of February 2020 until the 17th of March 2020.

In the press release of its current consultation (2020) Arcep stated, that the review process will be completed by the end of 2020. New decisions, including pricing aspects, notably for the copper pair, will be the result.

Generally, Arcep postulates copper switch-off as an aim while at the same time it shall be granted that copper lines work satisfactorily as they still remain the only fixed access in wide parts of France.¹⁰⁹ Regarding fibre, Arcep will examine both possibilities symmetrical and asymmetrical regulation. Arcep puts up for discussion the usage of different geographical areas accompanying the migration process. In areas where sufficient fibre had been rolled out economic incentives could be set to gradually switch-off copper. At the same time the QoS obligations for copper lines have to remain in all other areas.

4.2.3 Consultation 2019

Arcep sets out copper switch-off as a clear goal of regulation. Generally, two measures are intended in order to foster the process: First, a differentiation of regulation by different types of areas - depending on whether sufficient fibre is available or not – could be an option. Arcep names possible criteria for the definition of a “fibre zone”, e.g. completeness of other infrastructures, availability of diversified wholesale offers, full functionality in terms of QoS for all customers. Arcep could relax regulatory obligations

¹⁰⁷ Arcep (2019f)

¹⁰⁸ Arcep (2020b)

¹⁰⁹ In 2018 Orange was claimed by its competitors for insufficient QoS regarding its copper based wholesale access products.

regarding copper in areas where fibre networks are sufficiently supplied. Second, Arcep discusses economic incentives that could be used to accelerate copper switch-off. One possibility of setting such an incentive would be abandoning cost orientation for copper ULL. Moreover, giving Orange price flexibility regarding wholesale products relying on copper could set incentives for competitors for a faster migration to fibre. Otherwise, incentives could be set by a long term copper pricing. Arcep examines the a bandwidth of opportunities from maintaining all obligations associated with access to the local loop to an adjustment of these obligations in areas where certain conditions are met. Regarding an adjustment of conditions possible options discussed are:

- an adjustment of the access obligation¹¹⁰,
- a relaxation or lifting off the tariff obligation,
- a mixture of both, consecutives steps (first lifting off the tariff obligation followed if certain criteria are met by an adjustment of the access obligation)¹¹¹

The switch-off is planned in two stages. In the first stage a commercial stop would be performed which means that copper products will not be promoted and sold anymore. In the second stage technical closure will be executed meaning that the switches, e.g. MDFs, no longer needed by abandoning copper internet access products will technically be closed. In the closing process, Arcep considers non-discrimination of zones favourable (concerning the closing path) so Orange could not promote FTTH migration where Orange owns both infrastructures the legacy copper network and the FTTH network.

Until this two stage process is completed, Arcep wants to keep the copper network capable to provide a satisfactory level of service for users that still depend on it. Furthermore, a prerequisite to close the copper network is that the fibre network must be able to replace the copper network. This means it must become available to all users and be able to respond to different connectivity needs.

4.2.4 Consultation 2020

Arcep names the (1) the closure of the copper network and an ongoing accompanying (2) guarantee of QoS in the copper network as main goals.

(1) Commercial closure of copper network

Arcep examines how the process of closing the copper network can be facilitated through the adjustment of the regulation. The commercial closure is defined as the stop of commercialisation of new accesses based on copper.¹¹² In the closing process the commercial closing precedes the technical closing. In the consultations Arcep lays out

¹¹⁰ In this context the geographical delamination of areas is discussed.

¹¹¹ Arcep (2019f), p.48 et seqq.

conditions for commercial closing (see Figure 2-1). The envisaged preconditions for the closure Orange must fulfil in order to carry out the commercial closure are the following:

- at least one fibre optic network must be fully deployed
- there are optical local loops available allowing third-party operators to reproduce an least equivalent offer to what they supplied on the copper network. An indicator of adequacy of access conditions could be the presence of one or two commercial operators (excluding the infrastructure owner) and a portion of 10% (or 10.000 lines) of activated accesses (excluding the infrastructure owner) in the area that is covered by the offer.
- at least one FttH wholesale offer which meets the needs of business customers
- at least one FttH retail offer which is available for all premises.

If all of the above conditions are fulfilled, commercial closure can take place with a notice period of one month (6 months for business offers) at the level of the mutualisation point.¹¹³

If there is no sufficient number of operators present at the mutualisation point yet, the notice periods would be longer. Arcep plans to set a notice period of 18 months in less dense areas respectively 36 months in very dense areas for commercial closure in cases where the conditions are not yet fulfilled. The idea is to use the notice periods to “nudge” other operators to connect to the pooling points even if they originally had no intention to do so.

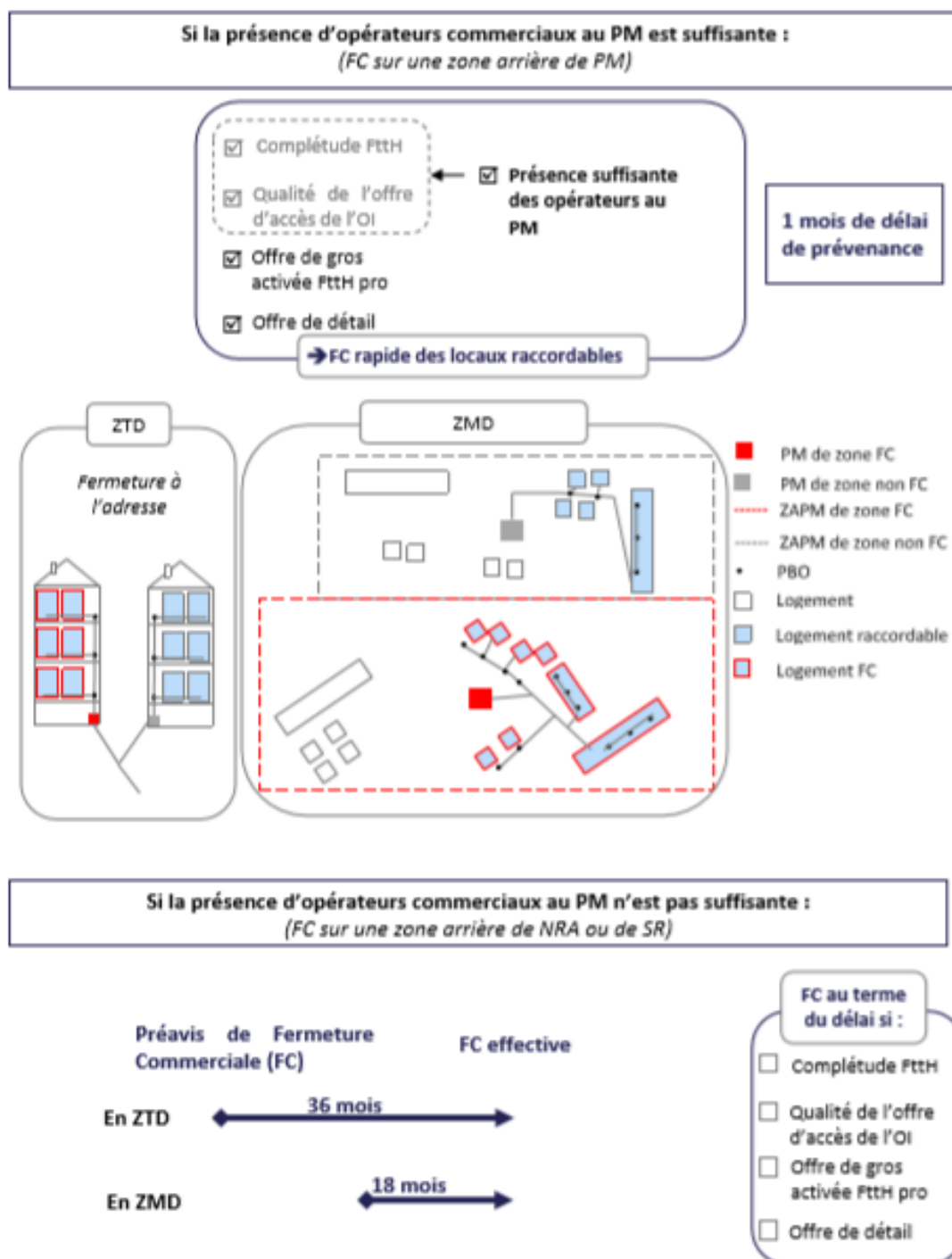
In the consultation Arcep asks participants whether the notice periods considered for commercial closing are appropriate and how many operators need to be present in the concerned areas.

¹¹² Arcep (2019f), p. 50

¹¹³ Arcep (2020a), p. 84

Figure 4-3 Commercial closure for general access

Figure 1 - Fermeture commerciale (FC) pour les accès généralistes



Source: Arcep (2020b), p. 89

(2) Technical closure

For the technical closure of an MDF¹¹⁴, a sub distributor or a group of lines a notice period of 36 months must be respected.¹¹⁵ The technical closure may not be carried out less than 12 months from the date on which the conditions for commercial closure are fulfilled. Concerning the closing path, equally for commercial or technical closure, Orange must lay out a non-discriminatory and transparent path.¹¹⁶ This means Orange may not favour areas for a commercial or technical closing where it owns the optical fibre infrastructure over those where third parties own the optical fibre infrastructure. Therefore, Orange establishes, maintains and publishes a list of MDFs and a list of mutualisation points to be closed including information on the FTTH coverage rate, the announcement of commercial closing, any additional criteria that was taken into consideration for the determination of the closing path etc. (see Arcep (2020a), p. 94).

Quality of Service parameters

While Arcep pursues its target to support the migration from copper to fibre it pronounces at the same time the importance of ensuring a quality of service for the historical local copper loop in order to guarantee access offers based on this network. This is especially true for areas which do not (yet) benefit from optical fibre and for which the local copper loop remains the only network available.

Therefore Arcep defines quality of service indicators and associated thresholds. To take into account the dynamic nature of the migration dynamic process Arcep plans to reassess the threshold after 2023.¹¹⁷

In the annex 5 of its consultation document concerning market 3a Arcep presents a table of indicators and associated thresholds (see Figure 4-4). The first line shows for example as an indicator the “failure rate of access concerning LLU”. This corresponds to the number of orders refused or not performed in relation to the total number of orders requested by third parties and Orange’s retail customers. This indicator is stated as percentage and may not surpass 6 %.

¹¹⁴ French: Noeud de Raccordement d'Abonnés

¹¹⁵ Arcep (2020b), p. 8

¹¹⁶ Arcep (2020a), p. 91

¹¹⁷ Arcep (2020a), p.130

Figure 4-4 Indicators and associated thresholds for ULL

	Unité	Type de seuil	Valeurs
Taux d'échec d'accès à la boucle locale	%	Plafond	6%
Délai moyen de livraison	Jours ouvrés	Plafond	5
Délai de construction de ligne – 95 ^e centile	Jours ouvrés	Plafond	20
Taux de signalisation sur les parcs livrés depuis moins d'un mois – cause Orange	%	Plafond	6,5%
Taux de respect du délai contractuel de relèvement (accès sans GTR)	%	Plancher	70%
Délai de relèvement – 95 ^e centile	Heures ouvrables	Plafond	100
Taux de réitération des défauts francs	%	Plafond	20%
Taux de réitération des défauts non francs	%	Plafond	40%

Tableau 1 : Seuils relatifs aux accès en dégroupage

Source: Arcep (2020a), p. 155

4.2.5 Arcep's further plans

Until today Arcep does not dispose a precise timetable for the closing or specific methods being envisaged by Orange.¹¹⁸

A second public consultation is planned for mid-2020. The results will be submitted to the Competition Authority for its opinion and then notified to the European Commission.

¹¹⁸ Arcep (2020a), p. 83

4.3 Dynamics of Arcep's approach

Orange welcomes Arcep's intention to lift cost orientation for the LLU pricing in order to foster FTTH migration¹¹⁹. At the same time Orange acknowledges that the migration from copper to fibre has already far evolved and expects the total number of FTTH accesses to be exceeding the number of copper based accesses during the upcoming regulatory period¹²⁰. In areas where the cofinancing regime has led to the roll-out of fibre infrastructure of multiple investors, Orange is in favour of abandoning cost based pricing for the copper LLU¹²¹. While this is only implicitly contemplated by Arcep's suggestion of loosening cost orientation obligation, it is becoming evident in Orange's interpretation of this consideration: In areas where sufficient fibre has been deployed, Orange will then be able to raise LLU access prices in order to foster migration¹²².

Arcep's intended strategy, which Orange hereby agrees on is to lift LLU fees in order for retail prices to increase. If access seekers face higher costs for copper based wholesale products they would increase retail prices, passing on the increase of costs. This chain of effects will be disproved in chapter 5 of this report, as access seekers will not be able to increase retail prices on the broadband market, even if fibre products are available. What is more, it seems contradictory by Orange to on the one hand acknowledging the fast migration process from copper to fibre and at the same time seeing the need for changes in the regulatory regime in order to foster migration.

Furthermore, Soriano anticipates that the dismantling process of Orange's copper network will be completed by the 2020's.¹²³ This contradicts Arcep's decision of 2012 when depreciation of copper infrastructure was reduced from 25 to 13 years which anticipated a full depreciation of copper infrastructure by 2025. As this are the guidelines for the LLU based pricing it would evidently be too high, allowing a price increase on fully depreciated copper assets.

Interestingly, and despite Arcep's current suggestions of this consultation phase, Arcep's president Sébastien Soriano in a recent interview has uttered the opposite alternative of regulatory measures to foster copper switch-off for Orange: The lower the prices for the copper LLU, the higher incentives would be for Orange to dismantle its legacy network. By Arcep's theory raising the copper LLU prices should on customer side incentivise to migrate to fibre products well knowing that just the opposite would be the correct measure to incentivise Orange to switch of its copper infrastructure.

¹¹⁹ Orange (2019b), p. 18

¹²⁰ Ibid.

¹²¹ Ibid, p. 20.

¹²² Ibid, p. 19, *"la levée de l'obligation d'orientation vers les coûts, dès lors qu'un niveau suffisant de couverture FttH est atteint au niveau de la zone concernée, ouvrant la possibilité pour Orange de pratiquer des tarifs d'accès plus élevés afin de renforcer la dynamique de migration sur la zone"*

¹²³ LesEchos (2020), p. 2

Other operators contradict this theory. Bouygues Telecom and SFR stress that the amount of investments operators have made into FTTH infrastructure form sufficient incentives to migrate costumers on this respective network as these investments can only pay out if sufficient end customers can be realised¹²⁴. Bouygues Telecom further claims that the customers' price elasticity is too small as being able to forward any cost wholesale increase to them¹²⁵. This assumption is in line with WIK's elaborations on the economic theory of pricing elaborated on in chapter 5 of this report. If this holds and access seekers will not be able to pass on cost increases, the intended effect of migration will not appear. Instead, profits will be shifted from the access seekers towards the incumbent, with the second effect, that this loss of profits will not be transformed into investments into other parts of the telecommunications network in France; such as the 5G network, as Bouygues Telecom claims¹²⁶. SFR further claims that Orange in the past years has been overcompensated for its copper network as it is largely depreciated. SFR claims that by this exceeded pricing access seekers have meanwhile contributed to the costs of dismantling the legacy network¹²⁷.

¹²⁴ SFR (2019), p. 15; Bouygues Telecom (2019), p. 33

¹²⁵ Bouygues Telecom (2019), p. 33

¹²⁶ Ibid.

¹²⁷ SFR (2019) p. 13

5 ULL pricing and copper switch-off

LLU prices form the benchmark for all other wholesale services. As a regulated service, NRAs seek to set prices for the LLU which represent the SMP regulated investments and foster competition at the same time. In the past years the LRIC standard has developed to be the most popular approach for LLU pricing across the European Member states. Despite its common use, this standard is not flawless and therefore also alternatives might be worthwhile analysing.

5.1 Pricing and incentives

In economic theory, pricing has a crucial impact on market participants' behaviour. Therefore, economist often argue and believe that efficient pricing is essential to achieve efficient behaviour of operators, access seekers and end customers. NRAs have the possibility to steer retail prices by setting wholesale prices, as these two are strongly related. The underlying economic assumption of being able to influence behaviour by price setting is that the market participants make their decisions based on margins and quickly adopt when prices changes occur. For example a small change of wholesale prices lead to retail price reactions and thereby the investment decisions of operators. Economic pricing paradigms are highly relevant and therefore important also to be considered when setting wholesale prices, yet the relevant experience from telecommunication markets has shown that often operators and end customers do not react at margin. Strategic reactions usually do not react to marginal price changes but (if at all) only to major changes of price levels and pricing structure. Therefore, prices are one parameter in the strategy determination which steers the outcome of economic behaviour.

Policy makers and regulators should be aware of this behaviour and of the relative importance of the pricing system compared to other factors when assessing concrete measures which impact the market and its participants. The importance of pricing might be increased by price segmentation (price discrimination): Different user groups or operators react differently on pricing measures and demand may therefore be elastic or inelastic depending on the market segment under observation. Therefore, in some segments pricing will play a significant role for decision makers and others may be subject to rather other factors. In particular, if a certain behaviour is ought to be triggered, regulators have to analyse this adjustment's impact and conclude whether or not adjusting the pricing scheme is an efficient measure to achieve the objective or whether other measures would be more suited. For this assessment, regulators have to be aware or identify:

- The relative importance of pricing,
- Other factors influencing the market participants in their decision making,
- Quantify the relative importance of all relevant factors, and

- Determine the efficient measure (or mix of measures) based on the gathered information

Wholesale price setting will affect two aspects of the market equilibrium. Firstly, high copper access costs consequently will lead to high retail prices for copper based products if the access seekers are able to pass on wholesale costs to the end customers. If copper based product prices are relatively close to the fibre based ones, an end customer might find the fibre product attractive and be incentivised to migrate. On the other side, an overcompensation for its legacy network, of which major parts may already be depreciated, the incumbent will not have incentives to switch-off this network and force migration towards fibre.

By economic theory, on competitive markets, competitors would set their prices equal to marginal costs (which do respect only for variable costs). As telecommunication markets are typically monopolistic markets, the incumbent will by own rationale put prices greater than marginal costs. Therefore, it is the task of the NRAs to oblige price setting which would be in accordance with competitive markets (“as-if competition”). Due to information asymmetries, marginal costs will not be implementable, so the second-best solution of average costs incurring for the production of a cost or service is the favourable approach for wholesale cost setting. The most common approach of determining the average prices is the cost standard of LRIC pricing.

5.2 LRIC Wholesale Pricing

In many European Members states wholesale bottleneck services are to be offered at a cost-oriented basis. This has been implemented under the so-called LRIC standard. LLU prices are to be determined on the basis of the current costs of an efficient copper access network¹²⁸. LRIC stands for Long-Run Average Incremental Costs:

- Long-Run means that the time span of new investments is included in the cost consideration. It also means that all inputs are generally considered as variable.
- „Incremental” means that the additional cost of a multi-product firm are relevant.

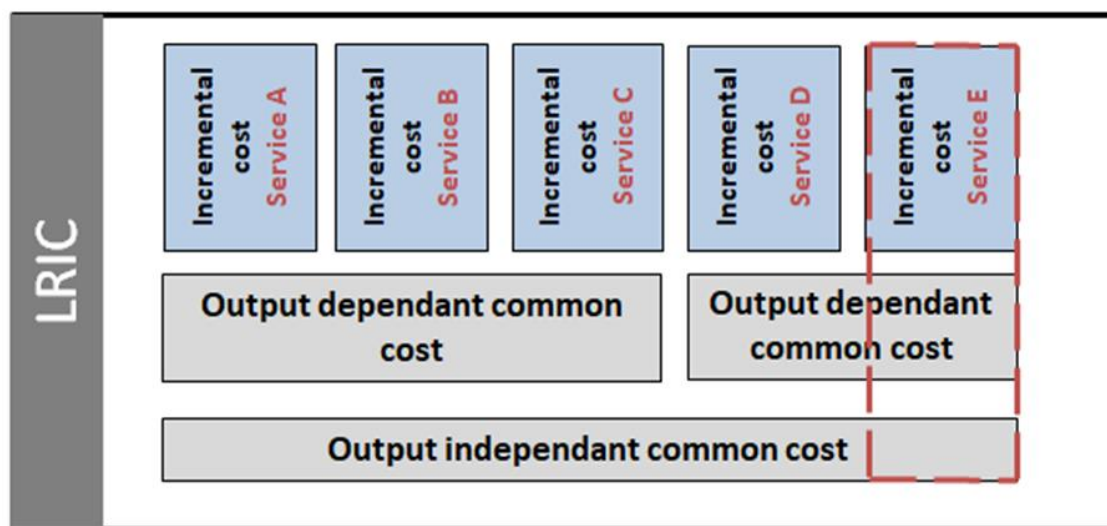
LRIC is a cost standard which, as a long-run measure, aims at the determination of costs an efficient production causes with all those variable and fixed costs (as said before, in the long run all costs are to be treated as variable) are included which are essential for the provisioning for a product, service, or a group of services. LRIC therefore covers all relevant costs including investment costs.

The following figure shows schematically the costs which are to be attributed to a certain service (“Service E”) which are its attributable incremental costs, which do not overlap with another service’s cost as well as output dependant common costs (rise

¹²⁸ In the process of a migrating network.

with the number of produced units of the service) as well as output independent common costs (such as land, buildings etc.). The common costs are often being accounted for in form of percentaged mark-ups.

Figure 5-1 LRIC cost components



Source: WIK

Setting wholesale prices by LRIC determination shall enable the incumbent to be able to regain its investments into the roll-out and maintenance of the telecommunications network, with the limitation that any inefficiencies shall not be accounted for and shall therefore not be regain able. Not only shall past investments be covered but also shall the LRIC prices provide incentives for incumbents to invest into their network. Market entrants and other network operators should be enabled by LRIC prices to enlarge their infrastructure leading to a decreasing share of network elements the alternative network operator has to purchase as wholesale input but produces on its own, which will lead to more service differentiation and pricing flexibility. On the other side, by setting prices accordingly, the environment of an “as-if competition” is created with wholesale prices which are ideally relatively close to prices that would be present on a competitive market. Therefore, LRIC pricing shall foster the aim of reaching competition on the service level. It shall further more lower barriers for market entrants and lead to an efficient market entry and therefore to an appropriate and efficient number of market participants (network operators). The LRIC should reflect that the network operators need to provide adequate qualities of service and at the same time, on the retail market enable them to provide low or affordable end user prices.

Lastly, as a concept, the implementation of the LRIC standard should be possible at reasonably low transaction costs. This means that the SMP network operator's as well

as other stakeholders' and authorities' effort to be able to implement this standard should not exceed its advantages which are listed above.

Despite the advantages which are ideally achievable on the telecommunications market, the application of LRIC is accompanied by certain difficulties. Firstly, the standard was developed for an expanding market (with regard to investments and maintenance of the network). As described before, LRIC is mainly being applied for price setting of the copper based LLU. This makes the contradiction apparent, as the cost standard for an expanding market is difficult to be applied for shrinking demand like for the service of copper access.

What is more, large portions of the copper-related costs are sunk which has led to significant overcapacities, given a decrease in demand on copper based access lines. These overcapacities are seldomly being accounted for in the traditionally calculated LRIC of NRAs. Incorporating only efficient capacities which would be an appropriate measure of actual forward looking costs should be lower than the LRIC.

Increasing input costs, which is of particular importance in the case of copper¹²⁹, lead to increasing access charges at current cost accounting as done by LRIC pricing. As a result, incumbents are being overcompensated for their past investment at low costs, when offering wholesale access today at increased charges.

Solutions have been found for a part of these problems by applying the LRIC calculations to a modern equivalent access (which is the chosen NGA technology) rather than on copper inputs. Yet not all NRAs follow this idea which was also postulated in the European Commission Recommendation on consistent non-discrimination obligations and costing methodologies¹³⁰.

A lasting critique of LRIC that under growing demand and market extension, economies of scales increase with the incumbent being the major profiteer of such scales. These economies of scale arise from a large portion of fixed assets which are typical for network industries, which are being allocated to the user base. When the demand is shrinking, the economies of scale melt away leading to increased costs per user which will particularly hit the alternative network operators and access seekers and make margin squeeze possible.

Given the problems that go along with the LRIC standard, it is worthwhile to investigate existing alternative pricing approaches.

¹²⁹ E.g. increasing copper costs

¹³⁰ European Commission (2013)

5.3 LRIC Wholesale Pricing plus Migration Tax

Arcep i.a. considers¹³¹ implementing a pricing approach lifting the LRIC prices by an additional component, which is intended to incentivise fibre investments¹³². By lifting the LLU prices above the level of cost-based calculation, alternative network operators shall be incentivised to migrate customers to their fibre network. The signal of the LLU pricing triggers the operators' build or buy decisions. The LLU-pricing exceeding cost orientation could be implemented in form of an explicit "migration tax", i.e. a component on top of LRIC based LLU costs. The tax could either be integral part of the LLU fee and therefore enrich the incumbent, or in form of an explicit tax forming part of public revenues. By economic theory, if the access seekers can pass on increased wholesale costs to retail prices, copper based products will become more expensive for end customers. The more copper based products in their retail prices approach retail prices for fibre-based products, the more such a price structure incorporates incentives for end customers to migrate to fibre products, because they promise higher bandwidths.

Therefore, raising the wholesale prices shall have the following implications for the end-customers which again shall drive operators' investment decisions:

- LLU prices which exceed the cost-based level will drive access seekers into facing massive losses or increase their retail prices correspondingly
- Higher ADSL prices should motivate more users to migrate towards fibre products.
- The increase in fibre demand shall incentivise network operators to extend their fibre networks.

In fact, the to be expected implications will not intensify fibre investments of alternative network operators but will strengthen the incumbent's market position. Knowingly raising the LLU prices above the level of cost compensation will increase the incumbents revenues and profits from the legacy network. This will incentivise the incumbent to maintain his legacy network rather than investing into fibre infrastructure. This effect could be damped, if the tax component of LLU prices form part of public revenue, which e.g. could be used for State Aid programmes of fibre roll-out. But if the access seekers face higher costs and react by raising retail prices, this will drive customers away from these alternative network operators towards the incumbent. Therefore, the retail pricing flexibility of the access seekers is very limited and passing on the increased wholesale costs to the end customers is limited to the retail price level of the incumbents' products. Therefore, the incumbent will face a favourable position having to choose between going along with increasing copper retail prices or receiving more clients from the competitors. The alternative network operators will face the opposite decisions of either raising retail prices and losing customers or facing costs

¹³¹ Arcep (2019f)

¹³² Additionally to the already implemented IFR.

which will diminish their margins. This problem will become particularly clashing in areas where the access seeker is not present with own fibre infrastructure and therefore has no opportunity to even theoretically migrate customers.

Similarly, the end customers' perspective will worsen either quite soon after the implementation of the increase of LLU prices facing higher prices even in areas where there is no fibre available or will suffer from less competition between the operators. A strengthened incumbent's position will in the longer run also lead to higher retail prices.

The behaviour of incumbent and alternative network operators will lead to welfare losses due to an artificially increased LLU price. On the retail side of the market, the expectable outcome will be that retail prices will not increase in the short run due to competition between the alternative network operators and with the incumbent and they cannot afford to lose customers. At the same time, the incentives for the incumbent to invest into a further fibre roll out and into migrating its customers diminishes. This again will lead to a distortion of the competition between the network operators strengthening the incumbent's position. A weakened competition might enable the incumbent to implement high end customer prices for fibre products as well. The current LLU pricing scheme already comprises a significant increase which should incentivise end customers to migrate to fibre based products and at the same time overcompensates Orange for its investments.

As a result, the measure under consideration of artificially increasing the LLU price does not match its intended effects but rather contradicts them. In the medium term such measure might even distort competition which will strengthen the incumbent's position who might use it for an increase of retail prices in the long run.

As shown in section 2.3 and 3.3.3 in practice retail prices seem rather stable and to a certain extent independent of investments in the telecommunications sector in France. Thus it can be assumed that the economic theory (passing on higher wholesale prices to customers) diverges from the effects that can be expected and observed in practice.

5.4 SRIC Wholesale Pricing

An alternative to LRIC based pricing can be the short-run incremental cost standard in order to create incentives for the incumbent to switch-off the copper network¹³³. In the short run, not all costs are to be viewed as variable, therefore the SRIC do not incorporate fix costs and therefore much better are able to reflect the marginal costs which form the basis for the producing operator's decisions in the short run. The short-run costs mostly consist of operational costs of the network as well as the repair maintenance. Fix costs are sunk and therefore do not affect the short run decision making. Only if the revenues of production in the short run exceed its costs, the

133 NERA Economic Consulting (2017), S. 87

producer of the respective service or good will produce and sell it. In the context of telecommunications this means that the incumbent will not have incentives to continue to provide services on his legacy network if the regulated wholesale prices are lower than the SRIC based prices. He will therefore not invest into further maintenance of the legacy network and decommission or dispose the corresponding assets. If the wholesale prices exceed the SRIC, the incumbent will still earn contributions to cover long-run or capital costs.

In a long-term perspective of the pricing regime, in order not to harm investments, it may be advisable to modify the SRIC to the SRIC+ approach in a way that it will cover the actual costs, including the costs of capital. The “+” element of this cost standard would allow for a return on assets which have not been fully depreciated¹³⁴. Applying SRIC+ instead of SRIC is a compromise between long-term investment incentives and the optimal incentives to switch-off an obsolete technology.

5.5 Copper Wedge Pricing

The concept of copper wedge pricing was originally developed by WIK in its study for ECTA (2011) on “Wholesale pricing, fibre take-up and competition”¹³⁵ and was further developed on behalf of Vodafone.¹³⁶ Vodafone submitted the concept to Ofcom where it is discussed in its current consultation (see 5.5.2).

Concerning the migration from copper to fibre, incumbents may have incentives to carry out this process at a suboptimal pace. NRAs could think about setting incentives by an adjustment of access prices in order to speed up migration. If prices for access to the copper network are lowered (also compared to access prices charged for fibre), e.g. down to SRIC (see 5.4), then the incumbent has an incentive to move off the copper network since renting it is not attractive anymore. On the other side, reduced charges do not incentivise access seekers to move off the copper network. The study conducted on behalf of Vodafone refers to this effect as the “access pricing paradox”. The copper wedge is one option to address this problem.

The idea is to optimise incentives of an incumbent to invest into fibre and at the same time create incentives for competitors to move off the copper network. If for both the access seekers and the infrastructure owner only one price is set, the transition to move to fibre cannot be optimally supported by pricing.

The concept of copper wedge pricing basically foresees that the price an access seeker is charged for the copper ULL is higher than the price the infrastructure owner receives

¹³⁴ Ibid.

¹³⁵ Hoerning et al. (2011)

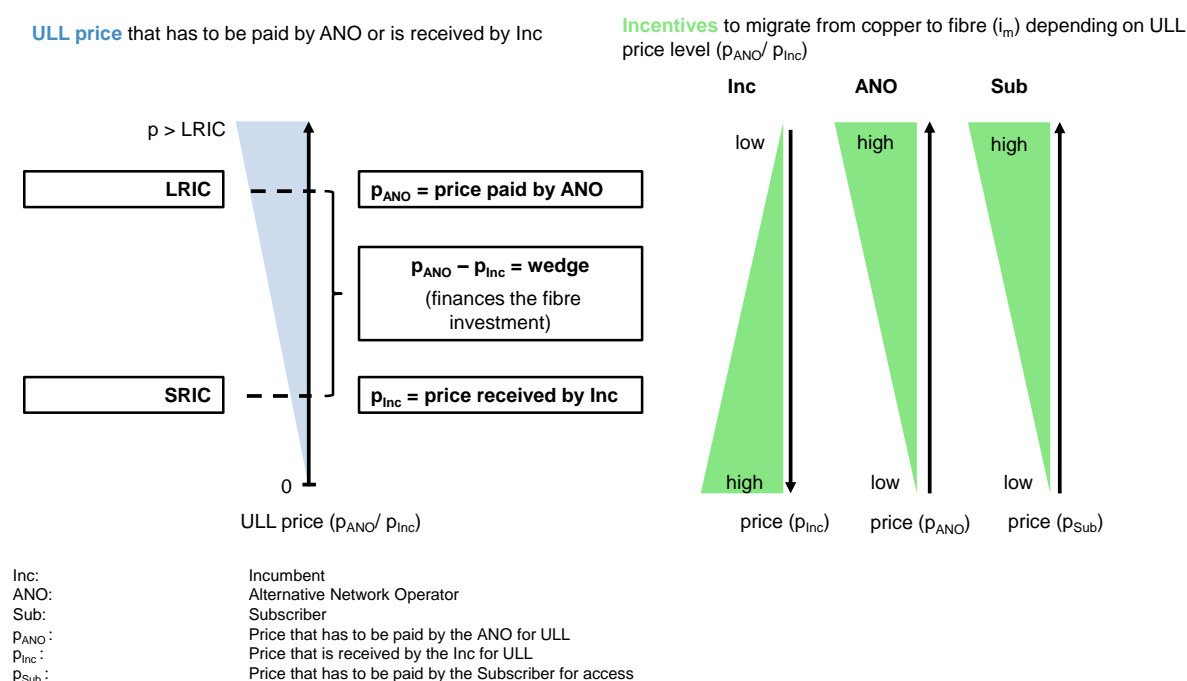
¹³⁶ Eisenach & Soria (2017)

for renting the copper ULL. The access seekers pays the LRIC price for the copper LLU while the incumbent will only receive SRIC+.

The difference will be put into an escrow account which could either be released to the incumbent if he actually conducted the fibre investment or which could be put into a fund to be allocated competitively neutral to all fibre investors in the market. The wedge model provides an effective tool for accelerating the transition from copper to fibre since wedge pricing increases incentives for both, incumbents and ANOs, to manage the transition to fibre more.

Figure 5-2 below summarises prices and incentives regarding the migration from copper to fibre for the different market players (the incumbent, ANOs and subscribers), e.g. the incumbent has lower incentives to move off the copper network the higher the ULL price p_{Inc} it receives is. For the ANO and for the subscribers it is vice versa.

Figure 5-2 Prices and incentives for the different market players in the copper wedge model



Source: WIK 2020

In the UK Vodafone put up the wedge for discussion in the context of Ofcom's consultation "Strategic Review of Digital Communications" in 2015.¹³⁷ Vodafone addressed in particular the concern that lower access charges for copper would reduce

¹³⁷ Vodafone (2015), p. 51

the incentives for access seekers to move away from the copper network by either switching their access to fibre networks or by investing into their own infrastructure. Thus the intended effect of migrating to fibre is either diluted or eliminated altogether.

5.5.1 Implementation

The study of NERA Economic Consulting for Vodafone¹³⁸ describes the implementation process of the wedge in three steps.

One step is the identification of areas where FTTH deployment is economically viable by private investment but is not deployed (yet). Those are the areas in which the wedge could incentivise the deployment of fibre networks.

A second step concerns the setting of the ULL prices. First, the one received by the incumbent (P_I) in areas identified in the first step such that it does not incentivise further investment into copper, e.g. SRIC+ (see section 5.4) and leaving the price paid by access seekers at or near LRIC (P_A) (see section 5.2).

When the incumbent has completed fibre in a certain area the price P_I will be increased to P_A or the access price regulation could be removed (if sufficient competition in the wholesale market is given) thereby rewarding investments.

5.5.2 Market dynamics concerning copper wedge pricing

Wedge pricing has not yet been explicitly addressed on a European level, therefore economic evidence is limited so far to national consultations.

The current discussion of the wedge, e.g. in UK¹³⁹, shows different aspects:

- a) Implications on the investments in fibre: If the incumbent receives less than what would cover actual cost, financial resources needed for the fibre investments would be missing, unless he like others investing in fibre can benefit from the funds in the escrow account at fair and non-discriminatory conditions
- b) Copper wedge pricing conflates two parts of the regulatory framework - 1) competition problems arising from market power; and 2) the universal service scheme for a minimum provision of services - Ofcom is not convinced whether it is appropriate to use “Copper wedge” to address a perceived gap in the provision, by mixing parts of the regulatory framework, which are intentionally separated

¹³⁸ NERA Economic Consulting (2017)

¹³⁹ Ofcom (2020a)

c) Challenges concerning the implementations

- Long process time for a new law if needed
- Uncertainty about the use of funds that the wedge produces, no guarantee if these funds stay in the telecom sector
- If implemented by using a tax this bears the risk of having another tax that stays longer than the migration process
- The upper price, the price paid by the access seekers (PP) must be left at or near forward-looking long-run incremental cost (FL-LRIC), any additional premium is contra-productive.

The wedge and further discussions in the current Ofcom consultation

In its current consultation, Ofcom assess different options of charge control in relation to LLU and wholesale local access by discussion how they perform against the objectives set: (i) supporting investment in fibre networks (ii) through promoting network competition (iii) while protecting consumers from excessive pricing or a loss of retail competition in the short term.¹⁴⁰ Thereby Ofcom distinguishes three areas:

- Area 1: High Network Reach Areas (HNRA): areas with high degree of rivalling networks to Openreach;
- Area 2: Areas with existing infrastructural competition of network operators, or where this seems at least economically feasible;
- Area 3: Areas where infrastructural competition by multiple operators is unlikely.

For these areas, Ofcom assesses different charge controls. Table 5-1 shows the assessed charge controls divided by areas under consideration. Options that have been discarded after discussion are not being displayed.

¹⁴⁰ Ofcom (2020a), p. 23 seqq.

Table 5-1 Pricing and non-pricing remedies by product and degree of competition

		Pricing remedies		Non-pricing remedies					
			Charge control	Network access ¹	Transparency	Quality of Service	EOI / Non-discrimination (ND)	No geographic discounts	
Product market									
low	Area 3	PIA	Physical infrastructure market	cost-based	✓	✓	x ²	✓(ND)	x
		Wholesale Local Access (WLA)							
		MPF (anchor)	cost-based	✓ ³	✓	as at 31.03.2021	✓(EOI)	✓	
		FTTC 40/10 (anchor)	cost-based	✓	✓	as at 31.03.2021	✓(EOI)	✓	
		FTTC (all other bandwidths)	cost-based	✓	✓	as at 31.03.2021	✓(EOI)	✓	
		FTTP or G.fast (all other bandwidths)	x Post-build RAB Post-copper retirement: 40/10 fibre premium	✓	✓	x ²	✓(EOI)	x	
		Access leased lines (LL)							
		CI Leased Lines (all bandwidths)	price continuity*****	✓	✓	as at 31.03.2021	✓(EOI)	x	
		Dark fibre	cost-based	✓	✓	As per Ethernet	✓(EOI) external	x	
		Wholesale Local Access (WLA)							
	Area 2	MPF (anchor)	price continuity	✓ ³	✓	as at 31.03.2021	✓(EOI)	✓	
		FTTC 40/10 (anchor)	price continuity	✓	✓	as at 31.03.2021	✓(EOI)	✓	
		FTTC (all other bandwidths)	x pricing flexibility	✓	✓	as at 31.03.2021	✓(EOI)	✓	
		FTTP or G.fast (all other bandwidths)	FTTC 40/10 price + premium ⁴	✓	✓	x ²	✓(EOI)	✓	
		Access leased lines (LL)							
		CI Leased Lines (all bandwidths)	price continuity	✓	✓	as at 31.03.2021	✓(EOI)	✓	
		Dark fibre	x	x	x	x	x	x	
high	Access leased lines (LL)								
	HNR	LL Access High Network Reach (HNR) At x "fair & reasonable"	✓	✓	x ²	✓(EOI)	x		
	Dark fibre	x	x	x	x	x	x		

¹ Including physical network adjustments where necessary in order for telecoms providers to be able to deploy their own networks. ² Voluntary KPIs. ³ Removal of General Access requirement for new copper services. ⁴ Only where a copper based 40/10 service is not available. ⁵ Only as protection during the transition period, as dark-fibre access is the primary focus of this regulation. "Price continuity": flat prices in real terms, inflation-adjusted from 2021 levels (CPI-0% control). "Regulatory Asset Base (RAB)": costs of investing in FTTP and G.Fast will be recovered across FTTP and G.Fast services and legacy MPF and FTTC services through the K factor, which will vary depending on the size of that fibre investment. Wholesale Fixed Analogue Exchange Line (WFAEL), Integrated Services Digital Network (ISDN) and Wholesale Broadband Access Market (WBA) are no longer markets suitable for ex ante regulation.

Source: WIK based on Ofcom (2020a)

To sum up the strategy in **competitive areas (Access High Network Reach)** Ofcom concludes to remove regulatory restrictions on Openreach's broadband products to encourage investment and innovation.

In **potentially competitive areas (Area 2)** a regulation scheme shall be designed that reduces overdependence on Openreach's network, facilitates network competition and shall unlock investment in fibre networks while ensuring sufficient consumer protection. This shall be achieved by 6 measures: 1. By opening up ducts and poles to reduce competitors' costs of network roll-out and guarantee network access for wholesale products. 2. By prohibiting geographically-targeted discounts to protect new entrants. 3. By controlling commercial terms that create barriers for using alternative networks. 4. By maintaining flat, inflation-adjusted, regulated prices ("price continuity") for Openreach's entry-level superfast broadband service (defined as max. 40 Mbit/s)¹⁴¹ to

¹⁴¹ Ofcom (2020b), p.3

provide stability and certainty to investors. 5. By not regulating prices of Openreach's higher-speed packages to encourage innovation. 6. By letting Openreach charge slightly more for products delivered via fibre.

Ofcom's strategy in **non-competitive areas (area 3) foresees** regulating prices and encouraging Openreach to invest in order to best serve the interest of consumers against the background of potential competition in these areas. This should be done by: 1. Allowing pricing flexibility on Openreach's fibre services and permitting to cover its costs across a wider range of services, ("regulated asset base" RAB model) including existing copper services in order to broaden the base and enable investments. 2. Otherwise, for MPF¹⁴² and FTTC products, apply a cost-based charge control. For access leased lines, Openreach is required to provide a dark fibre access service.

The wedge was one of the options discussed as a charge control only for wholesale local access products in area 2.¹⁴³ The options assessed were:

- a) *"Pricing continuity: keeping price caps the same in real terms, on wholesale services they currently apply to, and not imposing new charge controls on services not currently subject to charge controls.*
- b) *Cost-based controls: setting price caps on Openreach's wholesale prices across all services in line with costs.*
- c) *"Adaptive regulation': this would have two parts: (1) cost-based controls before rival fibre rollout has occurred in an area; (2) a price floor (with reference to an entrant's cost) once rival fibre rollout has occurred in an area.*
- d) *A 'copper wedge': introduce a gap between the price charged to access seekers for services delivered over the copper network and the price received by Openreach, and use the resulting funds to promote FTTP rollout in competitive and non-competitive areas."*¹⁴⁴

The last two options have been discarded by Ofcom.

Adaptive regulation, based on (1) cost-based controls prior to rival's fibre rollout and (2) a price floor (with reference to an entrant's cost) after a rival's fibre roll-out was discarded for the following reasons: The resulting incentives are evaluated as not strong enough and it could lead to potential legal issues (complex to implement and the administrative burden).

The copper wedge is understood to support a competitive network investment and to create incentives for Openreach to increase investments into its FTTP infrastructure

¹⁴² metallic path facility

¹⁴³ Ofcom (2020a), p.3

¹⁴⁴ Ofcom (2020a)

driven by diminishing profits on copper based products. Ofcom does nevertheless not consider it to be as effective as pricing continuity, as it does not allow Openreach to earn revenues above its cost and provide a direct contribution from copper to FTTP roll-out. Ofcom does neither discuss the escrow fund approach and its effects of fairness nor the thread of abuse of a tax income for not fibre roll out related purposes. Additionally, since this measure conflates two parts of the regulatory framework - 1) competition problems arising from market power; and 2) the universal service scheme for a minimum provision of services - Ofcom is not convinced whether is appropriate to use “copper wedge” to address a perceived gap in the provision, by mixing parts of the regulatory framework, which are intentionally separated. Ofcom seems to prefer a market let allocation of investments.

5.6 Pricing flexibility

Already by 2016, Arcep had proposed assigning more copper pricing flexibility to Orange but had ultimately not followed this approach in its 2017 decision¹⁴⁵, after the consultation phase. In the 2019 public consultation it was again made an issue to discuss, whether pricing obligations should be lifted by abandoning a strict cost-based approach for the copper LLU. If this suggestion would be set into force, Orange would be free to set LLU tariffs in areas where sufficient fibre has already been rolled out and would not be bound to regulatory cost-based calculations, yet still bound to “non-excessive” pricing, as Arcep suggests. Since one major advantage of cost-based pricing is the predictability of wholesale prices, this effect would get lost, if Orange would be given complete flexibility in pricing. Therefore Arcep suggests as well defining price caps which could be expressed in dependence of cost-based calculations in form of mark-ups. Secondly, a maximum yearly increase percentage of LLU fees would be implemented by Arcep.

But does loosening the cost-based obligations necessarily mean increased LLU fees as determined by Orange? The question may be answered by clarifying whether or not Orange would profit by decreasing LLU tariffs. From an overall end customer perspective, declining copper wholesale tariffs might lead to decreasing retail tariffs for copper based products and therefore would reduce incentives for customers to migrate from copper towards fibre-based products, which would be relatively more costly. Another effect of access seekers decreasing retail prices given lower wholesale costs would be that the incumbent’s clients will move to competitors, which Orange could only avoid by going along with the retail price decrease and thereby decreasing own profits. If the access seekers should not pass on the decreased wholesale costs to their end-customers, Orange will still face decreasing revenues from its wholesale business. In the unlikely market situation, that Orange will decrease retail prices, which the access seekers do not go along with, Orange would be able to increase its customer base by

¹⁴⁵ Arcep (2017b)

costs of even more diminishing profits. Therefore, it concludes that it cannot be expected that increased wholesale pricing flexibility would incentivise Orange to lower the LLU prices.

In case Orange would, against its rationale, decrease copper-based wholesale fees with the intention of intensifying price competition on copper-based retail products, this would keep end-customers away from fibre products. This again could be in favour of Orange in the long-run, as alternative network operators who have invested into fibre infrastructure would not be enabled to realise the necessary client base on this infrastructure and would therefore not regain their investments, while Orange would not be affected similarly, as they could rely on the relatively increased importance of the copper network – wholesale and resale. This again might push market participants out of the market and strengthen Orange's market position in the long run and slow down fibre migration massively.

Lifting regulatory obligations in setting LLU fees, would lead to increasing LLU tariffs, weakening the access seekers by short term until the completion of the fibre migration. As Orange confirms in its response to the 2019 public consultation, the incumbent will use loosened obligations to raise the LLU tariffs¹⁴⁶.

If Orange decides to use loosened obligations to increase wholesale tariffs, the situation and therefore other implications will be similar to the one discussed under section 5.3, LRIC + migration tax.

5.7 The limitations of pricing

As introduced in section 5.1 of this report, there are limits of provoking end customer and market participants reactions by pricing and therefore steer the desired outcome. As experience shows, user behaviour yet is far more complex than being able to be steered by one parameter. In this point of discussion, fibre migration is the desired outcome which is also influenced by other factors and all factors differently affect user groups. Customers with high bandwidth preferences will rather independently of the retail prices switch to fibre as soon as it is available, given their higher willingness to pay for high bandwidth. Experience shows, that about 1/3 will remain unaffected by pricing due to reluctance of opening their in-house cabling to be replaced by fibre, which might also be reasoned by legal causes. Just like there is a group of high bandwidth affine users, there will remain a group of subscribers without the need to upgrade a telephony only- or a narrow band subscription. By 2018 the share of narrow band subscribers in France was still 25 %, with a good share within these number of costumers that have technical access to higher bandwidths. Therefore, it will remain a fourth group of end customers that may be addressed by specific financial incentive measures to motivate their migration. As a result, only this group will react to wholesale-

¹⁴⁶ Orange (2019b), p. 18

caused retail price changes. A way of migrating other customer groups is by realising new accesses only by fibre, if available. Forced migration will not be pushed by operators as it will decrease customer satisfaction and therefore will increase churn rates. As SFR in the 2019 feedback of public consultation puts it: “In the case of existing customers, the speed of migration strongly depends on the customer's willingness to migrate to the new technology.”¹⁴⁷

Consequently, Regulatory Authorities should be aware that pricing alone is not the just means to achieve efficient fibre migration. As explained, pricing will only affect a small share of all subscribers and their willingness to migrate. In order to force migration on costs of customers' satisfaction, wholesale and retail prices would need to be raised to unreasonable levels. At the same time, network operators competing for customers, will not establish the perfect migration equilibrium, as the explanations of the previous chapters have pointed out.

¹⁴⁷ SFR (2019), p. 15: “*Dans le cas des clients existants, la vitesse de migration dépend fortement de l'appétence du client à migrer vers la nouvelle technologie.*”

6 Regulatory options and their assessment

In the previous chapter, various alternative approaches of copper LLU pricing have been analysed with regard to their respective effects on copper switch-off on the one hand, and their implications for end customer behaviour and their incentives to migrate to fibre products on the other hand. Yet as stated, pricing can be only one parameter of steering operators' decisions. Therefore, other regulatory options may be imposed in order to support the aim of accelerating a legacy network switch-off and a coherent end customer migration.

Overall, such obligations should aim at:

- Fostering a PSTN towards NGN (All-IP) migration, as a PSTN switch-off is a prerequisite for a copper switch-off;
- Removing regulatory constraints of the fibre migration;
- A reduction of closing periods;
- Earlier initiation of copper switch-off;
- Opening the obligations for USO and facilitate provision on alternative (mobile) infrastructures.

If the national NRA Arcep is not sufficiently legally empowered to actively manage the PSTN and copper switch-off framework in France we strongly recommend an appropriate legal initiative. Otherwise we see no realistic chance to control and manage to achieve the goals.

By October 2018, Orange has announced its plans of the PSTN switch-off: By end of 2018, the commercial closure of PSTN lines for residential clients was completed, one year later for business clients. PSTN lines shall though be operated and only be actively (enforced) decommissioned with the initialisation of the copper switch-off beginning in 2023.¹⁴⁸ The technical closure of the PSTN lines is, according to Orange, in line with the notice period of 5 years after commercial closure¹⁴⁹¹⁵⁰.

Orange claims to be bound to a 5 year period after the commercial closure of PSTN services before being able to decommission the physical infrastructure of the legacy network. Since this period is massively delaying the copper switch-off, the implications of such regulatory obstacles should be revised. A possible solution would be to allow for the decommissioning in areas where an area has been declared as "fibre-ready" instead of waiting for a nationwide VoIP migration in order to be able to initialise a nationwide switch-off. In such fibre-ready areas, PSTN switch-off and fibre migration

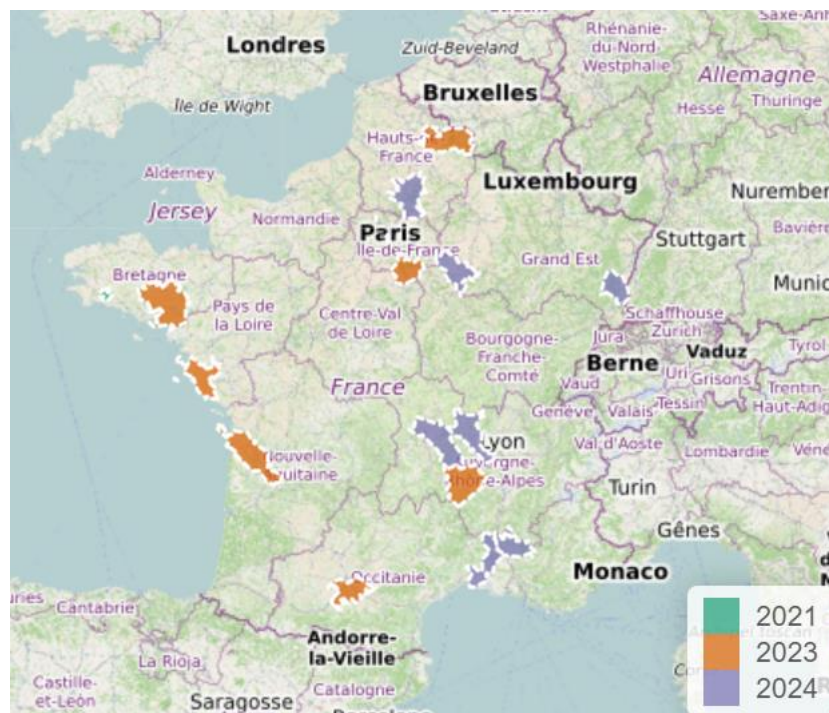
¹⁴⁸ Orange, <https://www.orange.com/fr/actualites/2017/fevrier/Orange-modernise-son-reseau-de-telephonie-fixe-vers-le-tout-IP>, accessed March 23rd 2020

¹⁴⁹ Orange (2018), p.3

¹⁵⁰ Arcep, <https://www.arcep.fr/demarches-et-services/utilisateurs/consommateurs-arret-rtc.html>, accessed March 23rd 2020

may also be conducted in one single step or within a reasonably short period of time of e.g. 3 months. Currently, Arcep proposes criteria for the definition of “fibre-ready” areas (see chapter 3.3.4) where copper switch-off may be conducted, which refer to the physical presence of fibre and to the competitive situation. But also if these criteria are met, a copper switch-off may be limited because PSTN switch-off has not yet been fulfilled in the respective area. In such a case, PSTN switch-off would form a bottleneck. As Figure 6-1 shows, the Orange-declared areas of a PSTN switch-off are (status 2020) still very limited which can be seen as a massive obstacle for fibre migration. Therefore, the regulatory obligations for PSTN and copper switch-off should be more aligned, which could be achieved by shorter notice periods for the PSTN switch-off, particularly because in a fibred area, technical requirements for a VoIP-migration will have been met by definition.

Figure 6-1 Announced Zones for PSTN Switch-off



Source: Arcep; <https://www.ARCEP.fr/demarches-et-services/utilisateurs/consommateurs-arret-rtc.html>, accessed March 23rd 2020

Besides PSTN-VoIP migration which has implications for the copper network switch-off, French regulation has currently imposed various other obligations that hinder a fast copper switch-off directly. These are:

- Unduly restrictive conditions for closing copper exchanges (e.g. long notice periods)

- Obligations to continue to supply copper-based wholesale products
- Keeping USO obligation related to copper network products

For the decommissioning of the LLU regulation currently foresees a five year notice period for other operators before closing the copper MDF. This period is unduly restrictive and therefore be shortened. As the example of copper switch-off from Sweden shows (section 3.5.1), the where copper switch-off has far progressed already (ca. 50 % of all MDFs), the NRA considers shortening notice periods from 5 years to 18 months in order to even accelerate the progress and tackle the switch-off of the latter 50 % of MDFs. Therefore 18 months' notice period should also be a reasonable period for the French market. As presented by Arcep in its 2020 consultation document, criteria are defined as when an area can be regarded fibre-ready. The technical closure after declaration of a fibre-ready area should be completed after 30 months. A commercial closure of copper products in fibre-ready areas should be very short. Arcep proposes one month for residential clients and 6 months for business clients, which is in line with WIK's recommendation of an average of 2-4 months.

In cases where fibre-readiness criteria are not completely met in terms of available competition, we suggest that Arcep should yet be able to declare the area as eligible for copper switch-off and may therefore grant an extension of the period of commercial closure. Thereby, Arcep should have the decision power of when to declare fibre-readiness. Yet, declaration of such zones should be in line with a priori defined migration paths and fibre roll-out plans and should define certain milestones. Such plan should foresee that a significant amount of areas will already meet the defined criteria and therefore switch-off should be initiated immediately in the respective areas. The granularity of areas eligible for fibre readiness shall move from whole MDF areas down to the access areas of mutualisation points. Such small granularity supports a quick migration progress compared to whole MDF areas where small segments could hinder or delay the migration as a whole.

A notice period of 18 months should go along with a short notice period for end customers. A 12 months period can be considered sufficient to migrate a customer from copper to fibre (or to other technologies, e.g. based on fixed mobile solutions, in exception cases).

A short notice period is a necessary, yet not a sufficient prerequisite for a fast switch-off. Another hindering aspect are QoS obligations that are being kept up for copper lines, where sufficient fibre has already been deployed. In a declared fibre-ready area, such obligations should be dropped. This will motivate access seekers to migrate their end customers towards fibre infrastructure, as service quality can no longer be guaranteed on the legacy network.

A similar impact like QoS do USO have on the switch-off process. The Ministry of the Economy and Finance defines USO as being to be delivered to 99 % by copper or fibre

and for the whole network for only 1 % of cases alternative solutions like fixed mobile/wireless solutions are allowed to cover this obligation¹⁵¹. The USO could be defined technologically neutral in order to loose constraints this forms for fibre operators of areas where (slightly) more than 1 % of households are remotely located so a fibre roll-out would not be able to be implemented. At the same time, in densely populated areas, no FWA solutions will be required. Therefore, optimally, it should be made to area-specific analysis to what extent USO may be provided by alternative network solutions.

As a result, apart from pricing policy, other aspects of regulation have to be revised in order to reduce obstacles for the fibre migration and copper switch-off. This means that particularly a PSTN switch-off should not form a bottleneck for copper switch-off in an area where fibre has been completely rolled out and competition is fierce. It might be worthwhile to revise respective notice periods.

Handling a demand gap

As shown in section 2.3 the relationship between supply and demand for fibre in France can be characterized as a demand gap. A gap between demand and supply of fibre is not in line with the targets of the French fibre infrastructure policy and it is not in line with economically efficient outcome.

It is an important challenge for the French communications policy to solve the demand gap and manage the transition of all customers and their access lines from the copper to the fibre network. While the deployment targets are well defined and in a successful implementation mode solving the demand gap is a less defined policy target from a strategic and an operational perspective.

Regulatory measures for fostering and supporting the migration process of customers should be assessed, and if evaluated as appropriate, be strategically defined in a comprehensive way. Thereby, the positive effects of potential market interventions must be carefully evaluated in front of possible market distortions. Possible instruments and lessons learned from other countries should be taken into consideration (see section 3.3.3).

Applying a consistent pricing approach

As explained in section 5.1 and 5.7 pricing alone is not the just means to achieve efficient fibre migration. As stated, pricing will only affect a small share of all subscribers and their willingness to migrate. Even if pricing is/should not be the main vehicle to achieve migration (for the above named reason) it should nevertheless a) be consistent within the regulatory framework and b) should not have a negative effect on migration.

¹⁵¹ Ministry of Economic and Finance (2017)

a) Inconsistency in the regulatory framework

Arcep implemented in its 2012 pricing decision, approved by its 2017 decision, the reduction of the depreciation period of the legacy copper cables from 25 to 13 years. Because the French government is striving for 100% coverage with high speed broadband by the year 2025, Arcep decided to thereby "send a strong signal" and assume that all copper cables currently in use should be fully amortized by 2025.¹⁵²¹⁵³ We believe this decision to be inconsistent, as described in sections 4.1.2 and 4.2.1. In contradiction to this planning Arcep's Chairman Sébastien Soriano anticipates that the dismantling process of Orange's copper network will be completed by the 2020's (see section 4.3).¹⁵⁴ Apart from Soriano's statement, as of today, it seems unrealistic to assume that the copper network will be completely switched-off by 2025. Thus Orange is now profiting from a soon depreciation of its copper network and could gain additional profits if the copper network is still in use after 2025 (given that the ULL price is not dramatically reduced after 2025). From today's perspective it seems that the pricing policy from 2012 is not in line with the current state of copper switch-off. If after 2025 wholesale profits are still generated through marketing the copper network the current ULL prices thus have to be evaluated as excessive and should therefore be adjusted, taking into account that the copper assets are fully depreciated.

b) Possible negative effects of increasing LLU tariffs on migration

As Arcep describes in their 2017 decision setting LLU prices for the years 2018 – 2020, relying solely on the BU LRIC cost model would have led to a price increase from 8.59 € in 2018 up to 10.71 € in 2020 which equals a 25 % increase over three years (see section 4.2.1). This increase is mainly resulting from a decrease of active copper lines.¹⁵⁵ Given the aim of a copper switch-off by 2030, this effect might even intensify resulting in an even harsher increase of prices, given that this cost model may give a realistic outlook of the costs increase of the operation of the copper network and provisioning of copper based services. Any additional increase of tariffs is counterproductive for the copper – fibre migration (see section 5.3). It just motivates the incumbent to keep the profitable copper network alive.

c) Constant pricing

Looking from the market and reflecting the arguments and solutions for price decrease, increase or splitting the price by introducing a wedge in a critical manner we propose to follow the British NRA OFCOM's decision that pricing continuity is its preferred approach. This would also be our conclusion for France. As further applying the current

¹⁵² Hence the (remaining) lifetime should be 13 years.

¹⁵³ Arcep (2012), p. 5

¹⁵⁴ LesEchos (2020), p. 2

¹⁵⁵ Even though the portion of copper lines compared to the portion of fibre lines which drive the cost has already been reduced (see Table 4-1).

costing methodology would not generate pricing continuity we propose to freeze the current ULL price level for the relevant future.

7 Conclusions

Despite the economic fascination of pricing measures to optimise the migration path to fibre our overall conclusion is that other regulatory measures are more suitable and needed to develop an efficient migration path in France.

We propose the need for a regulatory masterplan which not only formulates measures to protect market players (operators, access seekers, end users) in the incumbent driven copper switch-off process but also sets targets and obligations for the switch-off process itself. The latter targets and measures in particular aim at fostering the migration process towards fibre. Such measures are in our view important because the operator driven switch-off process proves to be rather unambitious and slow. Regulatory action in this regard is necessary because the market dynamics of the last few years show that the competitive interaction of operators alone is not generating the migration of a switch-off process which exhausts all economic benefits inherent in the availability of fibre in France.

Setting migration targets

The following proposal is based on the assumption that Arcep is legally empowered to actively manage the copper switch-off framework in France. If that is not sufficiently the case we strongly recommend an appropriate legal initiative. Setting the targets of a copper switch-off first requires to manage the PSTN switch-off.

- Develop and agree a PSTN switch-off schedule aligned with the fibre roll out in a way that PSTN switch-off cannot delay copper switch-off.
- Orange shall be mandated to switch-off PSTN latest when fibre readiness is declared.
- For a small part of remaining PSTN customers the migration from PSTN to VoIP may be conducted together with the migration from Copper to fibre access lines in one step.

For copper network switch-off the following tasks have to be performed:

- Arcep should set a time plan for copper switch-off which is in line with the upcoming and existing fibre roll-out in France.
- Whenever an area is declared as fibre ready according to a relevant list of criteria migration and switch-off should be mandated in that area not later than 30 month. Within that period all customer would have to be migrated to fibre.

Removing regulatory constraints and facilitating migration

- Arcep should define USO network obligations technologically neutral. Currently the USO is ought to be provided by 99 % via copper and fibre and limited to 1 %

via FWA (or mobile solutions). With the aim of a vast fibre roll-out, the number of accesses requiring FWA in rural areas may exceed 1 %.

- Change current access obligations (i.e. fault recovery process) such that they are in line with the copper switch-off plan
- Lift obligations to support special PSTN and copper dedicated services, which cannot be provided over VoIP. Remove any copper line power obligations.
- A not completed PSTN switch-off can be an obstacle for copper switch-off, even if an area is “full-fibre”. Therefore, notice periods for PSTN switch-off should be kept short.
- Take care that wholesale agreements regarding the PSTN or copper migration towards NGN respectively fibre do not foresee termination or migration fees for wholesale customers. If the regulatory framework allows to do so, to forbid migration and termination fees for end users could be supportive, as well.
- Regulatory or legislative support for operators to migrate customer contracts from copper to fibre based products in dedicated time frames consistent with the switch-off path (ability to terminate or change end user contracts)
- Remove copper line related quality obligations in fibre ready areas

Apply an active migration policy

- The copper switch-off process should start in an area of the network which has been declared of being fibre ready by Arcep based on transparent non-discriminatory criteria. The minimum size of such area can be the access area of the mutualisation points. Such small granularity supports quick migration progress compared to whole MDF areas where small segments could hinder or delay the migration as a whole.
- Relevant criteria for fibre readiness should be:
 - Fibre access line coverage by at least one fibre network within the whole area is given
 - The area is defined by operators committed deployment areas and at least should cover all homes addressed by a mutualisation point
 - At least one active wholesale offer with at least comparable quality to those on copper in the same area must be available
 - Furthermore customers should face competitive choice for fibre products by at least three operators present (building operator plus two coinvestors) in the mutualisation point, which have proved their market relevance by a certain market share or number of customers

- In a short period (i.e. 2-4 months) following the fibre readiness declaration operators should stop of commercially selling the copper access lines and related products (commercial closure).
- Existing copper access lines should be supported until they are switched off. Switch-off shall start after 24 month (begin of technical closure). Total migration should be terminated no longer than 30 months (end of technical closure)
- In case there is not yet a competitive market structure (less than three operators) Arcep may nevertheless declare the area as fibre ready but extent the period of commercial closure, begin and end of technical closure by six month each.

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