The Price of Copper and the Transition to Fibre (*)

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Abstract: The question of how to price access to the copper network during the period of transition to fibre has attracted much attention, both from regulators and in reports prepared by consultants (notably Plum Consulting and WIK Consult) acting for different groups of operators. Our paper considers three regulatory objectives - the two familiar ones of efficient cost recovery and efficient entry, and an additional one of efficient migration to fibre. It examines a range of possible pricing principles including the LRIC, HCA and CCA approaches, and mixed HCA/CCA approaches observed in France and the UK. These are simulated using a data set for the copper local loop in France, prepared by the regulator, ARCEP. Recognising that the number of instruments available to the regulator is less than the number of objectives, the paper proposes an approach which ensures nearly exact cost recovery, and which takes separate account of the obsolescent copper and of the continuing value of the trenches and ducts which contain it. Where full cost recovery allows it, the price of access to the physical works should be lowered to encourage the transition to fibre. The simulations show that the access prices associated with the proposed approach are lower than those derived from CCA and LRIC methods for pricing copper.

Key words: access regulation; asset valuation; NGA networks.

It is virtually certain that in due course high speed fibre networks, with lower operating costs, will replace copper access networks for a majority of fixed subscribers. In Europe, transition to next generation networks is a major objective of the Digital Agenda [1]: "The Europe 2020 Strategy […]

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restated the objective to bring basic broadband to all Europeans by 2013 and seeks to ensure that, by 2020, (i) all Europeans have access to much higher internet speeds of above 30 Mbps and (ii) 50% or more of European households subscribe to internet connections above 100 Mbps." To achieve these objectives, it is necessary to accomplish a wide deployment of next generation access networks. The replacement decision is greatly complicated by an access regime in the European Union and elsewhere which has required the incumbent telecommunications operator (the only fixed operator passing the homes of a substantial majority of the EU population) to make its copper loops available to competitors. To accomplish the transition, several operators in any location have either to switch their customers to fibre or to risk losing them. Especially when the old and new networks are in common ownership, the social benefits of accomplishing the switch are unquestionable, as it shortens the period of costly duplicated operation of two networks. But the interests of the owner of the access network, with its retail customers, and of rival operators, with their customers, may not be the same. A further complication arises if the ownership structure of the copper network differs from that of the fibre network, as a result, say, of co-investment in fibre by multiple operators.

The transition process can, however, be affected by regulation. The price of access to copper unbundled loops in the EU is almost invariably set by the national regulator, within the European Regulatory Framework. More recently, in the age of fibre, access arrangements have developed to embrace separate access to the civil works, especially ducts, as well as the copper or fibre conduit.

The existence of such regulated access prices creates both an opportunity and a challenge for regulators. Their decisions concerning the absolute and relative levels of such prices have various effects: on market shares in broadband, on the speed of construction and coverage of new fibre networks and the scope of inter-modal competition, and on the transfer of customers from copper to fibre. The European Commission's Recommendation on the regulation of next generation access network offers only limited guidance, but the importance of the copper access price in the

[1] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Digital Agenda for Europe. COM/2010/0245 f/2 26/08/2010.

transition to fibre was raised in a recent consultation by European Commission. [2]

The 'price of copper' has thus become a major regulatory topic, with contributions of a theoretical and policy kind from academics and regulators, as well as operators and their consultants. In this article we seek to locate the discussion firmly within the past history and enduring logic of calculations of regulatory value of the local loop. We also utilize for the purpose of comparisons of alternative approaches a detailed data base of the local loop of France Télécom, prepared by ARCEP, the French telecommunications and posts regulator [3]. But the questions we answer are the same as those addressed in other contributions - what is the best policy for pricing copper in the transition to fibre?

There are multiple theoretical works on the impact of access regulation on the investment incentives, [4] but not many of them have considered the question of access pricing in the context of transition to a new technology. BRITO *et al*. (2008) study the regulator's commitment problem. Lack of commitment may impede investment in the next generation network by the incumbent. They check whether a two-part tariff for access to a next generation network may solve this problem. They conclude that it is possible only under certain circumstances and if the fixed fee is not too high. BOURREAU, CAMBINI & DOGAN (2011) study investment incentives in next generation network both of an incumbent and of an alternative operator. They find that if access to fibre local loop is not regulated, the optimal copper access price should be determined as a compromise between three opposing effects: 1) the investment incentives of the alternative operator increase with copper access price; 2) the investment incentives of the incumbent decrease with copper access price; and 3) consumers' incentives to migrate to fibre increase with the copper access price. While the present article covers some of the same ground, as will become clear, our approach is different.

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[2] European Commission (2011b).

[3] In the absence of reliable accounting data on the annual investment values of France Télécom before 1993, ARCEP built in 2005 a simulated accounting database to settle the cost orientation of unbundling tariffs. The detailed results of this task have been published in the decision no. 05-0834 (http://www.arcep.fr/uploads/tx_gsavis/05-0834.pdf). To our knowledge, it is the only accounting cost reference for unbundled tariffs that is publicly available. All methodologies have been simulated with the parameters published in this decision.

[4] See ARMSTRONG (2002), VAREDA & HOERNIG (2010), KOTAKORPI (2006). For a recent account of work in this area in the context of next generation access models, see BOURREAU, CAMBINI & HOERNIG (2012).

Pricing objectives and their interpretation in the present conjuncture

Two traditional objectives of access pricing in general and of the local loop in particular are:

a) *A copper cost recovery objective*, according to which regulated firms are given an incentive to make further sunk investments by the regulator adhering to commitments to allow the recovery of efficient costs already sunk. In the interests of regulatory commitment and certainty, it is desirable that efficient costs incurred by the incumbent operator, including the capital and operating cost, should be recovered. Capital costs should include a component remunerating *ex ante* risk. For the civil engineering assets - the trenches and ducts which are required for both copper and fibre networks, simple HCA (historic cost accounting) or CCA (current cost accounting) pricing rules satisfy the condition. For the copper cable, cost recovery should imply the accelerated depreciation (for instance with volume-adjusted tilted annuity) to anticipate the retirement of copper cable in favour of fibre.

b) *An efficient entry objective*, according to which prices should be at a level which encourages efficient entry and discourages inefficient entry. This includes cases where zero entry is efficient, as is the case with copper networks in present circumstances. While a wide variety of valuations can achieve the former objective, in application to a continuing technology some form of current cost accounting or LRIC pricing has usually been favoured, in theory at least. Nevertheless, it cannot be optimal to continue using the same LRIC models based on the copper as the modern equivalent asset, when it is about to be replaced by fibre. So a change in methodology may be necessary. If it leads to cost over-recovery, this in its turn may lead to a distortion of the market. In the simplest market situation, where the incumbent operator holds a monopoly in copper and has already deployed fibre, the efficient entry objective is not relevant at the infrastructure level. Nevertheless, in several European countries or areas inside countries, a fibre network is being constructed by an alternative operator or by a consortium of several operators (sometimes including the incumbent); or in some other countries multiple fibre networks are deployed. The efficient entry objective requires that competition between operators is not distorted. This includes competition between fibre and copper networks, as well as competition between different fibre networks. Attention should be focussed on the behaviour of the incumbent which owns the copper access network and the underlying civil works. Monitoring potential distortions between players is a key success factor for the promotion of fibre investment. The

first and the second objectives together lead to the principle of strict recovery of copper local loop costs, especially in case of possible different owners of copper and fibre local loops: under-recovery impedes incumbent investments and over-recovery is an obstacle to undistorted competition. Of course, achieving this exactly in practice may be problematic. These two objectives have been shown to fit quite comfortably together. However, in the transition to fibre, a new pricing objective can be identified:

c) *An efficient migration objective*, ensuring a desirable transition by creating appropriate incentives on the part of operators and consumers to switch to fibre and switch off the copper network as soon as possible. The access price of copper has an impact on fibre investment and customer switching incentives through the retail price. A lower wholesale copper price leads to a lower retail copper price and, consequently, because copper and fibre connections are substitutes, to a lower retail fibre price. Thus data from a number of countries suggest that consumers are not ready to pay much more for fibre access than for the copper access, both services belonging to the same market of broadband and super-fast broadband.

Among the named objectives, the first one concerns incumbent's incentives, the second one - potential entrants' incentives, and the third one - all operators' incentives, because all of them may invest in fibre. Our analysis shows how these objectives may be (at least partially) achieved during the transition period and how investment in fibre may be elicited.

The following two sections discuss how different approaches to pricing copper lead in different degrees to the attainment of, respectively, the efficient cost recovery objective, and of the efficient entry and efficient migration objectives. The last Section contains our conclusions.

■ The cost recovery objective

Alternative ways of achieving the objective

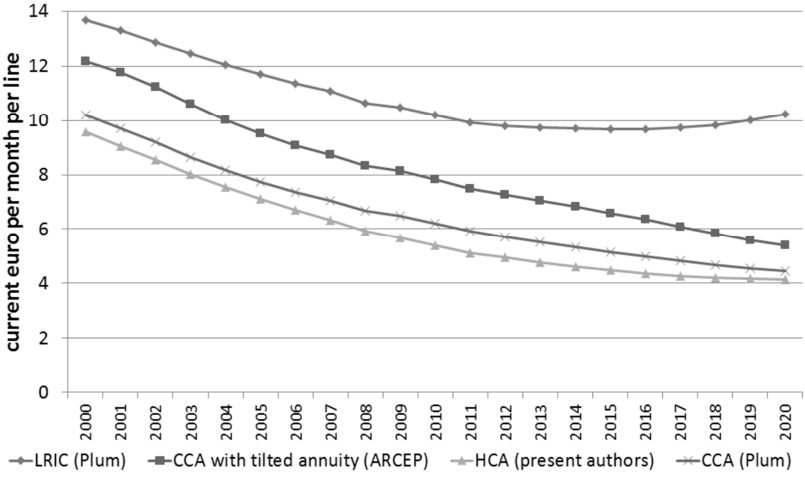
As was explained earlier, the objective of strict recovery of efficiently incurred costs is a significant one. Typically the incumbent operator holds a monopoly on local loop assets (copper cables, ducts, poles) that represent an essential facility. Cost under-recovery on copper will create regulatory

uncertainty that will negatively impact the investment incentives in fibre and may at the limit lead to abandonment of the copper network. Equally, cost over-recovery will have an adverse effect on end users and may distort competition in related markets. At stake are valuations of assets of two kinds: the copper loop, and the civil works (ducts etc.) through which passes the transmission medium adopted by a fixed network (copper, co-axial cable or fibre). The civil works, including particularly ducts, are an essential facility that is unlikely to be replicated. The pricing of duct access is neutral with respect to the transition from copper to fibre because ducts are used by both technologies. For this reason cost recovery is the main pricing objective for this type of asset. So, in the case of ducts, the useful lives of which are threatened neither by foreseeable technological obsolescence, nor by competition, it is possible simply to use HCA (historic cost accounting), which will ensure full recovery of costs (but no more) on an *ex ante* basis in the normal way.

In the case of the copper, in order to ensure exact cost recovery, accelerated depreciation may be necessary, because there is a risk that copper will be replaced before the end of its expected life. Alternatively a regime could be introduced which tracked the decline in copper connections over time and adjusted the level of depreciation from one year to the next to ensure a more exact cost recovery. This approach will be referred to as use of a (volume) adjusted tilted annuity.

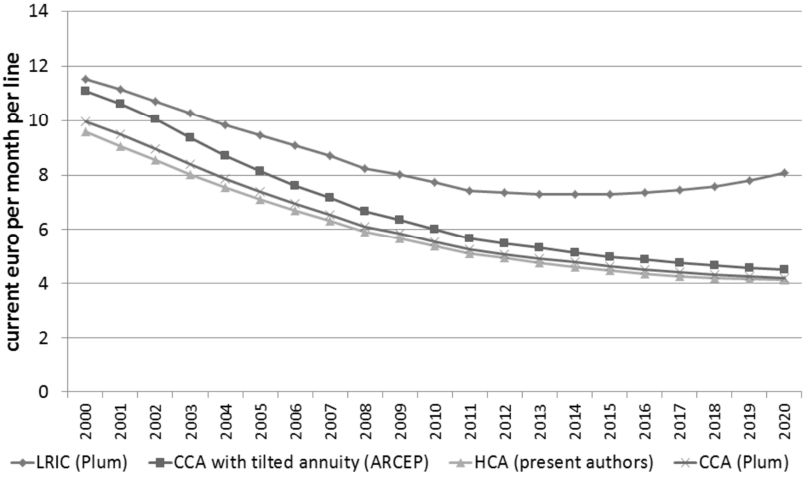
Figure 1 simulates different methods of cost estimation using the data on investments by France Télécom. In this article we make extensive use of a very rich data set on local loop investments made over a thirty year period by France Télécom, as computed by ARCEP in 2005. These data enable us to produce valuations based upon a variety of principles, as set out below. In some cases we reproduce ARCEP's calculations: here the data are attributed to ARCEP. In other cases we have implemented other authors' proposed approaches on French data. This in figure 1, 'LRIC (Plum)' denotes our calculation of FT's valuation using the LRIC methodology recommended by Plum Consulting, which is discussed in more detail in the following Section. The modelling is made based on the following assumptions. The number of copper lines linearly decreases starting from 2010 and falls to zero in 2030. This decrease impacts only the copper cable assets. The number of users relying on the civil works assets is stable and includes both fibre and copper users: these assets are technology neutral and may be used with both technologies. The local loop unbundling cost includes both CAPEX and OPEX.

Figure 1 - Simulation of local loop unbundling cost based on French data



Data sources: ARCEP, France Télécom, INSEE and own calculations

Figure 2 - Simulation of local loop unbundling cost based on French data when civil works is valued by HCA method and the copper valuation method varies



Data sources: ARCEP, France Télécom, INSEE and own calculations

The estimates based on the different methods vary considerably. At the end of the assets' life cycle, the top down LRIC estimate is very high, the HCA estimates are lower and the current cost valuations fall in between the

two of them. [5] As was explained earlier, HCA is one method for civil works valuation that respects pricing objectives and so is an appropriate method in many national contexts. Figure 2 represents the local loop access cost when civil works are estimated based on the HCA methodology, while the copper cable estimation methodology varies. Compared to the figure 1 the overall cost is quite similar to all costing methodologies based on incurred costs (HCA, CCA) and is much higher with LRIC.

Recovering from changed valuations

The use of a consistent depreciation method throughout the life of an asset can lead in a fairly straightforward way to strict cost recovery. But changing the method in mid-stream can lead to under or over-recovery, because different depreciation methods do not have the same annuity profiles. In order to correct for this windfall loss or gain, one should make the adjustment of net value when changing the method. In several countries the costing methodology has already changed at least once. In the United Kingdom Ofcom in 2005 made a correction and avoided an over-recovery situation. In France, over-recovery persists. We make simulations in order to show how the net value adjustment can prevent the over-recovery. Our quantitative analysis is implemented for the French case where the depreciation method used before 2000 was HCA, while between 2000 and 2010 it was CCA with a tilted annuity.

Example 1: France

In summary, a number of different bases of valuation of France Télécom's local loop have been adopted, in the period before and after the (partial) privatisation in 1997.

- Initially HCA of a fairly rudimentary kind was applied.
- Privatisation produced a valuation of company assets based on acquisition costs which was broadly consistent with the historic accounts.

[5] LRIC significantly diverges from the CCA after 2010 because the total investment that needs to be made by a hypothetical entrant is stable, and hence no account is taken of the fact that after 2010 it would be efficient to construct a network of a smaller dimension. See Plum Consulting (2011).

- From 1997 to 2000, ARCEP regulated France Télécom tariffs on the basis of historic cost accounts.
- In 2000, ARCEP moved to a basis for pricing the local loop, which used a long run average incremental cost (LRAIC) approach based on a combination of a top-down and a bottom-up model.
- ARCEP's 2005 valuation exercise involved a detailed reconstruction of France Télécom's local loop investment history. A number of alternative valuation approaches were considered, but ultimately ARCEP adopted the CCA approach with tilted annuity depreciation. This choice was governed inter alia by the desire to introduce stability in the prices of the principal access product of interest - the combination of copper wire and civil works which provides unbundled local loops or ULL. There was a concern that, absent of an adjustment, ULL price would decline and then, following further investment by France Télécom in the local loop, rise sharply. [6]

Given the change in relative input prices into the local loop over the period, it is inevitable that the revaluation associated with this choice had consequences running into billions of euros, and changed annually recoverable costs by correspondingly large amounts. In practice the expected growth in local loop investment does not seem to have eventuated on the scale expected (DUFFIEUX, 2011). Some windfall gains will be obtained in future and some have already crystallised. The simplest way to achieve strict cost recovery in future would be to revert to the HCA regime which applied before 2000. However, this would not deal with the question of the revenue already brought forward (compared with the previous HCA standard) in the period from 2000 to date. This figure, suitably discounted, should be netted out from future revenue in order to ensure cost recovery, but prevent over-recovery. We suggest below that for policy reasons, it should not be applied to reduce copper loop prices, as doing so would extend the period of dual operation of copper and fibre networks. Instead, it should be used to lower duct prices. [7]

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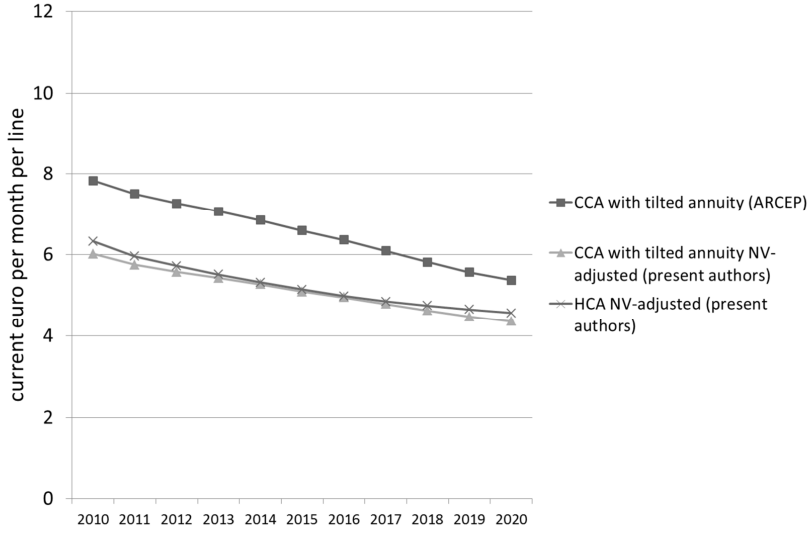
[6] *"[La méthode retenue] doit donc, dans la mesure du possible, être stable dans le temps et éviter les variations liées aux cycles des investissements dans les infrastructures. Dans ce cadre, l'Autorité s'attachera également à offrir aux acteurs la meilleure visibilité sur les évolutions du secteur afin de leur permettre d'engager leurs investissements dans un environnement favorable. […] L'Autorité relève que [la méthode de coûts historiques] ne permettrait pas de modérer l'impact tarifaire de variations marquées de taux d'investissements…"* ARCEP. Décision no. 05-0834.

[7] Since the advancement of revenue will have been large, if it were all applied to reducing duct prices it might make the latter low or even negative. In this case, the returned revenue could be put to use elsewhere, for example to subsidise fibre deployment in 'uneconomic' areas.

Figure 3 - Simulation of local loop unbundling cost based on French data: CCA with tilted annuity *vs*. HCA methodology



Data sources: ARCEP, France Télécom, INSEE and own calculations

Figure 3 demonstrates that the CCA with tilted annuity adjusted for the net value so as to avoid over-recovery gives a much lower price than the CCA with tilted annuity applied by ARCEP. The net-value adjusted CCA with tilted annuity is close to the HCA net-value adjusted valuation. The adjustment of net value has a greater impact on the resulting cost than the choice of method itself.

Example 2: UK

In UK, the valuation method has changed two times: in 1997 and in 2005. In 1997, the change in approach from historic cost to the current cost implied a cost over-recovery. Switching from HCA to CCA methodology generated a windfall gain for the incumbent operator. Even though both methods allow for full recovery of costs over the lifetime of asset, the profiles of the annual instalments are different. In fact, for the local loop assets the payments are higher for HCA compared to CCA during the first years; hence a change in methodology from HCA to CCA at any moment of the lifetime leads to over-recovery. In 2005 Ofcom decided to implement a new valuation method which allowed it to correct for the over-recovery. Starting from 2005, Ofcom decided to adopt a hybrid approach ('abated CCA'):

- Assets created after 1997 continued to be valued at CCA (as there was no over-recovery for these assets);
- Assets created before 1997 were revalued based on a regulatory asset value ('RAV') equal to net book value.

Ofcom is currently reviewing the LLU cost evaluation method for charge control in particular on the light of transition to fibre. In its consultation on charge control of March 2011, Ofcom (2011) proposes to maintain the current costing method - abated CCA FDC (fully distributed cost). Ofcom explains that such policy will be favourable to NGA investment with respect to the standard forms of economic efficiency which it habitually distinguishes: [8]

- *Productive efficiency:* producing goods and services as cheaply as possible, ensuring that the right combinations of goods and services are produced given the tastes and preferences of consumers;
- *Allocative efficiency:* correctly allocating resources of the economy among the various goods and services;
- *Dynamic efficiency:* engaging in investment and innovation.

First, Ofcom argues that since NGA investors can use already existing ducts, sunk costs should not be included in price as it is done in a full CCA. The currently used adjusted CCA is a good compromise because it comes close to marginal cost (thus achieving productive and allocative efficiency) but still allows for cost recovery:

> "Allocative and productive efficiency are served if prices are set on the basis of forward-looking costs (strictly, marginal cost), and sunk costs play no part in this measure of cost."

Second, Ofcom notes that increasing the current price to CCA would discourage current LLU operators and increase uncertainty which would have a negative impact on all investment in the industry.

Finally, productive efficiency requires that operators should make an efficient choice between continuing to use copper access and building their own NGA network. In its 2010 Wholesale Local Access market analysis Ofcom imposed among others the following remedies on BT (Ofcom, 2010):

- Local Loop Unbundling ("LLU") - access to the copper access network;

[8] Ofcom (2011) Annex 5. Ofcom (2012) contains the regulator's subsequent Statement.

- Physical Infrastructure Access ("PIA") - access to the ducts and poles which allow a competitor to deploy an NGA network.

If the first measure aims at maintaining competition on the current access network, the second one seeks to incite deployment of next generation access networks. The relative price of LLU vs. PIA matters.

> "In order to ensure that charges give incentives to make the most efficient choice of wholesale input, whilst maintaining incentives for upstream entry, then the difference between the charges for MPF [Metallic Path Facilities- i.e. the copper loop] and PIA should be at least as great as the difference in their respective incremental costs."

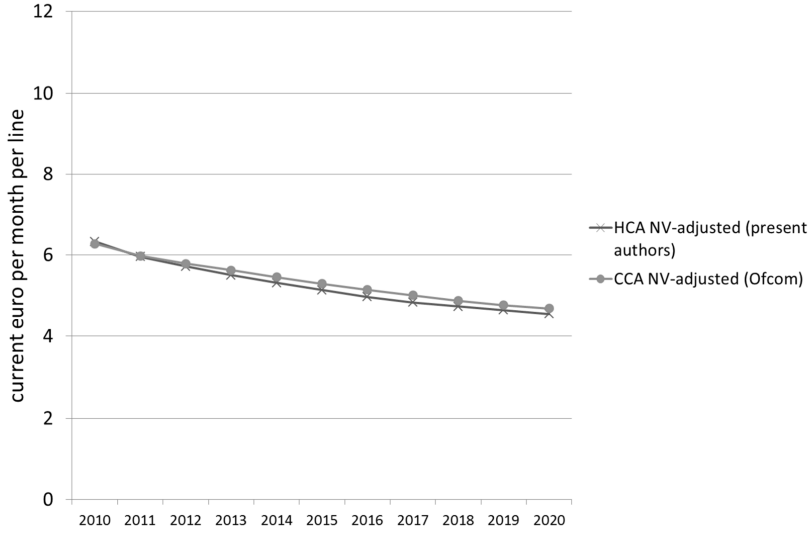
Competition between current and next generation network could be distorted if LLU is priced too low. The duct access price is not set yet (In fact, the price control obligation on PIA and LLU establishes the basis of charges, i.e. cost-oriented pricing based on forward looking LRIC. The charge control on LLU sets a price-cap for the next regulatory period but not on PIA.) but Ofcom proposes to include the regulatory asset value ('RAV') adjustment in the duct access charges:

> "So if we maintain the RAV adjustment in copper based access services, we would expect that any assessment that we make of duct access charges would reflect a consistent approach to asset valuation, recognising the RAV adjustment." (Ofcom, 2011)

In its reply to the request for information from the European Commission, Ofcom acknowledges that the relationship between the incentives to invest in NGA and the LLU prices is "complex and has not been considered in detail in the present notification". Nonetheless, Ofcom explains that it adopts an anchor product pricing approach that ensures that prices for existing services do not rise above the level implied by the hypothetical continuation of existing technology. The corresponding cost was estimated separately from the main CCA FDC model and answers the question of what the charges would be with a hypothetical continuation of the existing copper technology, without any NGA investment. The results differ slightly from the CCA FDC model, which allows Ofcom to conclude that the prices resulting from the cost allocation model are consistent with the anchor product pricing approach.

> "Ofcom is of the view that the 'anchor pricing approach' ensures that Openreach has incentives to invest in fibre if, and only if, it believes that consumers are willing to pay more for the higher quality product and/or the investments are justified by cost reductions." (European Commission, 2011a).

Figure 4 - Simulation of local loop unbundling cost based on French data: abated CCA vs. HCA methodology



The abated CCA treats differently two groups of assets starting from 1997. The post-1997 assets are depreciated on the standard CCA basis. For the pre-1997 assets, their 1997 net book value was taken and the further CCA annuities were calculated from this value and not from the replacement cost value. 1997 is the year when Ofcom stopped using HCA.

Data sources: ARCEP, France Télécom, INSEE and own calculation

Figure 4 demonstrates (using French data) that the abated CCA methodology used by Ofcom is close to the net value adjusted HCA. This shows once again that the value adjustment can counteract the effects of the choice of method itself.

■ Efficient entry and transition objectives

The efficient entry

The chosen costing method should satisfy the efficient entry or 'no distortion of competition' objective. It means that it should not bias competition in favour of one or another operator. WIK-Consult in their report for ECTA on copper pricing and fibre deployment (WIK-Consult, 2011) argue that the copper-based LRIC approach is not relevant anymore because the real modern equivalent asset of the copper is fibre and not copper. They

conclude that this makes it too difficult to implement properly the LRIC method. As noted below, Plum Consulting (2011) proposes carrying on regardless with prices based on the copper CCA calculation. The ongoing change in technology from copper to fibre imposes a change in modern equivalent asset. If before the modern asset equivalent to the copper had been copper, now it is other more efficient technologies - fibre and wireless. The copper is no longer appropriate because new deployment of copper network is not expected, and because choice of copper would have led to significant fluctuations following the fluctuations in raw material price. Consequently, during the transition, preference should be given to methods based not on reconstruction cost but on accounting data, such as an HCA or a CCA not based on modern equivalent assets.

Another advantage of HCA and CCA methods is that they yield a cost level that is lower than that of LRIC method and closer to the cost incurred by the incumbent. When the price is significantly higher than this, over-compensating the incumbent for past investments may distort competition. For example, the incumbent may choose to use addition financial resources to deploy next generation networks and to replace or weaken alternative operators from this new market place.

The migration objective

The chosen copper LLU pricing method should stimulate efficient migration from copper to fibre, on the part both of consumers and of operators. A low price of access to copper will negatively affect migration speed through two main mechanisms: consumers' incentives to migrate to fibre and operators' incentives to invest in fibre. With broadband and super-fast broadband belonging to the same retail market, there cannot be a great price differential between them. Otherwise, consumers would stick with the less expensive service. As the wholesale price impacts on retail price, the wholesale price differential cannot be too large as well. Indeed, today's customers of 'ordinary' broadband are likely to have high incremental willingness to pay for a high speed service, but a low incremental willingness to pay additionally for a very high speed [9]. Given the growing speeds available on copper networks, this means that customers are unlikely to pay

[9] For example, a USA survey concludes that "… the representative household is willing to pay […] $45 for an improvement in speed from slow to fast; and $48 for an improvement in speed from slow to very fast." ROSSTON, SAVAGE & WALDMAN (2010).

much more for fibre access than for copper access. The same reasoning is contained in Plum Consulting's report for ETNO. They argue that low copper access prices will undermine the case for investment in fibre as it will depress retail prices generally, thus making investment in fibre unprofitable.

WIK-Consult take the opposite point of view. In their report for ECTA on copper pricing and fibre deployment (WIK-Consult, 2011) they assume that the low copper price does not necessary bring down fibre retail prices. A crucial assumption of the model is the gap between consumers' willingness to pay for fibre and for copper: €40 for fibre vs. €32 for copper. WIK justify their assumption by the expected increasing demand for very high speed service. The demand will increase with the development of new applications of fibre access, for example, "specific benefits that a few customers may experience from fibre that cannot be achieved through other means such as home security through video surveillance". Moreover, they argue that if consumers are not willing to pay for the additional benefits of fibre access, then the fibre deployment is undesirable from a total welfare perspective.

To put it simply, the price of access to copper (having allowed for the difference in performance between copper and other networks) will affect the incentives of operators to invest in alternative technologies in the following ways:

- If the copper access price is higher than the annual cost of constructing the fibre access network from zero (LRIC Plus or LRAIC - long run average incremental costs), then the cost-oriented tariff will encourage fibre deployment by alternative operators.
- If the copper access price is lower than the annual cost of constructing the fibre access network from zero (LRIC Plus or LRAIC), then alternative operators will be encouraged to continue to upgrade their current access technology (VDSL2, pair bonding, vectoring etc.) and postpone the arrival of fibre.

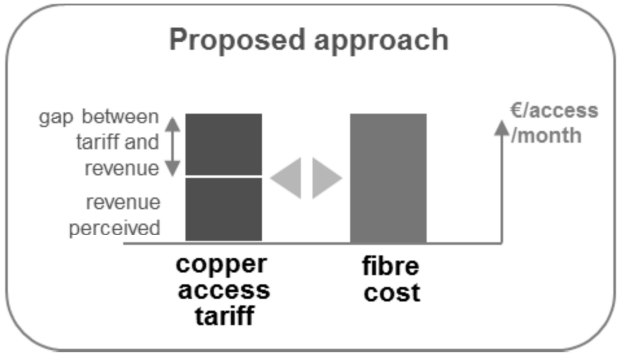
Thus the dilemma is:

- On the one hand, the copper access price paid by alternative operators should not be lower (having allowed for the difference in performance between copper and other networks) than fibre network construction costs; otherwise they will not invest in fibre (the migration objective).
- On the other hand, the copper access price received by the historic operator should not be higher than the cost of copper network construction

by the incumbent, since otherwise the historic operator will receive unjustified advantage on the market (the efficient entry objective), especially where the owner(s) of the fibre network(s) are not the same as the owner of the copper network.

One approach (see figure 5) that respects both objectives is for the difference between the incumbent's copper cost level and the fibre cost level to be dedicated to the funding of fibre deployment.

Figure 5 - Proposed approach



Below we discuss further the two above-noted contributions which explore the link between copper access price and migration to fibre; they reflect the respective positions of alternative operators and of incumbents.

The position favoured by alternative operators in more detail

WIK-Consult (2011) has issued a report concerning the impact of wholesale access prices on the competition and particularly on investment in next generation networks. Its main conclusion is that copper access prices should be reduced. Part of this derives from a view that current LRIC prices are too high. They argue that LRIC estimates that are based on an assumption of expansion (i.e. the next increment of investment) are not relevant in a declining market and overstate the appropriate price, which may be closer to short run incremental cost. In fact, the competitive price should decline following the decline of wholesale demand which flows from declining demand at the retail level. But, to the contrary, LRIC increases because fixed costs are distributed among a smaller number of users. The real cost standard should not take into account sunk costs because they are not decision- relevant anymore. LRIC pricing, which allows prices to follow the upward trend of unit costs, lead to over-recovery of costs.

They argue that the appropriate price lies between short run incremental cost and LRIC as estimated before demand declined, determined by 'demand and competitive conditions in the retail market'. In particular, the assets that can be reused for fibre networks should be valued closer to the upper bound, while copper-specific assets should be valued closer to the lower bound. In their model, short run incremental cost is 20% of LRIC. At some suitably chosen date in the future, the copper network would be switched off. But in the interim an increased copper access price would imply further demand decrease and over-capacity in copper network. The position of the copper access network would be weakened with respect to other networks. A high LRIC wholesale regulated price could partially compensate for reductions in demand, which would allow the incumbent to continue investment both in the existing copper network and in fibre. But the question arises whether such investment by the incumbent is efficient. In reality, the incumbent uses the revenues obtained from the copper to strengthen its position in fibre, and forecloses competitors' investments in fibre.

> "Generally, there is little need for investment under decreasing demand. While FL-LRIC [forward-looking LRIC] wholesale access charges may, under decreasing demand, provide enough contributions to enable an incumbent to make bottleneck investments, they would, by driving up prices, increase the problem of excess capacity and therefore would tend to lead to too little investment in replacement and maintenance. While the incumbent could channel the liquidity generated into investments for alternative technologies, this raises the question whether this would be in line with efficiency and competition given that the incumbent would effectively be able to leverage this advantage into these technologies undermining the potential for fair competition and foreclose the chances for competitors to invest in these alternative technologies."

Another disadvantage of the high LRIC price is the risk of margin squeeze by the incumbent. WIK argue that when faced with competition from copper competitors, incumbents might engage in a margin squeeze, by lowering retail prices but maintaining wholesale charges. This then leads regulators to force an increase in retail price, expanding excess capacity further. Instead, WIK consider that there should be no requirement to sustain LRIC wholesale charges. They are not perturbed at the implications for cost recovery, or perceptions of regulatory risk, as they seem to suggest this is just the result of 'market risk from declining demand for copper-based services'. They note that HCA pricing addresses the cost recovery problem better, but does 'not meet any efficiency standard'. Nonetheless they accept

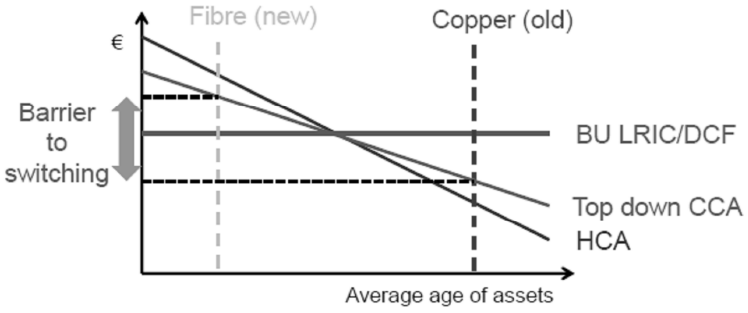
that HCA would arrive at a price that was 'coincidentally' somewhere in the 'appropriate range'.

The position favoured by incumbents in more detail

Plum Consulting (2011) issued a report concerning the impact of wholesale pricing on the transition to the next generation network. Plum argue that the copper price should be high in order to encourage fibre investment, and reject the suggestion that copper prices should be reduced in order to increase the relative attractiveness of investment in fibre. Instead, fibre investment must be attractive in absolute terms and not only in comparison with copper, because potential investors have a wide range of other alternatives. They also reject the proposition that lower copper prices will increase the broadband market, arguing that there are significant non-price barriers to remaining penetration. Finally they say lower copper prices will add to a perception of regulatory risk. The Plum report considers that an HCA approach is not appropriate, as it will lead to low prices for copper that will undermine the investment case for fibre and result in reduced or delayed investment. The same problem but to a less extent arises for the CCA method. Figure 6 below (reproduced from the Plum report) shows that if either HCA or CCA is applied to both technologies, the price of fibre is higher because the fibre assets are at the beginning of their lifetime.

However, the assumed profiling is based on the consultants' underlying assumption that straight line depreciation is used for both CCA/HCA. In reality alternative approaches are possible that can tilt revenues appropriately to assure cost recovery and raise the level of copper prices.

Figure 6 - Schematic representation of depreciation profile of different methods



Source: Plum report, figure 4-1

Plum argue further that switching to HCA towards the end of the life of copper networks may jeopardise cost recovery, since cost recovery is more front-loaded under HCA than under CCA. Nevertheless, this argument is not complete. Most of the relevant assets were not initially regulated on the CCA basis but on the HCA basis, the transfer to CCA being made later. The return to the HCA does not necessarily imply under-recovery.

With LRIC and DCF resulting in lowest price for fibre access and highest price for copper access, Plum conclude that: 'In the absence of regulatory precedents, bottom up LRIC would be preferred to provide the appropriate price signal for fibre rollout.' They recognize that bottom up LRIC provides little regulatory commitment and so increases investment risk, but they argue that this is not important because of the low level of expected investment in copper. On balance they favour retaining the status quo in pricing copper in each Member State (a variety of CCA, LRIC and top down /bottom up approaches) on the grounds that copper will be retired anyway, and changing the methodology would increase the perception of regulatory risk and might raise the cost of capital for new investment in fibre.

The report does not address the problem of over-recovery. In some countries there may have been excessive cost recovery to date under existing CCA/LRIC methodologies and the status quo will make this worse.

The CCA/LRIC solution proposed by Plum minimizes the potential problem of a barrier to switching. Nevertheless we have shown that CCA and LRIC lead to over-recovery of ULL incurred costs and distort the market places.

■ Conclusion and recommendations

Setting a regulated price for copper is like putting together a jigsaw puzzle whose pieces do not quite match. The essential problem is that the number of instruments is less than the number of objectives. As a result regulators have to prioritise, or make compromises between, their objectives, where the traditional objectives of protecting end users from exploitation by natural monopolists and creating conditions under an access regime which ensures efficient outcomes via fair competition are supplemented by additional 'transitional' goals, such as:

- encouraging investment in next generation access networks (with possible new prospects for infrastructure competition),

- transferring a fair access regime from copper to fibre, and
- providing appropriate incentives for both incumbents and access-based entrants to switch customers from copper to fibre in order to limit the period of inefficiently duplicated running of two access networks.

Our own analysis pays close attention to the goal of maintaining the regulatory contract by ensuring that efficiently incurred costs are recovered, but not over-recovered, over the life of the copper assets not subject to competition. Accelerated depreciation can be introduced to deal with a situation when the assets are to be taken out of use before the expected date. If regulators have introduced interludes of CCA valuation over the lifetime of assets generally treated in an HCA way, past over-payments (or, in principle, under-payments) can be computed and allowed for. Compared with the continuation of CCA/LRIC costing and pricing for copper, this approach has the logical advantage of acknowledging that copper is, under our very eyes, being (slowly) replaced.

We have also emphasised the important distinction between the copper and the ducts which carry it. The former compete with fibre and will be replaced; the latter are non-competitive, will go on and on, and can provide benefits to both copper and fibre networks, provided by the incumbent or alternative operators. This creates conditions in which different pricing policies can and should be applied to each. The pricing which emerges from the relevant principle of cost recovery is applicable to copper wire. In the case of ducts no accelerated depreciation is (yet) required. Past over-payments in temporary periods of revaluation can be recovered and focussed upon duct prices; or alternatively specifically upon the price of ducts used to convey fibre networks as a means of speeding up the fibre transition.

These measures are in the spirit of Ofcom's March 2011 proposals for pricing the physical infrastructure of the local loop and the assets it contains. They also were proposed by the present authors in a response to a recent consultation by ARCEP. [10] Their practical effects can be seen from figures 1-3 above. Figure 1 shows that the simulation results differ significantly with the choice of the method: CCA, HCA or LRIC. Figure 2 demonstrates the simulation where civil works are valued in HCA while the copper cost estimation methodology varies. In this case the gap between different evaluation methods is significantly lower. Figure 3 shows that adjustments

[10] Response on behalf of Bouygues to ARCEP (2011).

for past revaluations significantly change the cost estimates and make the gap between different methods less significant.

Considering other pricing objectives, regulators need to find a compromise between the objective of no distortion of competition and the objective of migration from copper to fibre. On the one hand, if an incumbent's revenues are too high, it obtains an underserved competitive advantage. On the other hand, if the wholesale copper price is too low, alternative operators will not be encouraged to switch to fibre. One of possible ways to solve this problem is to create a fund which will makes it possible to reduce the incumbent's revenues without reducing wholesale copper price.

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