WIK-Consult • Report

Study for the European Competitive Telecommunications Association ECTA

The Economics of Next Generation Access - Addendum

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Bad Honnef, 15 July 2009

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Management Summary

Purpose of the study

1. In May 2009 the European Competitive Telecommunications Association commissioned WIK-Consult to conduct a new study on Next Generation Access. This study is based on the previous study on the Economics of Next Generation Access which WIK-Consult has published in September 2008. It is the intention of this study to describe, analyse and assess new proposals which have come up in the debate on fostering a competitive development of NGA and to incentivise investments in NGA. The study examines various proposals on risk sharing and co-investment of market players, certain pricing proposals and puts particular emphasis on some recent proposals of multi-fibre deployment architectures and compares them to single fibre deployment approaches which have dominated the debate so far. We have expanded our NGA modelling approach such that it is now also able to quantitatively assess a multi-fibre network architecture.

2. The study is organised as follows: Section 1 deals with the risk of NGA investments. The various factors which have a systematic effect on the risk of NGA investments are discussed and assessed. Section 2 analyses various mechanisms to share the investment risk between various stakeholders like users, access seekers and co-investment partners. Furthermore, the implications of the various proposals on competition are assessed. In section 3 the regulatory approach of OPTA in the Netherlands on fibre LLU is presented which is (at least currently) the regulatory best practice approach in this field in Europe. The major part of the study extends our NGA modelling approach on a multi-fibre architecture. We show the impacts of multi-fibre on the overall investment requirements, on the degree of profitable coverage for various operator constellations, on risk sharing and on the replicability of fibre investment. Particular emphasis is provided for the multi-fibre proposal the Commission has presented in its new draft Recommendation on regulated access to Next Generation Access networks (hereafter ‘draft NGA Recommendation’). We do, however, also show the impacts of other co-investment proposals based on multi-fibre.

The risk of NGA

3. The WACC used by NRAs to calculate the cost of copper ULL is an appropriate starting point to determine the return on capital allowed ex ante for investments into fibre-based NGA networks. Only if there are systematic risks of NGA investments, which are different to those of the copper network, a supplement to the ULL WACC may be justified.

4. Relevant for determining NGA specific risks are the risk of penetration, the risk of sufficient willingness to pay by end-users, the regulatory risk and specific risks of certain business models. Risk increasing factors should be balanced against risk decreasing factors like capital benefits and OPEX reductions resulting from NGA deployment compared with existing copper access infrastructure.

5. The risk of penetration is closely related to the supply-driven nature of any efficient FTTH network deployment. The profitability of any NGA roll-out and/or the degree of profitable coverage depends on the penetration of the potential customer base. If and as soon as the whole subscriber base of an SMP operator is migrated to the (new) NGA platform, the penetration related risk is close to zero. If and as long as a new fibre NGA competes against the (remaining) DSL platform, there might be a remaining penetration risk. The risk of penetration will be lower, if the operator offers broadband wholesale access products due to the stimulating effects of competition on retail demand.

6. The profitability and the degree of profitable coverage depends on the average revenues per access line to be generated. If the business plan of the investor entails revenue assumptions over and above the current level of revenues, the investor bears the risk to meet these demand and willingness to pay expectations. Generally, risk in an NGA context has a geographic dimension. Investment in certain dense areas may not require any assumptions of increased ARPU whilst outside such areas ARPU increases may be required to make the business case viable.

7. Given the long-term nature of fibre investment, regulation can be a relevant risk factor. There is no regulatory risk related to decisions to be made before the investment is actually being made. It is more the change of the regulatory regime and of regulatory parameters over time which defines a regulatory risk. NRAs can manage this risk and keep it low. It is, however, socially not optimal, to eliminate it totally, for example by setting regulatory rules for the entire lifetime of the investment.

Mechanisms to share the risk and competitive implications

8. Risk sharing mechanisms do not necessarily reduce the overall systematic project-specific risk of NGA investments. They might, however, redistribute the investment risk from the investor to other stakeholders like co-investors, access seekers or users. This diversification of risk might also increase the level of NGA investments, if there are limitations on individual operators in bearing investment risks and if several operators have a limited capacity to make significant investments.

9. If the cost of capital of an access product is properly reflecting the project-specific risk of NGA, access seekers carry their appropriate share of the risk of the SMP operator's investments. The mechanism by which wholesale customers participate in the investment risk is the payment of access prices which are calculated on the basis of rates of return (or capital costs) which include a risk premium to cover the project-specific risk of the infrastructure investment. Pro rata to their market share, access takers take the risk of the infrastructure investment of the SMP operator. The access price calculated on the basis of the long run incremental costs including project- or risk-adjusted cost of capital rewards the risk an investor takes in making the investment. If the project-specific risk premium is calculated properly, there is no over- or under-compensation of the relevant investment risk. Therefore, and because the SMP operator and his competitors share the risk pro rata to their respective use of the underlying infrastructure, the risk premium approach as a risk sharing mechanism is competitively neutral.

10. Potentially there may be numerous forms of co-investment arrangements. Fundamentally they can be grouped around the following three models: (1) Two or more partners jointly undertake the investment in a certain region, city or district. Under such build and share arrangements the partners jointly own the network infrastructure usually arranged through a joint venture entity in which the partners take all (or most) of the equity shares (the "joint venture model"). The investment arrangement then has to define rules under which the partners get access to the capacity and rules on sharing the cost of the network. The arrangements also have to address the access opportunities for third parties which do not take equity shares in the joint venture. (2) A single investor may also set up co-investment arrangements with partners (the "investor model"). Under such arrangements the investing operator takes the decisions on the investment and the ownership rights in the network infrastructure. Prior or after the investment decision and the roll-out, the investor grants his co-investment partners rights of capacity use usually in the form of indefeasible rights of use, unbundled access or bitstream access. A typical model of this type is the cooperation agreement Swisscom is offering in Switzerland. The fibre network is rolled out in a multi-fibre approach. Partners would get access to their own fibre to the home at the distribution point and receive indefeasible rights of use to this part of the infrastructure. Investment and operating costs are usually intended to be shared on either equal sharing rules or some more sophisticated rules which take care of retail market success and/or prior commitment of capacity. (3) Two (or more) investors agree in which areas (region, city or district) each of them is deploying independently from each other a fibre network. Under the cooperation arrangement the partners agree on the deployment area of each partner and the swapping of capacity using rights in each others' deployment area (the "swapping model"). Rights of use can be

based on a multi-fibre approach, on unbundled access to fibre loops or on bitstream access.

11. Given the economic characteristics of NGA networks and investments, co-investment arrangements under certain circumstances can have not only private but also social benefits in terms of diversifying risks and overcoming individual operators' financing constraints. However, NRAs and NCAs do have to take care that anti-competitive tendencies inherent in the incentive structure of co-investment arrangements are not unduly reducing the social value of such arrangements. Cooperation arrangements can work as collective foreclosure agreements. There is a natural tendency and incentive that the investor and its cooperation partners jointly are looking for more favourable conditions to use the infrastructure and to compete in the retail market at more favourable conditions compared to third parties. However, an agreement which favours a limited number of operators thereby placing them in a better position as regards their retail market position and capacity to invest would tend to limit the 'penetration' benefits of competition and is incompatible with the objectives of achieving effective competition. Under the perspective of effective competition a regulator should check that the internal pricing conditions imputed to the downstream arm of an SMP operator within a co-investment arrangement reflect those available to third parties. Such checks should include internal prices reflecting long-term commitment discounts where permitted (see section 2.5) and undiscounted prices. In both cases, pricing should be consistent and no margin squeeze should apply.

12. Pricing of wholesale access products can be a proper mean of diversifying the risk between the SMP operator and the access seeker beyond the risk sharing indicated in the risk component in the cost of capital. NRAs have to take care that such risk-oriented pricing elements are non-discriminatory and not anti-competitive.

13. Buyer specific volume discounts are a pricing tool which incentivises the increased use of a (new) network infrastructure. However, volume discounts also discriminate against smaller competitors and later entrants. They generate barriers to entry for those competitors. If the discount scheme is not provided to the number of customers per individual wholesale buyer but to the total number of fibre loops sold to all access seekers (including the SMP operator) the basic incentivisation effects can still be maintained and the negative competitive implications could be avoided.

14. Allocation of investment costs to one-off pricing elements also shifts parts of the investment cost per line and also part of the investment risk from the investor to the access seeker. The one-off fee element can, however, at the maximum cover

the allocated part of the investment relating to the usual customer lifetime. Otherwise the pricing structure becomes a barrier to entry.

15. On the basis of long-term contracts and appropriate demand commitments the investor is able to sell the capacity in whole or in parts and to eliminate or reduce its risk accordingly. It is now the risk of the access seeker to fill the committed part of the network capacity. Risk sharing on the basis of long-term contracts only works, if the commitment is credible, binding and cannot be renegotiated. The risk sharing and risk reduction aspect of long-term contracts is stronger, if the contracts are concluded before the investment takes place. However, long-term contracts are not in all circumstances compatible with achieving effective competition and may increase incentives by an SMP operator to engage in discrimination. Appropriate thresholds should be set by the regulator to ensure that such arrangements are only permissible if multiple operators can participate given existing market positions and alongside important safeguards against discrimination. Furthermore, given that such schemes inevitably benefit mass-market (consumer) suppliers, It should be considered in this context whether for the purposes of discount arrangements, business-grade products are in the same market segment as products designed for the mass-market.

16. Where long-term contracts are permissible, agreements on access on the basis of long-term contracts should not exclude the simultaneous availability of access without demand commitment. Otherwise, risk sharing contracts would raise entry barriers and be a form of market foreclosure. On the other hand, there has to be a price incentive for access seekers who commit themselves on a long-term basis. Non committed access seekers should pay a wholesale price equal to LRIC. The price discount for long-term committed operators should exactly reflect the reduction in risk to the investor due to the demand commitment. This discount should be the same for all committed operators and be calculated on the basis of the sum of the long-term committed demand. Otherwise the investor would be overcompensated and would receive an unjustified risk reduction rent through a multiple consideration of the same risk.

Economic impacts of multi-fibre

17. There are three slightly different multi-fibre approaches under discussion in Europe: the approach of ARCEP in France, the approach of Swisscom in Switzerland and the approach of the EU Commission in its draft NGA Recommendation. Each of them has different economic impacts.

18. The ARCEP proposal defines a multi-fibre infrastructure to be implemented by the first investor in a mandatory manner (building-by-building on demand of competitors) in very densely populated areas which are explicitly listed. The distribution point may be within the building or very close by. Thus the shared part

of the network (inhouse network up to the distribution point) is relatively short. A distribution frame in the distribution point has to be provided on demand, an alternative option is a fixed splice of the fibre. Sharing of the feeder infrastructure is not foreseen. The assumption is that very densely populated areas may allow several separate feeder infrastructures to be economically viable.

19. The Swisscom approach is a voluntary unregulated attempt to achieve mutual agreements between competitors in Switzerland addressing a region, a city or a district. The investor is installing four fibres per home being concentrated in a manhole as the distribution point. The distribution point comprises a larger amount of buildings and is located outside of the buildings in the street. Thus the shared part of the network seems to be larger than in the ARCEP approach. The multi-fibre areas are not restricted to very densely populated areas, rather the approach is intended to be used in major parts of the country. The distribution point only houses splices between the fibres to the homes and the feeder networks of the different operators. Distribution frames are not planned. There is an option to also share the feeder infrastructure up to the MPoP.

20. The EU Commission’s approach is a voluntary approach, but may be an obligation on SMP operators in the drop cable or terminating segment, if that is feasible from a regulatory and legal perspective. It defines a distribution point comprising several buildings with an amount of homes which enables a viable access opportunity for competitors to collocate. The distribution point in any case houses a distribution frame enabling easy mutualisation of the drop fibres. Standard element of the Commission’s approach also is the investment sharing of the feeder infrastructure up to the MPoP, thus enabling a major part of the network investment to be shared between the operators. Our NGA modelling approach examines both the Commission’s approach of access at the MPoP and hand-over at the distribution point as one variation.

21. Multi-fibre with hand-over at the MPoP is the only multi-fibre architecture which allows one or even all of the participating co-investment partners to offer a wholesale unbundled fibre local loop service. A fibre hand-over at the DP implies wholesale sub-loop unbundling only.

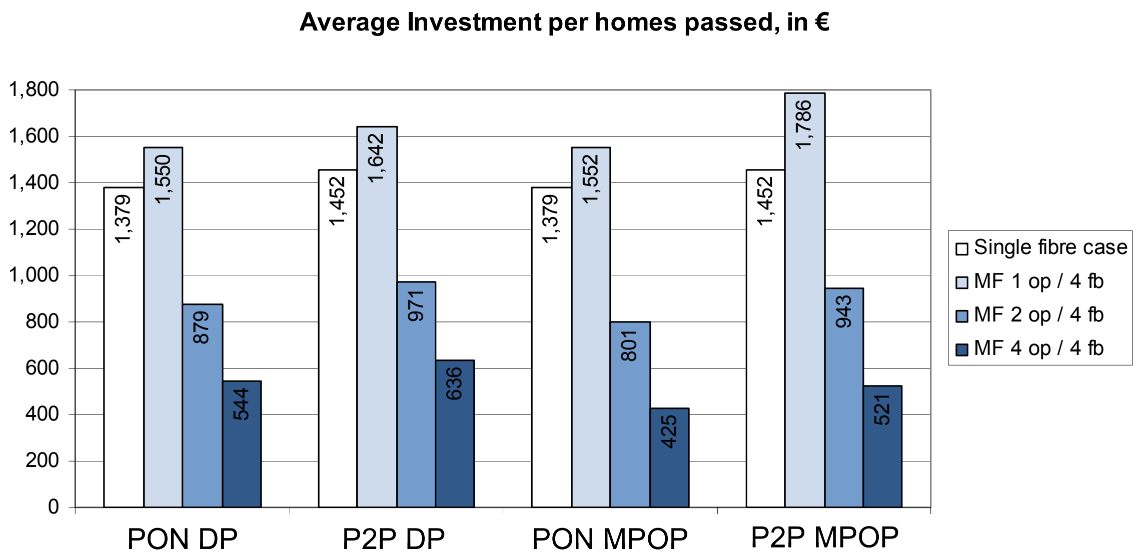
22. A multi-fibre network roll-out requires higher investments compared to a single fibre approach. Swisscom expects an increase of investment in the range of 10 % to 30 %. ARCEP assumes only a moderate increase of 5 %. Our own calculations for Germany indicate an increase of 13 % to 23 %. These numbers are in line to each other, when bearing in mind that these approaches consider different shared cable segment length. According to our calculations for Germany the differences in investment depend on subscriber density, fibre architecture and the degree of sharing. Multi-fibre FTTH investments in the four densest clusters are 13 % to

23 % higher than single fibre architectures. This holds for all scenarios considered (PON DP and MPoP hand-over, P2P DP and MPoP hand-over).

23. The basic economic advantage for the individual operator is that under a multi-fibre approach he only has to bear a certain proportion of the investment, but still can reach 100 % of the potential customers. Our empirical results show that the more network segments (drop cable incl. inhouse, feeder) are shared, the higher the benefit for several operators from sharing the investment. The investment savings for the individual operator amount up to 40 % if two operators share the relevant investment and up to 70 % if four operators share the relevant investment.

24. The higher the shared part of infrastructure, the more attractive the successful sharing approach gets. Thus hand-over at the MPoP is more efficient than at the DP. The greatest sharing benefits are generated by the Commission's approach; it is followed by Swisscom's approach and then by ARCEP's proposal. For efficiency reasons multi-fibre approaches should not be restricted to the drop cable segment only.

Average investment per homes passed, based on the four most dense clusters, 50 % market share, in €

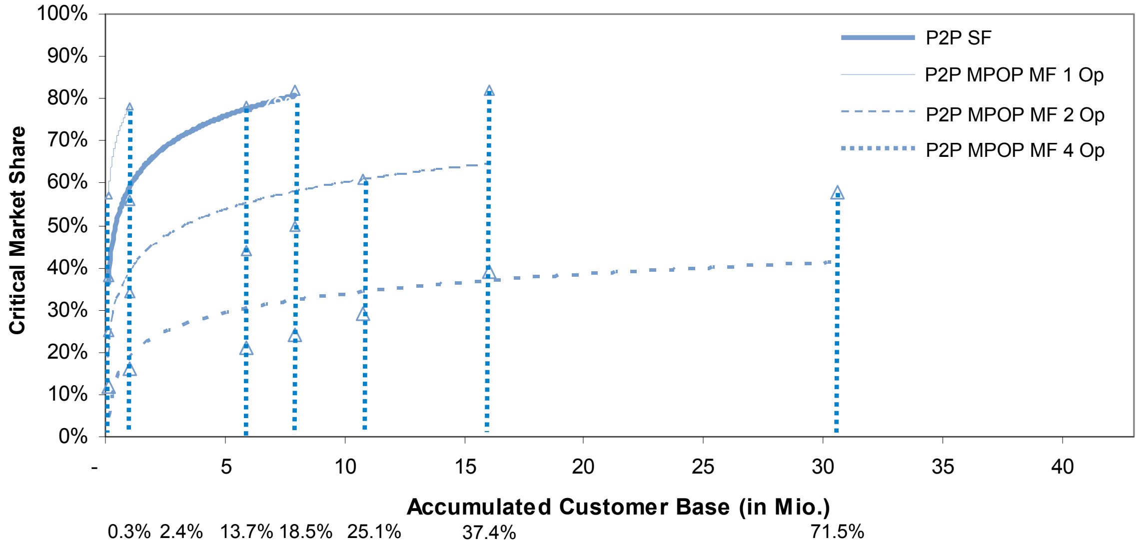


25. Fibre investments in a multi-fibre sharing arrangement increase replicability. The competition by several operators in the market is viable in a larger coverage area compared to single fibre end-to-end network duplication. The critical market shares for an individual operator for profitability therefore are lower.

26. Nevertheless, the areas where each of two or even four operators reach the critical market shares for profitability are rather limited. The coverage of a

successful infrastructure sharing with four operators is less than in a single fibre case (due to the higher investment needed). This coverage could be expanded, if higher ARPU is achieved than assumed in the model or if customers buy services from several operators in parallel and in total spend more than assumed in the model.

Critical market shares: P2P single fibre and multi-fibre networks with fibre hand-over at the MPOP



27. The investor has to bear an increased risk if he cannot contract the investment sharing in advance of the roll-out of a multi-fibre infrastructure. The viability of the multi-fibre investment is therefore supported by co-investment arrangements negotiated prior to the investment.

28. From a regulatory policy perspective, we do not see the relationship of unbundling and multi-fibre as mutually exclusive. Instead, the greatest economic benefit is achieved, if both options are regarded as complementary to each other such that operators have a choice between them. Operators should have the opportunity to make their choice unconditional such that one operator can choose a multi-fibre approach and another one the unbundling approach. In the same way one operator should be able to prefer the multi-fibre approach in one particular area and unbundling in another area.

29. The multi-fibre model has the following advantages:

    a. The multi-fibre model generates competition at the deepest level of the network and provides a relevant model of replicability of the fibre at lower costs than the end-to-end infrastructure duplication.

    b. The altnet has a better end-to-end control over his network infrastructure.

c. The multi-fibre model allows for a competitive scenario where the user can get different services from different operators.

d. The multi-fibre approach potentially can contribute to solve the termination monopoly problem. A user could for instance subscribe to different termination services from different operators.

e. In cases or scenarios where the multi-fibre approach actually has achieved effective competition, regulation becomes obsolete.

30. Besides the additional investment a multi-fibre approach has some further relevant disadvantages:

a. The significant higher requirements of sunk investment generate a significantly higher barrier to entry and generate increased penetration risks for non SMP operators.

b. The number of competitors is determined by the market in the unbundling model. In a multi-fibre model unconstrained by regulation, the maximum number of competitors is determined ex ante by the investor and his decision on the number of fibres to be deployed. It is fair to say, that this restriction may be overcome by a secondary market of fibre lines, e.g. on the basis of unbundling, in particular, if unbundling is mandated.

c. Depending on the distribution of market shares, the multi-fibre model can cause significant asymmetries in per line costs and therefore in competition which can result in unsustainability of competition.

31. Unbundling allows as many competitors to directly connect end customers via physical passive infrastructure as competitors are willing to collocate at MPoPs. In Germany there are more than four operators collocating at the MDF in a significant amount of MDFs today and they are addressing more than 70 % of the German households and businesses. The multi-fibre infrastructure only allows up to four operators to directly address end customers, unless one or more of them offer fibre LLU by themselves or the SMP operator is obliged to do so.

32. The major competitive asymmetries of the multi-fibre approach result from the inherent cost sharing rules. The usually proposed sharing rule requires an equal sharing of investment costs. This can best be demonstrated by a numeric example. Let us assume that the investment cost in the multi-fibre approach are 20 % higher than in the single fibre network. Two operators co-invest and share the investment cost on an equal basis. Let us further assume that the cost per line and month is 10 € in the single fibre case. Table 6 shows the resulting cost per line under various market share scenarios. The figures only relate to the shared part of the investment, which is representing around 80 % of total investment.

Table 6: Cost per line in single fibre and multi-fibre network

Single fibre + unbundling	**Incumbent**	**Market share**	100 %	80 %	60 %	50 %	40 %
		Cost per line	10	10	10	10	10
	Altnet	**Market share**	0 %	20 %	40 %	50 %	60 %
		Cost per line	0	10	10	10	10
Multi-fibre case	**Incumbent**	**Market share**	100 %	80 %	60 %	50 %	40 %
		Cost per line	6	7.50	10	12	15
	Altnet	**Market share**	0	20 %	40 %	50 %	60 %
		Cost per line	∞	30	15	12	10
	Assumptions: (1) Only shared investment considered (80 % - 85 % of total invest) (2) Two cooperation partners considered (3) Investment multi-fibre model = 120 % investment of single fibre model (4) Sharing rule: 50:50 (5) Numbers are for illustration purposes only						

In the single fibre case under cost-based LRIC pricing the incumbent and the altnet always face the same cost per line. Furthermore, the cost per line and under cost-based LRIC pricing also the price for the wholesale service is independent of the market share distribution between the incumbent and the altnet. It is only the total number of lines sold in the market which determines cost. In the multi-fibre case and an investment cost sharing rule it is no longer the total lines sold in the market which determine the cost for each operator. Instead, it is the share in the investment cost which determines the cost per line for each operator. To reach the same level of cost an operator has to achieve a market share of at least 60 %. In this case the cost of the competing operator are higher by 50 %. In case one operator only achieves a 20 % market share it has a cost disadvantage of 300 %.

33. There seem to be some competitive advantages of the multi-fibre approach. On the other hand barriers to entry increase, which means that the potential for competition and market entry decreases. The unbundling model is open for a variety of market structures and supports the search for the most efficient market structure; the multi-fibre model on the other hand often tends to a duopoly market structure including a tendency towards collusion.

34. The best solution would be to ensure that both options are available. Generally, it should not be the NRA which should pick a successful business model. This should be the task of market players and/or the outcome of the competitive process. If altnets have the choice between an unbundling access and a multi-fibre business model, they can choose the most efficient model for competition.

This choice may not lead to the same outcome in each fibre deployment area. Generally, a multi-fibre model may have comparative advantages in areas where an altnet already has a high market share and its own comprehensive feeder and backhaul network infrastructure such that, where such circumstances are fulfilled the altnet will likely look for access at the distribution point and share the drop and inhouse cable segment only.

35. The multi-fibre option could be a useful model for a multi-operator co-operative arrangement in some circumstances, if agreed before investments are made. In order to meet conditions for competition such a model should involve joint control of the co-investment vehicle and also address the availability of an unbundling option. The ARCEP approach of multi-fibre per building on demand presents an alternative scenario where fibre hand-over is realised at the lowest network level and optimises a decentralised decision making for network efficiency. The potential efficiencies of the multi-fibre sharing approach are, however, maximised, if access to shared network elements is available at the MPoP as the EU Commision is suggesting.

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Abbreviations

ADSL	Asynchronous Digital Subscriber Line
ALA	Active Line Access
altnet	Alternative Network Operator
AON	Active Optical Network
ARCEP	Autorité de régulation des communications électroniques et des postes
ARPU	Average Revenue per User
ATM	Asynchronous Transfer Mode
BIPT	Belgisch Instituut voor Postdiensten en Telecommunicatie
B-RAS	Broadband Remote Access Server
CAPEX	Capital Expenditure
CATV	Cable TV
CLEC	Competitive Local Exchange Carrier
CPE	Customer Premise Equipment
CPI	Consumer Price Index
Cu	Copper
CWDM	Coarse Wavelength Division Multiplexing
DE	Deutschland
DOCSIS	Data over Cable Service Interface Specification
DP	Distribution Point
DSL	Digital Subscriber Line
DSLAM	DSL Access Multiplexer
DTAG	Deutsche Telecom Aktien Gesellschaft
DWDM	Dense Wavelength Division Multiplexing
ECNS	Electronic Communication Network Services
ECTA	European Competitive Telecommunications Association
EPON	Ethernet Passive Optical Network
ERG	European Regulators Group
EU	European Union
EWZ	Elektizitätswerk der Stadt Zürich
FD	Framework Directive (EC Directive 2002/21/EC)
FTTB	Fibre to the Building
FTTC	Fibre to the Curb
FTTH	Fibre to the Home
FTTN	Fibre to the Node
FTTP	Fibre to the Premise

FU	Fibre Unbundling
GigE	Gigabit Ethernet
GPON	Gigabit Passive Optical Network
HFC	Hybrid Fibre Coax
HSDPA	High Speed Download Packet Access
IP	Internet Protocol
IRR	Internal Rate of Return
IRU	Indefeasable Right of Use
ISP	Internet Service Provider
ITU-T	International Telecommunications Union – Telecommunication Standardisation Bureau
KPN	Koninklijke PTT Nederland (PTT: Posterijen, Telegrafie en Telefonie)
LER	Label Edge Router
LLU	Local Loop Unbundling
LRIC	Long Run Incremental Cost
LSR	Label Switch Router
MCL	Metro Core Location
MDF	Main Distribution Frame
MDU	Multi Dwelling Unit
MF	Multi-Fibre
MPoP	Metropolitan Point of Presence
MoU	Memorandum of Understanding
NCA	National Competition Authority
NGA	Next Generation Access
NGAN	NGA Network
NGN	Next Generation Network
NPV	Net Present Value
NRA	National Regulatory Authority
NRO	Remote Optical Node
ODF	Optical Distribution Frame
OLT	Optical Line Terminator
OMDF	Optical Main Distribution Frame
ONT	Optical Network Terminator
ONU	Optical Network Unit
Op	Operator
OPEX	Operational Expenditures

OPTA	Onafhankelijke Post en Telecommunicatie Autoriteit
OSDF	Optical Street Distribution Frame
P2P	Point-to-Point
PON	Passive Optical Network
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RGU	Revenue Generating Unit
RO	Reference Offer
ROI	Return on Investment
SC	Street Cabinet
SDF	Street Distribution Frame
SLA	Service Level Agreement
SLU	Sub-loop Unbundling
SMP	Significant Market Power
TDM	Time Division Multiplex
TDMA	Time Division Multiple Access
TV	Television
ULL	Unbundled Local Loop
UPS	Uninterruptible Power Supply
VDSL	Very High Speed DSL
VoB	Voice over Broadband
VoIP	Voice over IP
VPN	Virtual Private Network
WACC	Weighted Average Cost of Capital
WBA	Wholesale Bitstream Access, Wholesale Broadband Access
WDM	Wavelength Division Multiplex
WiBro	Wireless Broadband (Korean standard)
Wi-Fi	Brand name for certified Wireless LAN
WiMax	Worldwide Interoperability for Microwave Access
xDSL	x Digital Subscriber Line

1 The risk of NGA

1.1 Systematic vs. diversifiable risk

In calculating the cost of access to the unbundled copper local loop of SMP operators NRAs usually include a return on (or cost of) capital in their methodology. This includes a risk premium for the (historic) investment in the copper network investment. Given the high and uniform penetration of access and the bottleneck nature of the copper network of the incumbent for competitors, the risk inherent in the copper network is rather limited. Given this proposition, the cost of capital used to calculate the cost of ULL, if properly calculated, should be lower than the company-specific risk of SMP operators derived from stock price developments. This follows from the fact that the incumbents' retail business due to competition and other businesses are more risky than their wholesale business, which sells bottleneck infrastructure services.

The WACC used by NRAs to calculate the cost of copper ULL is an appropriate starting point to determine the return on capital allowed ex ante for investments into fibre-based NGA networks. Only if there are systematic risks of NGA investments which are different to those of the copper network a supplement to the ULL WACC may be justified. Furthermore, it is essential that this additional project-specific risk of NGA cannot be diversified away. We see potentially the following factors which may cause project-specific (or systematic) risks related to NGA investments:

(1) The risk of penetration.

(2) The risk of sufficient willingness to pay.

(3) Regulatory risks.

(4) Specific risks of certain business models.

1.2 The risk of penetration

We have shown in last year's report on the Economics of NGA[1] that any efficient NGA investment roll-out is mainly supply- and only to a rather limited degree demand-driven. A fibre network cannot be rolled out according to a given customer demand at a given point in time building-by-building and/or household by household. Any efficient roll-out has to cover a certain district, city or region completely in the sense that the network passes all buildings and/or flats. The efficient deployment of the network is consistent with not serving certain districts or one family homes so that only 80 % or 90 % of the

1 Elixmann, Ilic, Neumann, Plückebaum (2008).

potential customer base is connected to the network. In the case of a FTTC architecture this means that all street cabinets are connected to the fibre network; in the case of FTTB all buildings of the coverage area have to be passed and connected and in the case of FTTH all flats in a building should be connected or should at least get the capability to be subsequently connected in the short term.

It is not only the efficiency of the fibre deployment which requires a network coverage of usually at least 80 % of a deployment area. It is hard to apply a successful marketing approach if the network is not capable to connect customers which are approached by the marketing measures and are willing to subscribe. Not only marketing itself would become inefficient in such a situation, provisioning processes and field service as well become more complex and expensive. Also the chain of self-supporting demand externalities is broken if interested and relevant customers cannot subscribe to the network.

The supply-driven investment path makes the penetration of the potential customer base a key factor to the profitability of the NGA investment and at the same time a key risk factor. The profitability of the network becomes higher the higher the penetration of the potential customer base is. If the penetration does not reach a certain threshold, the NGA investment may not even be profitable at all. The necessity of high penetration rates and high market shares also is the reason for the very limited degree of replicability of NGA networks as we have shown in our previous study.[2]

Certain NGA scenarios generate different degrees of risk:

(1) If and when all customers of the SMP operator are migrated to the NGA platform, if there are no competing NGA fibre network platforms and if the degree of infrastructure competition by a cable network remains unchanged, then there is no penetration related risk associated to NGA which is higher than the one currently is associated with the copper network for ULL.

(2) As long as a new fibre NGA platform competes against a remaining copper network DSL platform, the risk of penetration becomes obvious. The existing broadband penetration, the demand for additional bandwidth, consumers' willingness to pay and the likelihood of alternative operators migrating their customers to fibre loops become relevant factors for determining penetration besides those as mentioned in scenario (1). These penetration related risk factors can be eliminated when the fibre network entirely replaces the previous copper network, which is the rational path to go anyhow following a given migration period. The last aspect underpins that the penetration related risk of NGA investment is to a large degree a risk which is only relevant for the migration period towards NGA. As long as the parameters of the migration path are totally

2 Elixmann, Ilic, Neumann, Plückebaum (2008).

under control of the SMP operator, one might even argue that there is no penetration related risk because it is up to the SMP operator when he wants to migrate the existing customer base (retail and wholesale) to the new NGA platform. It may in this context not be possible or even optimal to migrate the customer base in a very short period of time. This situation may be regarded differently if for instance the NRA determines the path of migration, e.g. by defining certain rules and restrictions how and when to dismantle the remaining copper network. In this context, NRAs can best replicate this 'SMP operator'-driven migration decision by offering the option for SMP operators to set a migration period of their choice if they in parallel migrate competitors to fully equivalent wholesale products which do not strand or otherwise compensate for any stranding of competitors' assets.

1.3 The risk of sufficient willingness to pay

The profitability of an FTTH roll-out depends on revenues which can be generated from using the fibre infrastructure. If only the current set of retail services, the current level of ARPU for each service and today's mix of services will be representing demand of the future, only a limited degree of FTTH deployment will be profitable (although VDSL profitability is much more widespread on this basis). If on the other hand new retail services requiring enhanced network quality requirements in terms of speed and quality are developed which can only be delivered over fibre, an additional willingness to pay for these new services may emerge The same holds if telecom operators will become able to sell a larger share of higher valued multi-service bundles like triple play, the level of ARPU compared to current levels may increase. If the FTTH deployment and coverage is rolled-out with the assumption of a higher ARPU level in the future, it remains a considerable risk whether the higher level of ARPU materialises in due time. NGA investments are mainly sunk once the investment has been made. This will make market exit rather costly if future demand for new services does not turn out as expected. If the business plan of the investor entails revenue assumptions which do not represent current demand but a higher willingness to pay (on a per-line basis) in the future, then the investor bears a project-specific risk which is reflected in his cost of capital and therefore has to be reflected in his return on capital.

1.4 Regulatory risk

Given the long-term nature of NGA investment, regulation may also be a risk factor for the NGA investor. If there is unpredictability of regulatory behaviour, regulation can generate a risk attached to the investment. Regulatory risk like any other non-diversifiable risk increases the cost of capital and requires a higher return to make an investment profitable. There are potentially four factors of regulatory uncertainty an investor might be facing:

(1) It is first of all the question whether a certain NGA investment would face access regulation at all or whether the investor can make its approach on whether and when it provides wholesale services to competitors on pure commercial considerations, terms and conditions.

(2) Regulation may or may not have an impact on the amount of investment expenditure if and when regulation makes obligations towards the NGA architecture to be deployed by the investor.

(3) The investor may face uncertainties about the regulatory obligations attached to the infrastructure he is investing in. In case of price regulation even the general principle of cost-based pricing (for wholesale services) may be applied in quite different forms and with different implications: The regulator may calculate costs on a current or a historic cost basis, investment expenditure may be depreciated straight-line or economically. Costs can be calculated using regulatory accounts, top down or bottom-up modelling tools. Wholesale prices may be determined from time to time using one of the measures or instruments mentioned above or may be determined by a more dynamic regulatory instrument like price caps.

(4) A further regulatory risk factor is the uncertainty about the regulatory regime and the change of parameters of regulatory instruments over time. It is less the potential change of regulatory regimes or parameters which generates a systematic risk. It is more the discretionary change which is not correlated to predictable economic parameters, like on SMP position, which generates uncertainty and risk.

All the factors mentioned above do not generate a regulatory risk increasing the cost of capital to the investor over the whole lifetime of the investment. Some risk factors only depend on single regulatory decisions to be taken. One example is the regulatory decision whether the SMP operator would have to face a certain type of access regulation or whether obligations apply to the NGA architecture. If such regulatory decisions are taken prior to the investment, they generate by definition no regulatory risk at all because the investor knows the relevant regulatory regime before he actually commits to the investment. Only when such decisions are subject to change ex post a regulatory risk may remain. Usually investors are only committed to or can commit themselves to a certain period of time and the risk of change in relevant regulatory parameters remains. It is important to mention here that the baseline of regulatory risk of regulated entities is already reflected in the company-specific risk of the operator.

NRAs have it mostly in their hands to manage the regulatory risk and to limit or reduce it to a socially optimal value. By managing the regulatory risk of the investor properly, NRAs contribute to keep the capital cost of the investor, the incumbent operator as well as its competitors, low. By drawing up principles of NGA related regulation in due time, NRAs provide greater clarity. Specifying in advance to the investment the principles of tariff regulation that will apply to unbundled fibre access by an SMP operator constrains regulatory risk related to price control significantly.

Theoretically, a NRA could eliminate the risk of changing the parameters of its approach towards price control totally, if it fixes the parameters of the price control formula for the whole period of the economic lifetime of an NGA investment. This approach vests the greatest possible certainty in regulatory conduct and therefore eliminates the regulatory risk. A multi-year tariff regulation lowers or eliminates uncertainty for SMP operators and for access seekers. Both market parties face more predictability for their respective business plans. Alternative operators can make more rational and efficient decisions on their choice of make (invest in their own infrastructure) or buy (using wholesale services of SMP operators). SMP operators or investors can maximise operational efficiency. The crucial point, however, is that this approach could maximise the risk of erroneous regulatory intervention, if we are, for instance, talking about a 20 year regulatory period. If the market dynamics or technological developments change, however, too long a regulatory commitment can cause errors and inefficiencies. The Netherlands' NRA OPTA, concludes on this trade-off in a way which we share and support: "*Advance specification of the framework governing how potential future intervention will take place, without setting out the precise details of that regulation reduces the risk of erroneous intervention. At the same time investment incentives will not be prejudiced*."[3] For this reason it is socially not optimal that the NRA commits itself for an unreasonably long regulatory period. Therefore, the attempt to eliminate the regulatory risk has an opportunity cost and is not a value in itself. This can be shown by taking the analogy to an investor's business case. If major market parameters have changed, it is not rational and efficient for an investor to orientate its decisions to the original business plan made prior to the investment.[4] If the changes are strong enough, it becomes more rational to adapt the business plan to the new market environment.

1.5 Risk management

We mentioned already in section 1.1 that the equity risk premium covers only the diversifiable risk. In sections 1.2, 1.3 and 1.4 we discussed several risk factors which might generate systematic project-specific risks of NGA investments that probably will not be covered by the efficient capital market hypothesis in the equity risk premium. These project-specific risk factors may be covered by supplements to the "normal" equity risk.

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3 OPTA (2008), p. 20.
4 See ERG (2009), p. 21.

It is, however, worth mentioning that there are other measures at the disposal of the company itself to manage systematic risks. Among the measures regarding a positive management of risk are optimal use of resources, achievement of a high growth rate and maintaining long phases of profitable growth. Besides the positive risk management there are also measures to decrease risk like hedging, insurance, and selection of a capital structure that takes account of this risk. Project-specific risks can also be reduced by sharing or transferring parts of the risk to end customers, access seekers and vendors. Another factor reducing the risk of FTTH investment for an incumbent is the cost saving gained by the reduction of ongoing OPEX compared to copper based networks, together with more short term capital benefits if exchange buildings can be sold.

1.6 Risk and business model

The project-specific risk of NGA investment depends on the business model. First of all, the systematic risk depends on the asset-specificity of the NGA investment. According to this criterion, investment in non-replicable physical assets such as civil engineering infrastructure is less risky than investments in certain NGA architectures. Because of non-replicability such investment has a bottleneck nature and generates a relevant first mover advantage against competitors. Furthermore, these physical infrastructures like ducts can be used for other purposes than NGA. The Commission even concludes that civil engineering investment is not specific to the deployment of NGA networks and would therefore not generate a systematic NGA related risk which would have to be compensated by an NGA risk premium where access obligations are imposed on SMP operators.[5]

Major parts of the FTTH investment on the other hand are NGA specific. Therefore, there may be a higher risk attached to the deployment of FTTH. These risk factors relate to penetration, customer willingness to pay and take-up of new services. FTTH could entail a risk, particularly in areas where increased ARPU assumptions are required for the business plan to be viable, which are not balanced by compensating OPEX reductions.[6] In these circumstances, access to the unbundled fibre loop should be calculated on the basis of a cost of capital which includes an NGA specific risk premium.

In our previous NGA study we have calculated that the investments for deploying FTTH are five times higher than the investments for deploying FTTC or VDSL. Investment into FTTC is more a partial upgrade of the existing access network than investment into a

5 EU Commission (2009), Rec. 13 and Annex I, Nr. 2.

6 FTTH networks compared to copper based networks imply a lower OPEX level which mainly results from the higher share of passive equipment in the FTTH case. Generally, the maintenance and operating effort is lower for passive equipment than for active equipment.

new NGA architecture. There is less uncertainty involved about demand for bandwidth delivered via VDSL. These NGA investments should therefore have a significantly lower risk profile than investments into FTTH.[7] FTTC investments are not only less risky than investments into FTTH. The Commission even has doubts whether there is a NGA specific risk to be compensated via a risk premium when calculating the cost of WBA based on VDSL at all. The same holds for access to the copper sub-loop.

As in the broadband market today it should also be expected for NGA that the relevant retail markets are (significantly) more competitive than the corresponding wholesale markets (WBA, fibre ULL, ducts). Furthermore, there are NGA related risk factors that are relevant to the retail business but not to the wholesale business. Therefore, the NGA specific risks of an integrated retail/wholesale business model are higher than the systematic risks of the wholesale business model.[8] For calculating the appropriate risk premium for the costs of the wholesale service, NRAs should not derive it from an integrated business model or should exclude the retail related risk factors.

1.7 Final evaluation of the risk of NGA investment

Our analysis and findings on the risk of NGA investments can be summarised as follows:

(1) It is only the systematic NGA specific risk and which is not diversifiable which might need to be compensated by a risk premium as part of the capital cost of fibre investments.

(2) Relevant for determining NGA specific risks are the risk of penetration, the risk of sufficient willingness to pay, the regulatory risk and specific risks of certain business models. Risk increasing factors should be balanced against risk decreasing factors like capital benefits and OPEX reductions resulting from NGA deployment compared with existing copper access infrastructure.

(3) The risk of penetration is closely related to the supply-driven nature of any efficient fibre network deployment. The profitability of any NGA roll-out and/or the degree of profitable coverage depends on the penetration of the potential customer base. If and as soon as the whole (retail and wholesale) subscriber base of an SMP operator is migrated to the (new) NGA platform, the penetration related risk is close to zero. If and as long as a new fibre NGA competes against the (remaining) DSL platform, there might be a remaining penetration risk.

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7 Only the weaker competitiveness of VDSL against cable compared to FTTH works in a different direction.

8 In our previous NGA report we have provided evidence for the quantitative effects of the wholesale business in improving the business case of the SMP operator (see section 5.4.2.4 of our previous report).

(4) The risk of penetration will be lower if the operator offers wholesale access, due to the stimulating effects of competition on retail demand.

(5) The profitability and the degree of profitable coverage depends on the average revenues per access line to be generated. If the business plan of the investor entails revenue assumptions over and above the current level of revenues, the investor bears the risk to meet these demand and willingness to pay expectations.

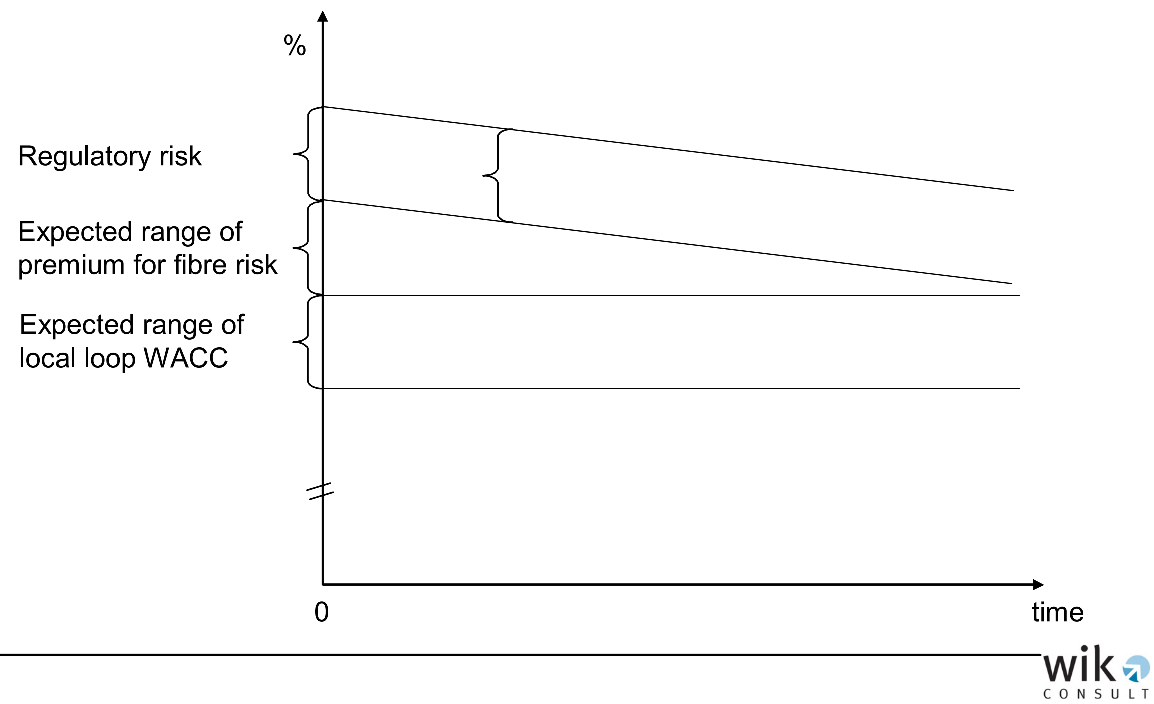
(6) Given the long-term nature of fibre investment, regulation can be a relevant risk factor. There is no regulatory risk related to decisions to be made before the investment is actually made. It is more the change of the regulatory regime and of regulatory parameters over time which defines a regulatory risk. NRAs can manage this risk and keep it low. It is, however, socially not optimal, to eliminate it totally. The baseline of regulatory risk is already reflected in the company-specific risk of regulated entities.

(7) Because there is a retail-specific risk in NGA, the risk of an integrated wholesale/retail business model is higher than the risk of the wholesale business itself. It is only the latter one which should be taken care of in calculating the access prices.

(8) The risk of investment will be lower for an incumbent, since he could sell parts of its existing MDF buildings and potentially other assets used in the former copper based network and use this income for effectively reducing the FTTH investment. This option does not exist for other companies so that he faces higher risks of investment. The altnet also has to consider disadvantages due to its lower market share compared to that of the incumbent. Furthermore the capital costs of altnets usually are higher than those of incumbents.

The project-specific risks of NGA investments can be illustrated by the following diagram, which represents the so-called "all risk WACC", which OPTA (2008) has applied for fibre access.

Figure 1: Elements of the project-specific risk of NGA



Source: OPTA (2008)

The base line is the WACC applicable to the existing copper local loop, which is relatively stable over time. The second element is a premium to the WACC representing the demand related risks of penetration and willingness to pay. This risk is expected to be higher at the beginning of the investment and decreases gradually over time. The third element takes account of asymmetrical regulatory risks.

2 Mechanisms to share the risk and competitive implications

Investors can limit or reduce their risk attached to a certain investment when they share the risk with other stakeholders. Investors in FTTH can limit their risk when they shift parts of the investment to the users of NGA. They might do it via a wholesale business model, so that altnets market the incumbent's infrastructure. NGA investors may go into co-investment arrangements with one or several of their (potential) competitors to share exposure to risk. Furthermore, NGA investors may diversify the investment risk by certain access pricing regimes for access seekers and/or long-term contractual arrangements with access seekers. We will analyse these options and their implications in more detail in the following subsections.

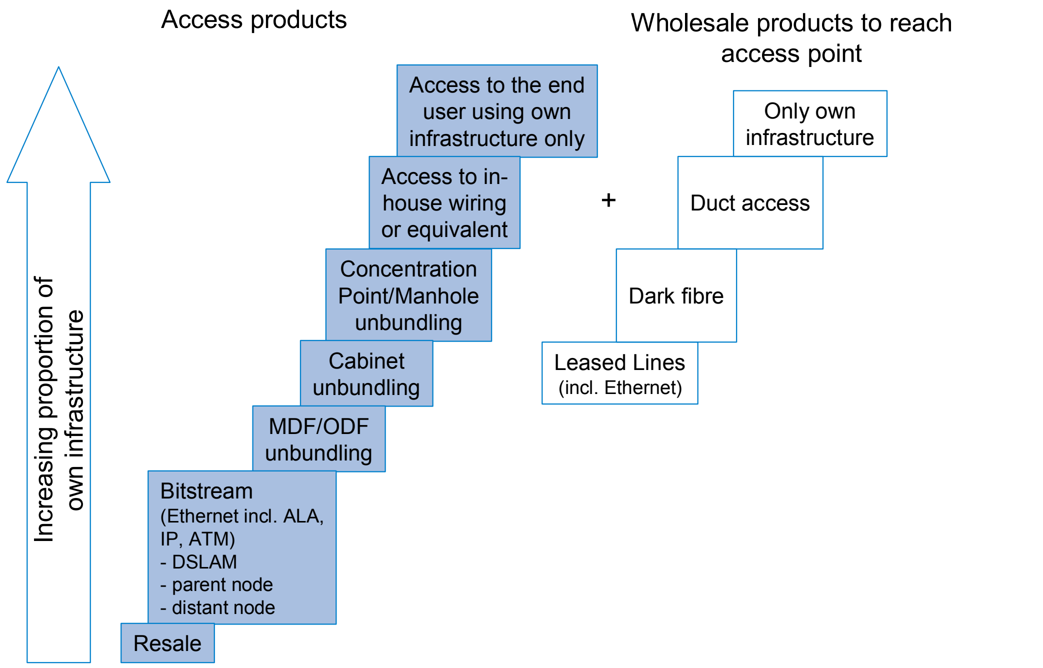
It is often assumed that risk-sharing arrangements automatically limit or reduce the project-specific risk of investment. The ERG for instance argues in its recent NGA report: "*Co-investment and risk sharing arrangements have as purpose to limit the risk of investment and as a result lower the cost of capital for investments*."[9] This is, however, not the case, at least not necessarily and not in each particular case. In many cases risk sharing arrangements do not reduce the overall (or social) level of risk attached to a certain NGA investment. The nature of such arrangements only means to redistribute a given investment risk to other market participants. The overall or remaining risk of the investor will nevertheless be decreasing due to the reduced capital committed by each party.

2.1 Wholesale offers and project-specific risk premium

Incumbents sometimes argue that they need at least temporary protection from competition to come into a position to invest in NGA. Protection from competition may take the form of regulatory holidays, the unavailability of essential wholesale services, the delayed availability of wholesale products or the overpricing of wholesale products. We do not want to go into the structure of various access products and the advantages and disadvantages of active and passive access products. The structure of the various access products can best be presented by an NGA ladder of investment as in figure 2.

9 ERG (2009), p.22.

Figure 2: NGA ladder of investment



Source: ERG (2009), p. 14.

We are only interested here in the relationship of access, pricing, competition and investment risk. If the investor is the only or the dominant player in the retail market, he has to bear all or major parts of the risk, particularly the risk of penetration. The recent history of the broadband market in the EU impressively proves the positive correlation between penetration of broadband and the degree of competition in the markets. Germany gives two supporting examples of this general trend in the EU. When the German incumbent DTAG had a market share of more than two thirds in the broadband retail market, the German penetration was significantly below the EU average. This relationship changed significantly together with increasing competition. Germany became one of the fastest growing broadband markets in Europe with a penetration rate which is in the meantime significantly above the EU average. A more recent example of the German market reveals the relationship between penetration, competition, access products and risk in an even more dramatic form. In Germany, there are de facto regulatory holidays with regard to VDSL-related wholesale products. Up to now, there is no VDSL bitstream product available in the market and no agreement on collocation at the street cabinet to get access to the unbundled sub-loop in place. DTAG has a de facto monopoly in VDSL. Although DTAG has upgraded its network to provide VDSL access to around twelve million customers, the company has sold less than 300,000 VDSL lines after three years service launch, which is a penetration rate of less than

2.5 %. Such take-up rates imply a significant investment risk. If proper wholesale products were available, competitors would also invest in the development of the market. The demand for wholesale products related to the NGA infrastructure would not only lead to a participation of access seekers at the investment risk of the incumbent. Insofar as the investment of competitors in the retail markets and the competition will lead to faster penetration and take-up, it will also reduce the systematic risk of the NGA investment. At first sight an access seeker does not seem to have sunk cost and therefore does not seem to bear a similar risk as the "investor". Any access-based business model, however, requires complementary investment which is associated with sunk cost and brings an access seeker into a similar position to the investor in the bottleneck facility.[10]

The mechanism by which wholesale customers participate in the investment risk is the payment of access prices which are calculated on the basis of rates of return (or capital costs) which include a risk premium to cover the project-specific risk of the infrastructure investment. We have discussed the relevant risk factors in section 1. Pro rata to their market share, access takers take the risk of the infrastructure investment of the SMP operator. The access price calculated on the basis of the long run incremental costs including project- or risk-adjusted cost of capital rewards the risk an investor takes in making the investment.

If the project-specific risk premium is calculated properly, there is no over- or under-compensation of the relevant investment risk. Therefore, and because the SMP operator and his competitors share the risk pro rata to their respective use of the underlying infrastructure, the risk premium approach as a risk sharing mechanism is competitively neutral. This presumption holds insofar as there is no margin squeeze.

2.2 Investment sharing between the user and the investor

In the very end it is the user of a telecommunications infrastructure who finances and pays for the investment. The mechanism by which this transposition of the financing of investment usually happens is through the “user cost of capital” (depreciation plus interest) calculated as part of the product price on a pro rata basis in terms of quantity and timing of use. Over the lifetime of the infrastructure (or a bit earlier in case of a profitable investment), the user actually pays for or refinances the infrastructure investment of the investor.

This common transposition mechanism of the market interaction between the user and the investor can also be organised in a different way regarding the timeline of such payments. Telecommunications has a long history from its beginning that the user

10 We discuss this aspect in more detail in section 2.4.1.

directly contributes to the investments of a (new) network. Why should this model not be activated in the context of NGA, which is in case of FTTH by far the largest investment the telecommunications industry has ever made? This model has particular relevance for those part(s) of the investment which are specific to a single user or a dedicated group of users. In the context of an NGA network (as in any other fixed-line network) the directly user dedicated part of the investment relates to inhouse cabling and the drop cable as the connection of a building from the street.

The sharing of investment between the user and the network operator can take two forms: Either the user takes responsibility of the investment into these network elements himself or he makes an ex ante financial payment to the operator in the amount of the user specific investment. Both approaches have specific comparative advantages and disadvantages which we do not want to analyse here in detail. Both approaches, however, are suitable approaches to reduce the investment exposure of the network operator and are reducing the risk of the investment. The user de facto makes a lump-sum payment at the beginning of the use of NGA services and has to pay lower monthly rentals (in case of competition) because the user cost of capital for using the service is lower. At the same time this mechanism of investment sharing leads to a sharing of risk between the user and the network operator.

This model of risk sharing is competitively neutral because under a cost-based pricing regime the wholesale price is calculated on the net investment costs of the SMP operator. These net costs reflect the savings in investment costs which are due to the direct investments of the end user or its financial investment contribution. This risk sharing approach is, however, not competitively neutral against other platforms (eg. cable, mobile). Because the user is directly investing in platform-specific network elements, he has a sunk cost related to this platform. This generates switching costs to other platforms.

2.3 Co-investment arrangements

Certain characteristics of the deployment of NGA facilitate or indicate the cooperation of stakeholders or competitors in the market such that these potential competitors jointly arrange the infrastructure investment, share the cost and the risk of the investment:

(1) FTTH networks are in most relevant cases not replicable such that the parallel deployment of end-to-end fibre network infrastructures is an unrealistic scenario.

(2) The high level of investment required for a major coverage of the fibre network in a country may even overburden the cash flow assets of an incumbent operator. Sharing of the investment cost can make it easier to participate in the network roll-out at all and can reduce the exposure of any single operator but does not reduce risk overall per se.

(3) Diversifying the risk of fibre deployment on several shoulders by some form of investment and risk sharing may lead to a more timely and faster deployment of NGA networks.

(4) Co-investment of several market players will reduce or eliminate the first-mover position of a single NGA investor and put co-investors in a more equal position in the retail market competition.

(5) All operators in the market including the incumbent face at least some level of financing constraints. Co-investment arrangements could potentially at least help to overcome such financing constraints.

(6) Under appropriate non-discriminatory rules of access to the jointly invested network infrastructure cooperation can both reduce penetration risks for the joint investors in FTTH and support competition.

Potentially there may be numerous forms of co-investment arrangements. Fundamentally they can be grouped around the following three models:

(1) Two or more partners jointly undertake the investment in a certain region, city or district. Under such build and share arrangements the partners jointly own the network infrastructure usually arranged through a joint venture entity in which the partners take all (or most) of the equity shares (the "joint venture model"). The investment arrangement then has to define rules under which the partners get access to the capacity and rules on sharing the cost of the network. The arrangements also have to address the access opportunities for third parties which do not take equity shares in the joint venture.

(2) A single investor may also set up co-investment arrangements with partners (the "investor model"). Under such arrangements the investing operator takes the decisions on the investment and the ownership rights in the network infrastructure. Prior or after the investment decision and the roll-out, the investor grants his co-investment partners rights of capacity use usually in the form of indefeasible rights of use, unbundled access or bitstream access. A typical model of this type is the cooperation agreement Swisscom is offering in Switzerland.[11] The fibre network is rolled out in a multi-fibre approach. Partners would get access to their own fibre to the home at the distribution point and receive indefeasible rights of use to this part of the infrastructure. Investment and operating costs are usually intended to be shared on either equal sharing rules or some more sophisticated rules which take care of retail market success and/or prior commitment of capacity.

11 The details of this model are elaborated in section 4.2.

(3) Two (or more) investors agree in which areas (region, city or district) each of them is deploying independent from each other a fibre network. Under the cooperation agreement the partners agree on the deployment area of each partner and the swapping of capacity using rights in each others deployment area (the "swapping model"). Rights of use can be based on a multi-fibre approach, on unbundled access to fibre loops or on bitstream access.

All co-investment arrangements have to address answers to the same questions. The most prominent ones are:

- Who makes decisions on investments, costs and roll-out?
- What is the technical mode of access for cooperation partners?
- What are the rules of sharing the investment cost?
- What are the conditions of access for third parties?

The models mentioned above do not by themselves indicate certain predetermined answers to these questions but favour certain outcomes.

The pure joint venture model gives each co-investor equivalent rights to make decisions. The symmetry of partners here only depends on the equity shares in the joint entity and the distribution of rights according to the equity positions. In the joint venture model, providing no operator maintains overall control of the co-investment vehicle, the usual dichotomy between the role of the investor and network owner on the one hand side and the role of the access seeker on the other hand side become rescinded.

In the investor model the distribution of rights is much more asymmetrical. The investor is the dominant decision maker in this model. Its position is even stronger if the investor is the SMP operator in the market. If the cooperation partners join the investor prior to the investment their influence on network roll-out, network architecture and costs of investment is larger.

By nature the swapping model looks like a rather symmetrical model. Each investor has decision autonomy in its own deployment areas and has incentives to minimise costs. In practice, symmetry may be distorted by different areas which the cooperation partners intend to deploy with fibre. If the areas are of different size and different costs, the arrangements may have to foresee financial compensations besides swapping of capacity.

The technical mode under which the cooperation partners can access the fibre infrastructure are not predetermined by the form of the cooperation model. In all three models access to capacity can be arranged in a multi-fibre approach, via single fibre unbundling or through bitstream access. The multi-fibre approach which we analyse in detail in section 4 offers the deepest level of end-to-end control for a cooperation partner. At the same time it requires a relevant amount of unshared own investment if the access is handled at the distribution point. The swapping model tends to an unbundling or bitstream access approach amongst the swapping parties.

Under symmetrical circumstances the swapping model may work without cost sharing or other forms of financial compensation between the investor in a region and the access seeking partner. The typical cost sharing rule of the joint venture and the investor model splits investment costs on equal shares. This sharing rule can, however, cause very severe competitive asymmetries. Under such a sharing rule costs per customer served will depend on the market share distribution between the cooperation partners.[12] This may imply that one partner due to retail competition will become a profitable entity and the other one a loss making entity. For becoming viable and stable, more intelligent sharing rules may be needed to make such cooperation work. To solve the symmetry problem related to market share dependent costs, the cost shares have to be more related to the effective market shares partners actually achieve. On the other hand, if the cost allocation is managed ex post, the risk sharing mechanisms in the cooperation model may not materialise. A possible solution may be a cost sharing according to capacity commitment which may be adapted to actual market success to a certain degree.

From a regulatory but also from a certain business perspective cooperation arrangements cannot work as closed shop agreements where only the cooperation partners would get access to a bottleneck infrastructure. Otherwise, the cooperation arrangement would be a collective foreclosure agreement. There is a natural tendency and incentive that the investor and under a cooperation arrangement the cooperation partners jointly are looking for more favourable conditions to use the infrastructure and to compete in the retail market at more favourable conditions compared to third parties.

Under the perspective of effective competition a regulator should check that the internal pricing conditions imputed to the downstream arm of an SMP operator within a co-investment arrangement reflect those available to third parties. Such checks should include internal prices reflecting long-term commitment discounts where permitted (see section 2.5) and undiscounted prices. In both cases, pricing should be consistent and no margin squeeze should apply.

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12 For details see section 4.7.

2.4 Risk sharing and pricing

2.4.1 Option value pricing

Sometimes it is argued that the risks associated with the investment in NGA are not sufficiently taken into account in the relationship between the investor and the access seeker.[13] This shall be especially true with regard to the risk of a complete failure of the investment. The risk of a complete failure of the investment, so the argument goes, lies with the investor while the access seeker benefits from the upside but can avoid the downside. Due to the irreversibility of the sunk network investment the investor has only a limited choice of business options once the investment has been made. The access seeker on the other hand has a "wait and see" option. He can wait up and until NGA becomes a success before he enters the market and requests access to the incumbent's NGA network on a wholesale basis at a later point in time. Furthermore, the entrant has the make or buy option of making the NGA investment if and when that makes sense. Compared to the investing incumbent, so the argument goes, the access seeking competitors have more real options. From this analysis it is derived that the value of these real options of the access seekers should be considered when calculating the access price. According to the theory, the access price should then be determined on the basis of the cost (including the risk-adjusted cost of capital of the investor) plus a mark up which reflects the economic value of the real options. This pricing rule implies that the downstream cost of the incumbent is lower than the wholesale price the alternative operators have to pay. Otherwise, so the argument goes, the access seeker is in a strategically better position than the SMP operator: The competitor is flexible; he has not only the option to wait and see whether market entry makes sense and the timing of it. He buys the access product only when he has acquired a retail customer; therefore he has lower sunk costs and is more flexible including the option of market exit.

The arguments presented here are theoretically relevant. It is, however, rather questionable whether entrants really have the claimed advantages over the SMP operator. First of all, the characterisation of the SMP operator as the investor and the entrant as the access seeking non-investor is a paradigm which only holds in case of a pure resale business model of the entrant. If the alternative operator bases his business model on an unbundling approach, he also is an investor. He is investing in all network elements which are replicable and is only seeking access to network elements which are not replicable due to economies of scale and scope. His investments include CPE, all active components of the network, collocation and the aggregation network to link all access points to his backbone network. This investment also is mainly sunk similar to

13 See e.g. Never (2008)

the SMP operator. With regard to the investment the alternative operator is in a similar position as the SMP operator.

The wait and see option is not costless. The downside of this option is to give the SMP operator even greater opportunities to make use of its already strong first mover advantages. If the alternative operator decides to enter the market later and to make use of the option, the first mover takes the most interesting part of the market first and it becomes more difficult or more costly for the altnet to reach the critical market share needed for profitability.

The make or buy option in the context of NGA is of rather limited value. We have shown that the degree of replicability of FTTH infrastructures is limited in a way that this option in most countries and in most areas simply does not exist.

A more detailed look into the real options of alternative operators reveals that either these options de facto do not exist or that they are of no value. In any case they do not justify an increase of access prices above costs causing even more asymmetries in the competition between incumbent and alternative operators in the downstream market.

For a similar reason the Commission[14] regards option value pricing only as acceptable if these prices reflect the reduction of risk for the investor (e.g. long-term commitment pricing) and if there is a sufficient margin between wholesale and retail prices to avoid a margin squeeze. We will discuss this option – and some further considerations – below.

2.4.2 Volume discounts

If wholesale prices are calculated on the basis of LRIC, network costs (per line) are not dependent on the quantity of wholesale products (access lines) an access seeker purchases. It is the total number of lines sold by the SMP operator and his rivals which determines cost. There may be some cost savings for the SMP operator, if he sells a bulk of lines to an individual access seeker compared to selling the same quantity to a number of smaller access seekers. These cost savings which may justify volume discounts in a cost-based pricing regime are mainly related to the "retail" part of the wholesale business like billing. These volume-related cost savings are, however, small by nature and can be neglected in the present context.

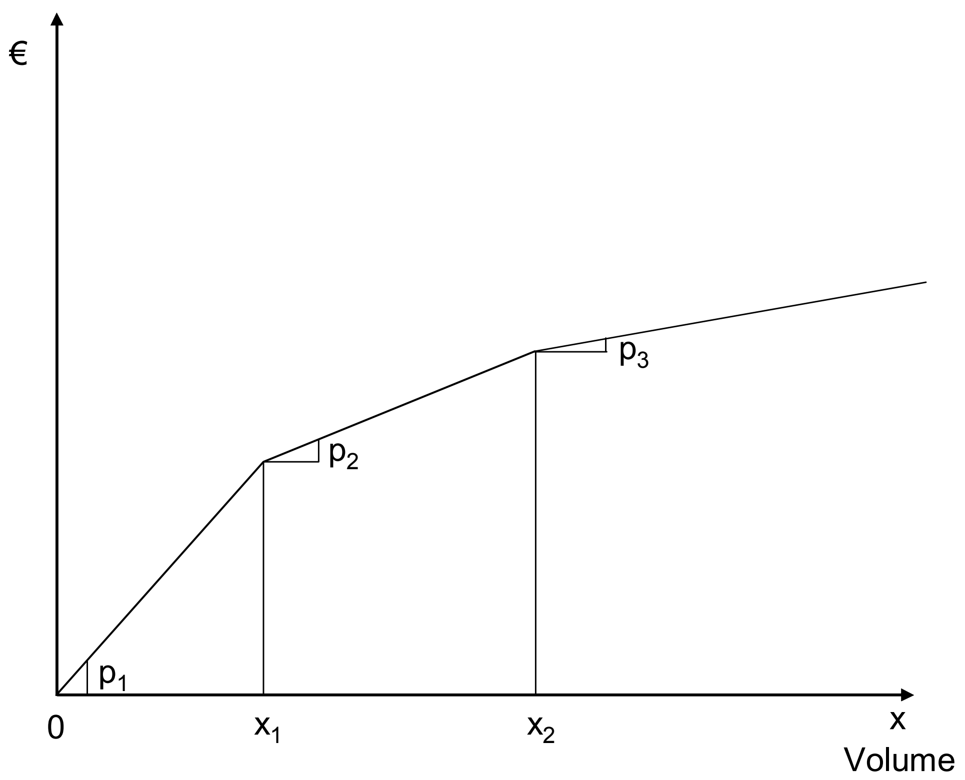
Tariff differentiation according to demand profiles like a volume discount scheme as presented in figure 3 can be a pricing tool to incentivise the increased use of a (new) network infrastructure. Under such a pricing scheme the access seeker has an incentive to increase investment in its retail activities to reach a volume of x_1 and to get access to the lower wholesale price p_2. A more intensified use of an NGA infrastructure

14 EU Commission (2009), Annex 1, p.17.

increases penetration and thereby decreases the systematic risk of NGA. The reduction of risk decreases the cost of capital and the cost per line. These effects justify a volume discount under a cost-base pricing regime.

Figure 3 also shows the potential competitive implications of such a volume related wholesale pricing scheme. Buyer specific volume discounts discourage and discriminate smaller competitors and therefore may undermine penetration benefits resulting from competition. In particular later entrants are discouraged when established competitors already benefit from volume discounts and thereby lower costs. Volume discounts generate barriers to entry to them. If the incumbent also has a strong market position in the downstream market as it is generally the case in broadband access in Europe, volume discount schemes generate an (additional) competitive advantage to the SMP operator. If he is the largest competitor in the retail market, he might be the only downstream competitor which has access to the wholesale price p_3. This differentiation is of particular relevance if a margin squeeze test is based on the concept of an equally efficient operator.

Figure 3: Volume discount pricing scheme



If the discount scheme is not provided to the number of customers per individual wholesale buyer but to the total number of fibre loops sold to all access seekers (including the SMP operator) the basic incentivisation effects can still be maintained and the negative competitive implications could be avoided. If wholesale prices depend on the penetration of NGA access lines in the whole market, access seekers are still incentivised to increase their retail investments to get access to the discounted lower wholesale price. This incentive is, however, a little less than under an individual buyer-specific discount scheme. This follows from the externality involved that all other access seekers benefit from the increase in penetration caused by the effort of an individual access seeker. However, this structure of volume discounts excludes competitive distortions and links discounts with the actual cost drivers involved.

2.4.3 One-off fees

Wholesale prices can also be structured in detail such that there is risk sharing between the investor and the access seeker. Wholesale prices (as well as retail prices) can consist of one-off pricing components and periodic elements ("monthly rentals"). One reason for one-off fees are the compensation of one-off costs for the provisioning of a line when the access seeker commissions a line for an individual customer. This allocation of costs is not related to the risk sharing aspect, it is just related to cost causation. Risk sharing between the investor and the access seeker occurs if one-off fees recoup some of the investment allocated to a single line. In this case the capital cost of a line will be split or allocated to a one-off and a periodic element. This pricing structure shifts part of the investment per line and also a part of the investment risk from the investor to the access seeker. If all costs are allocated to the one-off price component, the whole risk of recouping the investment cost on a per line basis is shifted from the investor to the access seeker. The general rule says, the higher the allocation of investments costs to the one-off component, the more investment risk on a per line basis is allocated from the investor to the access seeker.

On the other hand, if there is churn in the market such that customers can and do change their access service provider, an access seeker cannot assume that he keeps an acquired customer for the whole economic lifetime of the fibre loop. At the maximum he can bear the investment up to the usually expectable average customer lifetime. If the economic lifetime of the fibre loop asset is 20 years and the customer lifetime is 5 years, then the access seeker can (roughly speaking) only bear up to 25 % of the investment cost as a one-off price component. The wholesale business on the other hand is not affected by the risk of churn. [15] The line is used by the same end-user, but only is operated by a different service provider. If the pricing structure requires a higher share of investment costs to be recouped by the one-off fee, the pricing structure

15 If the churn is not caused by platform competition.

becomes a barrier to entry. The access seeker cannot expect to get the one-off fee refinanced from the end-user under the prevailing customer lifetime. Any price point between a zero one-off fee and the maximum as described above defines an economically viable shift of risk from the investor to the access seeker.

This pricing concept does not necessarily require the one-off fee to be paid when a specific line is being ordered. The risk sharing concept also works if the one-off fee is paid when a certain line is terminated in the form of a deactivation fee.

2.5 Long-term contracts and demand commitments

The major risk of NGA investment is the risk of penetration or in other words, the risk that the infrastructure deployed is actually being used or being sold for use. We have discussed this aspect in more detail in section 1.2. If the investor is able to sell the whole capacity in total or in parts to one or a group of wholesale customers for the economic lifetime of the assets in advance, there is no longer a risk attached to the investment at all. Depending on the strength of the long-term contracts the investment risk is totally eliminated. The risk for the investor is reduced accordingly if he can sell (only) parts of the capacity or for a limited period of time.

If access seekers agree to make a binding commitment to the investor to “buy” a certain amount of access lines of a FTTH network prior to the investment, they reduce the risk for the investor. Furthermore, the ex ante risk of penetration or capacity utilisation is reduced, because a certain part of the capacity is sold prior to the investment.

Long-term contracts and demand commitments generate a new balance of risk associated with the NGA investment. Parts of the investment risks are shifted from the investor to the access seeker.[16] The risk of filling parts of the capacity which is committed by the access seeker no longer remains with the investor. It is now the risk of the access seeker to fill this part of the network capacity. Insofar as the demand commitment is binding, the access seeker now has a sunk cost which is not only related to his complementary investment but also to those elements of the network which he buys on a wholesale basis. In that respect the altnet is in a similar situation regarding irreversible investment and sunk cost as the SMP operator. The SMP operator has to assess this competitive equality against an increased degree of competition in the retail market. A committed wholesale capacity makes more pressure on the altnet to reach a certain market share in the retail market.

However, this model contains some inherent challenges. Unlike the co-investment model described in section 2.3, a term discount arrangement enables transfer to other

16 See Never (2008).

operators of ‘penetration risk’, but does not give those operators control over cost and deployment aspects of the investment, which remain with the SMP operator. Only certain ‘demand’ aspects of the risk are thus defrayed from an SMP operator to third parties without any control over other aspects of the business model which could defray the risk. This model is thus less inherently pro-competitive than a model involving collective ownership and co-investment. Furthermore, in certain scenarios this model is also associated with discriminatory effects which could be incompatible with the goal of effective competition. An SMP operator will always be in a position to benefit from the term discount without significant penetration risk (it already has the necessary penetration), but depending on existing market shares of competitors, there may be no or only a limited number of competitors which can benefit from the same discounting structure. The existence of binding volume commitments and inherent penalties for failing to meet such commitments further incentivises an SMP operator to engage in non-price discrimination. In addition to itself benefiting from maintaining a higher market share vs its competitors its competitor would be penalised for failing to reach the volume targets necessary to achieve a discount.

Consequently, certain important safeguards are needed. For compatibility with the goal of effective competition, a term discount scheme should be permissible only if the number of operators that can realistically benefit from such a scheme is compatible with effective retail competition, taking account of existing market positions and capital constraints. Particular vigilance in the enforcement of non-price non-discrimination should be a permanent regulatory task under such scheme to address increased discrimination incentives. Furthermore, given that such schemes inevitably benefit mass-market suppliers, there is an automatic penalty for non mass-market high volume (consumer) suppliers. It should be considered in this context whether for the purposes of discount arrangements, business-grade products are in the same market segment as consumer-grade products.

Risk sharing on the basis of long-term contracts only works if the commitment is credible and therefore has to be binding and cannot be renegotiated, if the market development turns out worse than expected. In the NGA context the access seeker would commit a certain amount of access lines in a predefined city, region or district, Depending on the access concept these lines could be unbundled fibres or bitstream lines. These lines would be abstract (and not dedicated to certain destinations or customers) and reflect a certain market share where the access seeker has to find its customers for in a later customer acquisition process. Different to a co-investment arrangement as considered in section 2.3 the commitment is not related to a whole region, city or district, it is, however, implicitly related to a certain market share.

The risk sharing and risk reduction aspects of long-term contracts are stronger, if the contracts are concluded before the investment takes place. Otherwise, they do not generate an investment incentive in itself and the (potential) investor might make use of his wait and see option. Long-term contracts have to be long enough until the risk of penetration is valid in the business case. However, such a period would normally be shorter than the economic life time of the invested assets.

The risk of an access seeker to meet the committed amount of access lines can be lowered by reselling parts of this capacity. On the resale basis a secondary wholesale market will evolve and more competitors will be entering the market. To foster competition and to support market penetration reselling of long-term committed capacity should therefore not be prohibited or restricted by the contractual arrangements.

Access on the basis of long-term contracts should be offered alongside access without demand commitment. Otherwise, risk sharing contracts would be a form of market foreclosure. This would be the case if a limited number of operators (including the investor/SMP operator) would commit and purchase all available access lines.

On the other hand, if access opportunities are available without commitment, access seekers will only engage in long-term and risk sharing contracts, if there is an economic benefit or incentive to do so. If the price of the access lines were the same under both arrangements, committed access seekers would take a risk they are not being rewarded for. Therefore, if the risk sharing approach via long-term contracts is to work, price differentiation between short-term and long-term contracts is necessary.

How to calculate a price premium for short-term contracts or a price discount for a long-term contract? Under the assumption that the NGA project-specific investment risk including the risk of penetration is properly taken care of in the cost of capital, then the LRIC calculated on that basis is the proper baseline to calculate the cost per access line for not committed access seekers. Their demand is as unpredictable to the SMP operator as the demand of end-users. Access seekers who subscribe to a long-term contract have to receive a discount to the so determined LRIC. Under a competitive market condition such discount would exactly reflect the reduction in risk to the investor due to the demand commitment.

If the discount was lower, the investor would benefit unduly because he receives a reduction in risk which is higher than the economic price he has to pay for. Such a result is not compatible with competitive market conditions. In this scenario the incentives to engage in risk sharing contracts are lower than would be possible and efficient and the overall risk of NGA investment would not be minimised. If the discount was higher than the economic compensation for the reduction of risk for the investor he cannot earn a sufficient return of capital to cover his cost of capital.

The price differentiation described above also generates competitive parity between access seekers which have committed long-term contracts and those which buy access services on a line-by-line basis without a wholesale related risk sharing contractual structure. The nominal purchase price per line is lower for a long-term committed access seeker than for the "usual" altnet. To determine the effective price, this purchase price, however, has to be adjusted for the risk component. This adjustment is similar to a risk premium within a project-specific WACC calculation. The risk-adjusted purchase price is the same as the (unadjusted) price the usual access seeker has to pay as a wholesale price.

To take care of a fair and efficient shift of risk from the investor to the long-term committed access seeker, the externalities of multiple long-term contracts have to be considered when calculating the risk reduction to the investor. It is not the reduction of risk by the individual long-term committed access seeker which has to be the basis for the risk-related cost reduction factor. Instead, the sum of the long-term committed access lines have to form the basis for calculating the price discount for the individual access seeker. Otherwise, the investor would be overcompensated and would receive an unjustified risk reduction rent through a multiple calculation or compensation of the same risk.

Because the wholesale demand commitment is related to a certain (minimal) amount of access lines, the price differential looks like a volume discount which may distort competition between smaller and larger altnets. There is, however, a major difference between a volume discount and a price discount for a long-term wholesale contract: A volume discount becomes effective once the threshold quantity has been purchased. There is usually no ex ante commitment related to a volume discount. The discount becomes valid ex post. The price discount for a wholesale commitment becomes valid ex ante before the committed volumes actually are met. From the ex post view the commitment discount looks similar to a volume discount. But this similarity only emerges where there is no longer a risk attached to the commitment. Before that occurs, the commitment discount is an economic price for bearing a certain risk, what the volume discount is not.

Potentially, the demand for commitment contracts can be larger than the whole capacity available. This outcome may occur in particular, if the investor also has to obtain an access contract for its own retail activities. If that outcome is possible or even likely an auction mechanism should be organised to allocate capacity contracts. Such mechanisms should be under regulatory control to grant equal access of all interested parties to such capacity. The allocation rules also may have to reserve a certain amount of capacity to third parties which are not prepared to make demand commitments.

3 Regulatory practice: Fibre LLU in the Netherlands

As the first NRA in Europe OPTA has dealt with the question of pricing an NGA wholesale product in the context of FTTH. OPTA defines FTTH as fibre networks in areas with mainly residential customers.[17] In the first instance OPTA concluded that the relevant product market for (physical) access to network infrastructure at the wholesale level covers copper local loops (based on MDF-access and SDF-access) as well as access to fibre-optic local loops (based on ODF-access). OPTA found KPN including the recently established joint venture KPN/Reggefiber[18] to have SMP on the defined market and consequently imposed a number of regulatory remedies on it, including a cost oriented price control obligation for unbundled access to the fibre ODF access network.

OPTA has detailed the implementation of the price control obligation in its policy rules for unbundled fibre access.[19]. The rules describe the tariff principles OPTA uses for tariff regulation of unbundled fibre access, the methodology for determining the tariffs at the start and for the subsequent regulatory periods. OPTA was driven by the needs to find a balance in the trade-off between fostering competition in the short-term and encouraging investments in FTTH as the long-term perspective. Furthermore, the price control approach should have addressed all price-related competition problems that are of importance in unbundled fibre access, namely margin squeeze, price discrimination and excessively high tariffs. OPTA wanted to address the concerns of FTTH investors in the FTTH business case risks, the worries about the risk of regulatory intervention and at the same time OPTA wanted to address worries of access seekers about regulatory protection and the risk of too high access rates. To meet these potentially conflicting challenges, OPTA developed an innovative regulatory approach, which balanced the various requests.

The first competition problem that tariff regulation aims to prevent is price discrimination where an SMP operator deploys different tariffs for different buyers or categories of buyers. Price discrimination can lead to impairments of competition between the SMP operator and its competitors and/or among its competitors. The following rules of conduct are directed for providing a non-discriminatory outcome:

(1) Selective price undercutting is forbidden: Wholesale products cannot be supplied under different conditions to access seekers with the same or a similar demand profile.

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17 Fibre networks in areas with mainly business customers are considered by the authority as Fibre to the Office (FTTO) networks. OPTA applies to FTTO networks the same tariff regulation approach as for other general wholesale products, i.e. the regulation is based on the embedded direct cost/wholesale price cap approach. It does not apply the specific FTTH rules as presented here.

18 KPN realised a joint venture with Reggefiber to jointly roll-out fibre projects in 2008 and holds a 41 % share with a call option on a majority share.

19 See OPTA (2008) in connection with OPTA (2009).

(2) Loyalty discounts are forbidden.

(3) Tariff differentiation on the basis of the demand profile is permitted under certain conditions or safeguards. Differentiation on the basis of demonstrable underlying cost differences is also permitted.

(4) Tariff differentiation on geographical criteria is permitted under certain non-discrimination conditions. Furthermore, demonstrable underlying cost differences are a prerequisite.

These non-discrimination rules have specific implications for discount schemes in pricing and the relationship between one-off and periodic tariffs. OPTA regards wholesale buyer incentivising discounts for individual buyers as discriminatory, because late comers in the market and smaller competitors face a competitive disadvantage under such schemes and the pricing scheme creates barriers to entry. This ruling does not exclude discounts in general. If discounts based on scale advantages e.g. due to high fibre network penetration rates are applied to all buyers including the SMP operator's retail arm, they are desirable and allowed. OPTA allowed discounts depending on penetration equally applied to all wholesale customers. With an increasing amount of customers per connection area the discount percentage increases by a minimum of 2.5 % as of 2,000 customers up to a maximum of 20 % as of 26,000 customers in a given area.

The penetration expectations of the business plan foresees a fast take-up of fibre such that the target level of 60 % will already be realised in 1.5 years according to the path described in table 1.[20]

Table 1: Penetration development of fibre access lines per quarter

Penetration curve		**Q0**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
Change	%	25.0	20.0	5.0	5.0	2.5	2.5	0.0	0.0
Penetration level	%	25.0	45.0	50.0	55.0	57.5	60.0	60.0	60.0

A tariff differentiation between one-off fees and periodic fees is generally accepted. One-off price components[21] are regarded as a means of risk sharing between the investor and the access seeker and thereby as a tool to decrease the investment risk of the investor. One-off fees recoup some of the investment in the first phase of the network, which de facto lowers the capital requirements of the investor and therefore

20 See OPTA (2009), p. 24.
21 We are referring here on the (partial) coverage of the capacity costs of the fibre line over and above the one-off costs which occur for the operating costs of the individual connection.

the investor's risk. The investment risk is partially transferred to the access seeker. OPTA accepts this price differentiation only insofar as the one-off fee component does not create a high barrier to entry. In practical terms, OPTA allowed a one-off charge of 100 € per customer including an investment contribution of € 80 and a cost compensation of € 20.

The second competition problem to be prevented by price regulation is margin squeeze. According to Dutch Law a margin squeeze exists if the difference between the wholesale prices charged by an SMP operator to other companies and its own end-user tariffs is such that those other companies have no real opportunity to acquire or retain a market position. OPTA did not specify any margin squeeze requirements in detail. It just concluded that no margin squeeze may occur in tariffs that are at or below the price cap for the unbundled fibre loop. At a later stage, OPTA specified the margin squeeze requirements in more detail. OPTA rule no. 5 (applied in OPTA's Market Analysis Decisions with regard to fixed telephony, leased lines, wholesale broadband access and access to unbundled local loops)[22] specifies that tariff differentiation is not allowed if a margin squeeze in the upstream market means that service providers in the downstream market are unable to provide their services against competitive conditions. OPTA has formulated its rule no. 5 to prevent this from happening and has issued five additional policy rules in order to specify the execution details of OPTA rule no. 5.[23]

The third competition problem that tariff regulation aims to prevent are excessively high wholesale tariffs by the SMP operator. The incentive for such behaviour results from the possibility of de facto denial of access, higher margins and excessive profits. Excessively high wholesale tariffs do not only harm competition and competitors; if they are passed wholly or partially to the retail level, they are also to the detriment of end-users.

The principle of cost orientation of the unbundled FTTH access price is implemented by means of a multi-annual price cap. The price ceiling is fixed at the beginning of the first regulatory period and then is indexed annually on the basis of the Consumer Price Index (CPI). The initial prices are derived from the business case of the investor, which OPTA has assessed according to whether the inputs in the business case contain "*reasonable, genuinely expected values*" on discount rate, economic life time of assets, penetration level, investment expenditure, and operating costs. The relevant wholesale price is derived from the business case as that price which makes the net present value of the discounted cash flows zero. This price cap is determined individually for each unbundled tariff element, e.g. for one-off and periodic tariffs for the unbundled lines, for collocation and for backhaul. There is no flexibility for the SMP operator to change the

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22 OPTA/AM/2009/202721, OPTA/AM/2009/202714, OPTA/AM/2009/202717 and OPTA/AM/2009/202719.
23 Beleidsregels inzake gedragsregel 5 - OPTA/AM /2009/201145, 27 May 2009.

wholesale pricing structure within one price cap. Structural price changes are only possible by different degrees of exploiting the ceilings of the individual price cap.

The initial prices for the monthly fees are dependent on the level of the investment per fibre connection in a specific area. OPTA has defined the following capex areas but does not exclude the distinction of more capex areas in the future:

Table 2: Monthly fees for fibre unbundling in the Netherlands in 2009

Capex	Monthly fee
775 – 825 €	14.5 €
825 – 875 €	15.25 €
875 – 925 €	16.00 €
925 – 975 €	16.75 €
975 – 1025 €	17.50 €

To calculate the relevant cost of capital (WACC), OPTA introduced a so-called all-risk WACC. The all-risk WACC consists of the WACC related to the existing copper loops, a premium for the systematic risk associated with FTTH investments as well as a premium to take account of the asymmetric regulatory risk relating to FTTH investments. We have described this approach in more detail in section 1.4. Reggefiber applied an Internal Rate of Return (IRR) in the range of [7 – 10]% in its business model and OPTA has set the regulatory risk premium at a level of 3.5 % for the initial review period. It is interesting to note, that the initial fibre ULL wholesale prices were set by Reggefiber/KPN about 2.50 € below the price cap set by OPTA.

Although the structure of the price regulatory approach should remain stable according to OPTA's intentions, it will be reviewed periodically. At the beginning of every new regulatory period of three years, OPTA will check the appropriateness of the price cap parameters by comparing the prevailing IRR of the SMP operator realised in the business case in that moment in time with the all-risk WACC at the same time. If the effectively achieved IRR is higher than the calculated all-risk WACC, the price cap will be adapted and the wholesale price cap be reduced for the following regulatory period. If the IRR is lower, e.g. by reaching a lower than planned penetration rate, then the price cap will not be changed. This risk is already covered in the allowed rate of return. The SMP operator can monitor the IRR itself and adjust it downwards if it approaches the all-risk WACC by providing more discounts or reducing tariffs and thereby avoiding regulatory intervention. Instead of reducing tariffs, OPTA also offers the option that the operator rolls out the fibre network more quickly than assumed in the original business case in less profitable areas and thereby also reducing the IRR. This option generates an interesting incentive for investment and in expanding the coverage of fibre networks. In case of adaptation of the price cap OPTA can either prohibit indexation of the tariffs and freeze the nominal tariffs or reduce the price on a one-off basis (with or without restrictions on future indexation).

OPTA's approach is innovative in various respects and gives a clear orientation and framework for market participants to make their NGA investment decisions: The (primary) investor as well as the competitors are using this infrastructure on an unbundled basis. Setting up a regulatory pricing regime and publishing policy rules how this regime may be adapted during the lifetime of the investment is a relevant approach to constrain and keep a regulatory risk low. Nevertheless, the remaining regulatory risk will be taken into consideration by a risk premium as part of the allowed rate of return. This premium is fixed at a generous level of 3.5 %. We believe that the chosen price regulatory regime gives sufficient certainty about the tariff regulation and also a sufficient compensation for costs and risks associated to the fibre investment. Deriving the regulated price from the business case of the investor is a rather innovative approach to determine a cost-based rate. In economic terms it can be derived and proven that this price reflects the relevant LRIC at economic depreciation which shows again that LRIC pricing, properly applied, can be a sufficient regime not only in case of pricing for access to already existing infrastructure but also in cases of price determinations where the investment still has to be made.

4 A multi-fibre approach for NGA

4.1 Basic characteristics

The NGA FTTH architecture establishes a direct fibre connection between the customer home and the Metro PoP (MPoP), which offers high capacity connections without any electromagnetic interference or cross talk noise and not being affected from major attenuation problems like in FTTC VDSL architectures or, to a lesser extent, in cable TV networks. Thus these networks allow to offer a homogenous bandwidth in the area, not being dependent from the copper sub-loop length.

The nowadays relevant two FTTH architectures are fibre point-to-point (P2P) and Passive Optical Network (PON). With fibre P2P there is an individual fibre connection from each home to the MPoP, while PON concentrates an amount of fibres from the homes (up to 128) to one single fibre using a splitter in the Distribution Point (DP). Administering the multiple use of the single fibre by an GPON OLT causes a bandwidth limitation for the commonly used downstream signals to 2,5 Gbit/s and for the upstream signals to 1,25 Gbit/s. P2P in contrast only is limited by the port speed of the end systems in the customer home and the MPoP, thus offering 1 Gbit/s per home – or even more - in a symmetric manner. These architectures have been described in more detail in our previous NGA report.[24]

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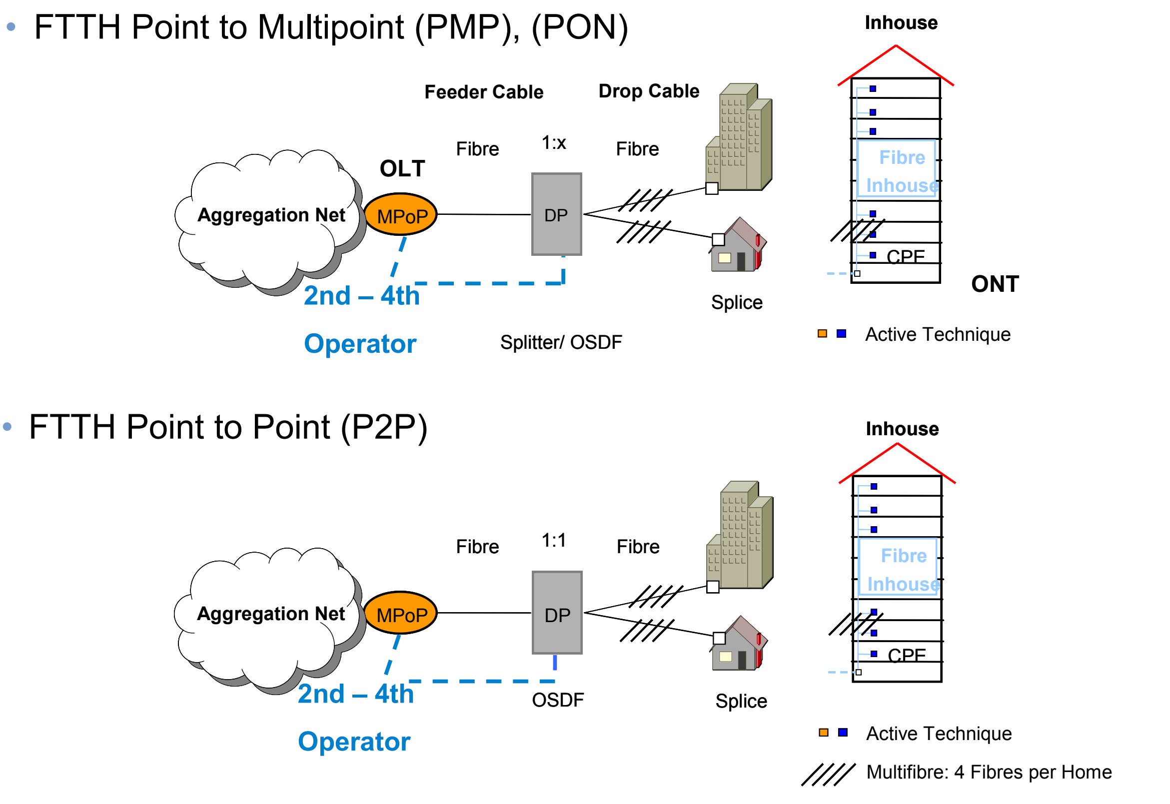
24 See Elixmann, Ilic, Neumann, Plückebaum (2008), section 4.1.

Figure 4: NGA FTTH architectures



Multiple-fibre architectures deploy more than one single fibre per home, e.g. four (Swisscom proposal), in the drop cable segment and (optionally) in the feeder cable segment, in order to enable several operators in parallel to get access to the same end customers and thus offering the end customers a wider choice – on the infrastructure level limited to the four operators. The investing operator connects at least one fibre per home to its ongoing feeder network up to the MPoP. The second to fourth operator each shares fibres in the drop cable segment to the end customer homes and in principle has the choice to connect these fibres to its own separately ducted feeder network (e.g. local power utility ducts) at the Distribution Point or to also share fibres in the feeder infrastructure up to the MPoP and collocate there.

Comparing multi-fibre with a fibre unbundling approach at the DP or MPoP one will not find differences in quality for the transmitted signals but may identify less process risk in switching on and off new services, because the fibre has not to be changed between the operators and providing a new service could happen in parallel to an existing one, which then might be switched off later. The operation of the fibre is done by the investor in the multi-fibre case and by the incumbent in the fibre unbundling case, thus normally by a third party from the view of an access seeker. If both the investor respectively the incumbent equally operate the fibres, the process between the access seeker and the fibre operators for failure analysis and repair have to be synchronised and performed in the same manner and therefore do not differ from each other.

4.2 The case of Switzerland

Switzerland seems to be at the moment the only European country where a concrete multi-fibre deployment model and an access model based on this network roll-out has been under active negotiation for some time. In the next section we will present the just recently proposed multi-fibre approach of ARCEP in France. Before describing the multi-fibre approach proposed by Swisscom it is worthwhile to give a short overview on the competitive landscape of the broadband market in Switzerland.

Broadband competition in Switzerland is mainly dominated by the competition between the dominant fixed-line incumbent Swisscom and the cable companies with Cablecom as the major player in this segment. Fixed-line competitors have a much weaker position in the market than in most EU Member States. Their service offerings basically rely on bitstream access and resale; access to the unbundled copper loop, which was introduced rather late (in 2007), (so far) only plays a minor role. Due to the strong competition by cable companies, Swisscom followed a powerful VDSL deployment strategy aiming at a nationwide coverage in the last three years. Since the end of 2008, 75 % of all households in Switzerland have access to this VDSL network.

As a response to some local utility plans to roll-out fibre networks in some major cities, Swisscom stopped the further roll-out of VDSL in 2008 and announced a far reaching FTTH network roll-out. 100,000 apartments (3 % of all households) shall be connected through FTTH by the end of 2009 and 33 % of population by 2015 at an investment of 2.8 billion CHF.[25] None of the competitors have followed Swisscom in VDSL (yet). Swisscom has to provide sup-loop unbundling as a prerequisite for an altnet's VDSL approach. Regulation to bring sub-loop unbundling about currently is on hold because competitors are in a negotiation process with Swisscom on terms and conditions of sub-loop unbundling.

Swisscom deploys a FTTH P2P network architecture. Swisscom is connecting each home in a multi-fibre approach with four fibres from a manhole into each home. On the basis of cooperation models with other operators or utilities, Swisscom intends to negotiate co-investment arrangements to swap fibres and to share the terminating fibre segments with these partners. Swisscom has signed the first letter of intent for a multi-fibre co-investment arrangement with the local utility Group E in Fribourg in March 2009.[26] On that basis Group E and Swisscom intend to construct a multi-fibre FTTH

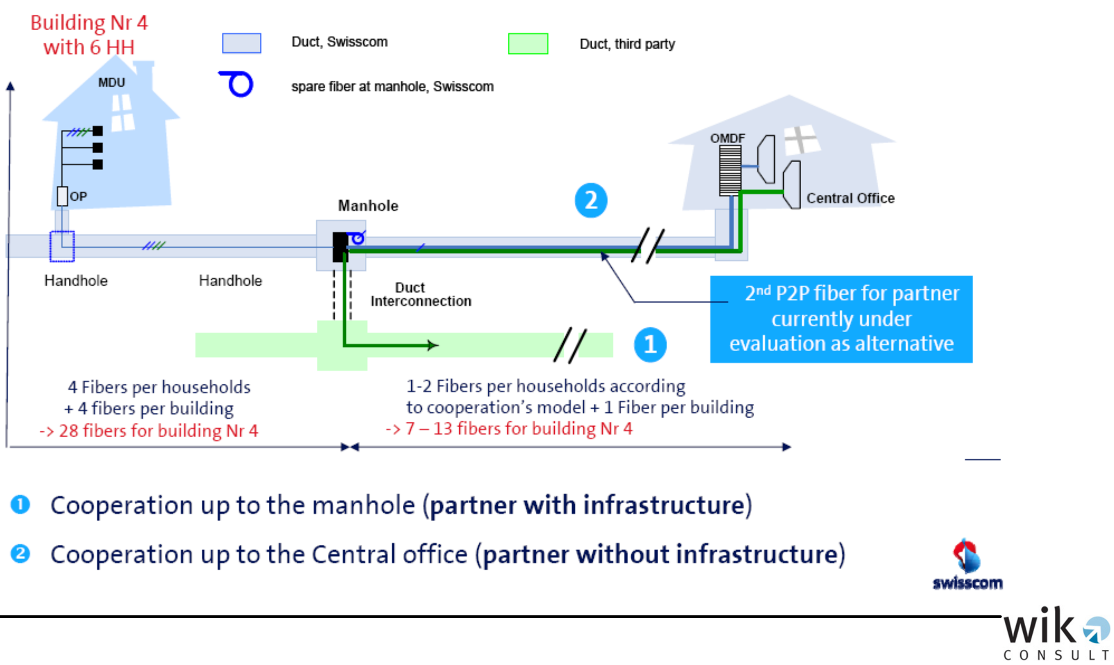
25 See ERG (2009), p. 171.
26 See ERG (2009), p. 171 f.

network in the Fribourg area. Both partners will deploy the network in different areas and swap the fibre capacity to each other. Each operator will lay four fibres from each apartment up to the manhole in each area. Fibres will then continue up to the constructing operator's ODF and through duct connection at the manhole to the partner's ODF. This model is currently being tested before final and binding deployment agreements are being made.

In several other cities (e.g. Basel and Bern) Swisscom is negotiating further cooperation agreements with local utilities on a similar basis. In cities where Swisscom has no cooperation agreement (yet), it is nevertheless laying four fibres in order to allow for possible further cooperations. The most prominent example of this kind is the City of Zurich. Here the publicly owned utility EWZ is deploying a FTTH P2P fibre network. EWZ is deploying four fibres inhouse but only one fibre to the building.

Technically, Swisscom's cooperation model is described in figure 5. Each home in a building is connected with four separate fibres, all ending in a standardised plug. At the other side all fibres of a building end in a manhole close to the building. At this distribution point at least one fibre per home is directed through the distribution cable to the Optical Main Distribution Frame (OMDF) of Swisscom (resp. the constructing operator), the other fibres may be accessed by competitors running their own infrastructure down to the manhole, where they connect to the shared fibre end lines.

Figure 5: Build and share cooperation model of Swisscom



Source: Crausaz, Débieux (2009)

If alternative operators do not have ducts or fibre for their own feeder cable, Swisscom seems to be willing to provide alternative operators access to the fibre at its OMDF. This type of cooperation model – depending on the unknown details – is or comes close to a fibre unbundling access model. The main difference, however, still is that the altnet has to commit itself for a comprehensive region, city or district where the commitment in the unbundling case only relates to one single line.

There are some more interesting details of the cooperation model important to be mentioned:

(1) The cooperation arrangement proposed is always related to coherent regions, cities or districts.

(2) The cooperation partner receives indefeasible rights of use (IRUs) which define the exclusive use of the particular fibre.

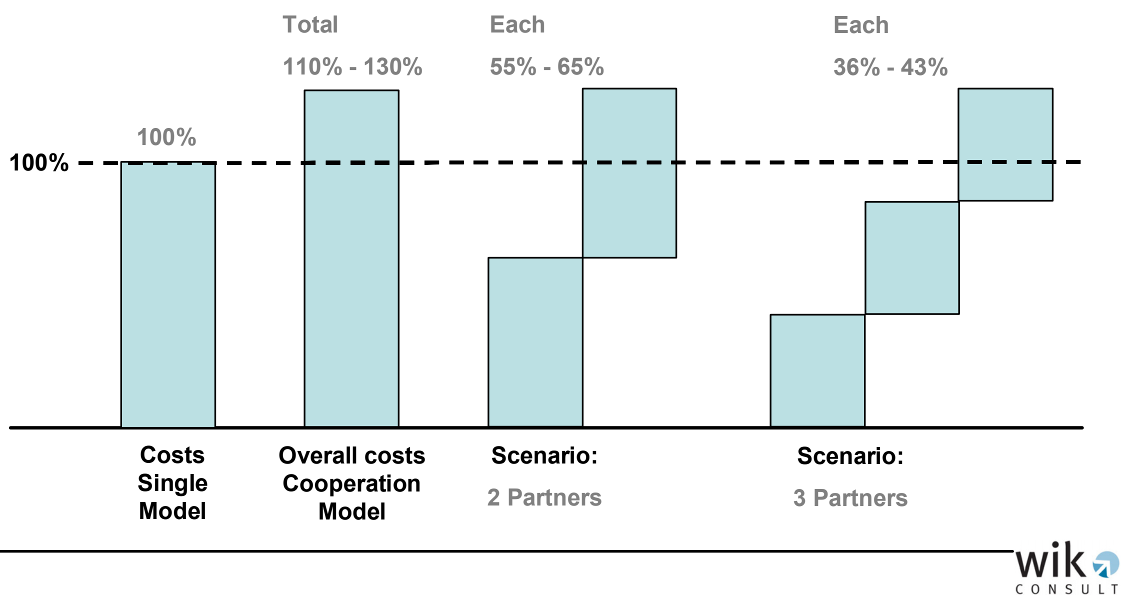
(3) The sharing of investment costs follows the model to be applied for international undersea cable contracts: The first partner pays the investor 50 % of the investment cost plus a margin to cover the project-specific investment risk. A second partner has to pay 33 % of the investment cost plus the margin mentioned above. The payment of the second partner will be shared between the investor and the first partner.

(4) In the (symmetrical) swapping model there is no financial compensation, because both partners are investors. Instead, they grant each other IRUs for one fibre in their respective roll-out area.

Figure 6 shows the impact of the sharing assumptions on the distribution of investment cost. Swisscom assumes the total investment cost to increase by 10 % to 30 %.[27] Compared to the single fibre architecture, the investor has to bear only 55 % to 65 % of the total investment. The same holds for his investment partner. Both partners can reach 100 % of the potential customer base at a lower investment than on a stand-alone investment case.

27 See Gromard (2009).

Figure 6: Potential investment cost distribution in the multi-fibre model



The Swisscom cooperation model reveals already some inherent problems of the multi-fibre approach:

(1) Total investment cost increase by 10 % to 30 %.

(2) The demand commitment is always related to a whole region, city or district and not to an abstract number of fibre access lines.

(3) In case of duct connection the incumbent's architecture decides on the location of the manhole access points to which the feeder cable of the altnet has to be connected. This may or may not fit with existing duct or fibre infrastructure of the altnet; insofar as it does not fit, the altnet's costs are higher than those of the incumbent.

(4) If the incumbent uses two fibres, a four fibre roll-out only gives access opportunities for two more alternative operators. The number of operators in the market is limited accordingly.

(5) If the incumbent uses two fibres, it has more technological options than the cooperation partner which only receives one fibre. E.g. the SMP operator could use two unidirectional fibre interfaces for bidirectional (duplex) communication, which are cheaper than single fibre interfaces, or the operator could use a separate fibre for the TV signal distribution – outside the triple-play IP stream and thus saving bandwidth in the IP network and not needing a multicast function.

(6) The asymmetries mentioned under (5) may even be increased if the uneven allocation of fibres has no influence on the allocation rule of investment costs.

(7) The cooperation model as such does not provide an incentive compatible approach to keep costs low. It is basically the investor who decides on the capital expenditure and the operating expenditure. Due to the sharing rule, the investor has an incentive to transfer (unjustified) parts of the cost to the altnet.

(8) The cooperation model as such does not provide an incentive compatible approach towards discrimination. The SMP operator has under the defined sharing rule a strong incentive to favour his own use of the infrastructure compared to that of the altnet by shifting costs and by imposing different conditions of use.

(9) A cooperation model where two partners have equal rights to use the built capacity and share the costs of the built capacity equally, generates significant asymmetries, when only one partner decides on the technical details of the roll-out, the investment expenditure, OPEX and other day-to-day decisions. Such a cooperation model calls for joint ownership of the infrastructure company which deploys the shared capacity and at least a symmetrical decision making structure.

(10) Depending on the distribution of market shares, the cooperation model can lead to significant cost asymmetries. Only in case of an equal distribution of market shares, the cost sharing rule leads to symmetrical costs. Assume e.g. in case of two partners a market share distribution of 60 % to 40 %. In this case, the smaller operator will be facing costs per customer served which are 50 % higher for the shared infrastructure. The shared infrastructure amounts to around 80 % of total costs. In case of a market share distribution of 80 % to 20 %, the costs of the shared infrastructure differ by a factor of four or are 300 % higher for the smaller operator.[28]

4.3 Proposal of ARCEP

The French regulatory authority ARCEP published on June 22nd 2009 a consultation paper on the modalities of access to the fibre infrastructure in buildings. The proposals listed in this draft document are only to be applied to areas with a very high population density. The classification of these areas takes into account the population density and in addition the share of buildings with more than 12 households. About 148 regional districts with around 5.16 million households are classified as part of this area type

28 For a more detailed discussion see section 4.7.

whereby more than half of these homes are located in and around Paris. In the proposal the affected regions are listed in tables. The consultation paper explicitly does not address areas with lower densities and states that these areas will be treated at a later point in time.

ARCEP states –and this is according to our previous and today's analysis- that in very dense areas the fibre roll-out could be viable for several fibre networks, especially if– in addition - these networks end at the point of mutualisation (a type of distribution point) and the inhouse cabling segment could be shared. ARCEP prefers this approach in its consultation paper. According to the authority the following points need to be realised:

- Optional deployment of additional dedicated fibres: The building operator (this is the operator chosen by the house owner to deploy fibre in the building) has to offer second operators the option of additional dedicated fibres per household. All building operators are obliged symmetrically to provide fibres regardless of their SMP status. If second operators request for this option, they have to pay in advance for the additional fibre installation and to co-finance the part of the jointly used civil engineering investment. If no second operator requests an additional fibre, the building operator is free to deploy the number of fibres according to his choice.

- Installation of ODF equipment: The building operator has to offer third parties the installation of ODF equipment, if required. Generally, the equipment will be installed at the point of mutualisation (typically at the building basement or nearby) or a higher network level (e.g. point intermédiaire). The fibre hand-over at the MPoP as recommended by the Commission is not explicitly considered as an option. ARCEP states that apart from the PON operators, P2P operators may not require ODF equipment, but ask instead for a fibre hand-over at the splicing point in the point of mutualisation. According to the consultation paper, each altnet should be free to order the preferred mode of connection (by ordering either ODF equipment or fibre hand-over at the splicing point).

Thus the multi-fibre architecture according to ARCEP is between the mutualisation point (in terms of the EU Commission the distribution point) and the customer home and mainly comprises the inhouse segment. The location of this DP in many cases[29] and thus the size of the drop cable segment shared is not concretely defined. The decision for multi-fibre infrastructure is determined by second operators demanding it. A house owner may install a multi-fibre cabling on his own and then is responsible for its administration. The installation of a distribution frame in the distribution point is on behalf of the operators claiming demand for it. It is an option besides splicing the feeder

29 The DP may be in the building, if the building is larger than 12 homes or if the building is connected to a mansized sewer. Otherwise the location and the size remain undefined.

to the drop cables in a fixed manner. A hand-over at a more central site (e.g. the MPoP) and sharing infrastructure up to that point is neither recommended nor obliged.

ARCEP carried out some deployment analysis in the beginning of 2009 and found that the installation cost for four fibres per household including corresponding ODF equipment is 15 % higher compared to a single fibre inhouse deployment. In addition, the authority states that the additional investment compared to the total investment is at about 5 %[30].

ARCEP points out that the two bullet points mentioned before are in line with the required technology neutrality, since they ensure compatibility of various technologies (PON and P2P). It also states that the structural approach would allow potential innovations and does not restrict any potential regulatory decision in the future.

According to ARCEP, the regulatory propositions improve the dynamics of competition and offer an option for the future without creating deep going restrictions for operators. The authority states that on the one hand, the additional investment of 5 % is relatively moderate compared to the single fibre architecture and on the other hand, the proposed approach provides incentives for additional fibre deployment in the building, since the add-on installation implies cost and risk sharing. This concept would motivate a second operator to deploy its own fibre network downwards to the point of mutualisation.

From a consumer's point of view, the authority sees the advantage that the installation of additional fibres eases the change from one operator to another (without losing the service) and allows subscription of services from different operators. The concept would improve the situation of the customers by offering a higher choice. According to ARCEP, the concept would provide an additional advantage for house owners and inhabitants: the number of interventions of operators in the building would be limited, since most of the works could generally be carried out at the point of mutualisation.

4.4 The EU draft NGA recommendation

The European Commission on June 12, 2009 released a draft recommendation "on regulated access to Next Generation Access Networks (NGA)", in which it defines multiple-fibre FTTH as "*a form of fibre deployment in which the investor deploys more fibre lines than needed for its own purposes in both the feeder and the drop segments of the access network in order to sell access to additional fibre lines to other operators, notably in the form of indefeasible rights of use (IRU)*"[31].

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30 There is a discussion in France since France Telecom CEO Didier Lombard recently declared the difference to be 40 %. For our calculations see section 4.6.

31 Draft Commission Recommendation on regulated access to Next Generation Access Networks (NGA), p. 11

Compared to the Swisscom and the ARCEP cases, where access to the multi-fibre infrastructure is normally granted at the distribution point, this definition describes the point of access normally to be the MPoP[32]. In order to achieve this the feeder segment in the access network must have the same multiple of fibres per home as the drop segment, e.g. four like in the Swisscom example, for a Fibre Point-to-Point architecture.

The draft NGA recommendation defines the function of the distribution point as hosting "*a distribution frame mutualising the drop cables, and possibly unpowered equipment such as optical splitters.*"[33] Thus in the Commission's view on NGA architectures a distribution point hosts a distribution frame and in the case of PON architecture the splitters too. In Swisscom's view there is possibly no distribution frame needed, since all fibres from the homes may be directly spliced to the operator's upstream infrastructures (PON splitters or P2P fibres). The ARCEP case offers the option of direct fibre splices for P2P.

Terminating all fibres in the DP at a distribution frame gives high flexibility in connecting these fibres to different operators. But it introduces additional cost for the ports and the patch cables and the additional space requirements of the distribution frame compared to fixed splices between the feeder and the drop fibres. In the case of PON the distribution frame allows the operators to flexibly optimise the amount of splitters and OLTs needed. Fix splicing is inflexible, but may be justified when each one of the multiple-fibre investment sharing partners get a fixed share of customer connections, e.g. in the case of a P2P MPoP architecture. A distribution frame in the DP could replace a distribution frame in the basement of the customer buildings, but is harder to deploy in already existing manholes or street cabinets due to its space requirement – as it is common for most existing networks which only have to be upgraded. In a greenfield FTTH approach we believe the approach taken by the Commission to be most flexible and efficient.

For PON the splitters concentrate the fibres from the customer homes according to the splitting factor to one fibre between the DP and the MPoP. Thus the amount of fibres needed for backhauling the splitters in pure PON-only architectures is by the splitting factor less than in a pure P2P architecture[34]. Of course one can imagine any combination between PON and P2P access operators. Thus it is not easy to dimension the feeder infrastructure appropriately, avoiding both underinvestment on the one hand and sunk cost on the other.

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32 If a multi-fibre installation is obliged by the regulator in the terminating (drop) segment as proposed in the draft the access to this infrastructure can only be granted at the distribution point unless the SMP operator offers infrastructure sharing at the feeder segment on a voluntary basis, Draft Commission Recommendation on regulated access to Next Generation Access Networks (NGA), p. 12, no. 18.

33 Draft Commission Recommendation on regulated access to Next Generation Access Networks (NGA), p. 11

34 If operators already consider to migrate at a later stage from PON to P2P or even P2P multi-fibre, they might already install more fibres than currently needed. This assumption cannot be considered in a PON model since for PON it is not efficient to do so.

The PON backhauling of the splitters could also be realised by the use of empty ducts or dark fibre of the investor, thus by typical wholesale products of the broadband access business. These options are not described in the NGA draft recommendation.

4.5 Modelling a multi-fibre approach

The model we used is the same as already described in the main study,[35] bottom up LRIC based. As before we model a steady state situation some years in the future where a stable market share has been achieved. This approach neglects all ramp up cost borne in earlier years and thus is showing a better profitability than in reality would exist.

For the evaluation in this addendum we concentrated on the German market as an example. As in the main study the country is segmented into eight clusters, determined by the density of households per square km in falling order.

Table 3: Clusters of subscriber densities

Geotype		Cluster	Subscriber density per km^2
Urban	(1)	Dense Urban	> 10.000
	(2)	Urban	> 6.000
	(3)	Less Urban	> 2.000
Suburban	(4)	Dense Urban	> 1.500
	(5)	Suburban	> 1.000
	(6)	Less Suburban	> 500
Rural	(7)	Dense Rural	> 100
	(8)	Rural	≤ 100

In order to include multiple-fibres in the drop cable as well as in the feeder and backhaul segments[36] we of course had to amend the model to some extent. Now the amount of fibres per home can be set as one parameter. Due to the large amount of fibres in the P2P multi-fibre approach we increased the maximum number of fibres per cable up to 592, now being able to run different, optimised cable sizes in each of the access segments.

The Distribution Point already was modelled in the previous study, but could be a simple sleeve underground or in a handhole. Its location has not been changed and concentrates around 200 homes on average. Now, in any of the multi-fibre cases considered, it is equipped with a distribution frame, coherent with the Commission's

35 See Elixmann, Ilic, Neumann, Plückebaum (2008).
36 Section 4.1, figure 17 of the main study.

definition. This allows a high degree of flexibility to access the drop cable fibres in the DP by either using own infrastructure or share the feeder infrastructure to some extent or by allowing PON and P2P architectures by the different operators in parallel. The DP is assumed to be a street cabinet or a manhole, being able not only to host the distribution frame (OSDF: Optical Street Distribution Frame) but the necessary splitters also. Since the distribution frame in the DP allows to access each of the individual fibres per home separately and in a flexible manner the change between the outdoor (underground) cable and the inhouse cable in the basement of the houses is considered as a fix splice between the two cables.

Our model describes the view of an investor, investing in a greenfield approach, but being able to cooperate with other infrastructure providers by constructing commonly, where appropriate. We used the model variant of a first mover, not being the incumbent, thus we did not take into account a possible return from selling dismantled MDF locations. This scenario is motivated by the fact that investors not necessarily are the incumbent and that the MDFs may still have to be kept in operation for a longer transition period. If there are several operators, the investment of the commonly used infrastructure in the drop and feeder cable segments are shared in equal parts. Thus, each operator has access to the whole customer base in the deployment area (100 % of homes passed). Therefore the model scenario with multi-fibre and one operator describes the total investment needed for the multi-fibre approach.

The view of a second operator is the same as long as it is sharing the same infrastructure in equal parts and as long as its own infrastructure (e.g. that to the DP) is as effective as the infrastructure of the investor.[37] This position might change if the second operator does not share the feeder infrastructure but uses empty ducts of the investor or even dark fibre.

The model considers as before only the amount of active access equipment needed to support the market share achieved, thus the investment for this equipment is variably growing up with the customers connected. The ports for the distribution frames in the DP and MPoP and the patch cables are treated the same. To be more precise: all fibres in the drop segment end on a distribution frame port, but the other (upstream) side is dimensioned according to the market share. The same dimensioning has been designed for the OMDF in the MPoP. Splitters and OLTs in the case of PON and Ethernet ports in the case of P2P have been considered as in the main study according to the market share.

37 Normally, one cannot expect that existing ducts of utilities etc. touch the DPs planned by the telco investor. Therefore costs to connect these networks would arise and the other operators' infrastructures to connect the DP are less efficient than that of the investor. Therefore, our assumption is valid only for greenfield approaches. One may remember the result for sub-loop unbundling in our previous study to be less efficient than collocation at the MCL (MPoP).

In order to draw conclusions on the profitability of an architectural approach one has to model the cost of the complete value chain of products to be offered and compare the cost with the income, received through the average revenue per user (ARPU). Since we vary the inhouse cabling infrastructure in a multi-fibre approach we have to consider the inhouse cabling investment, which had not been included in the German case of the previous NGA study due to the fact, that this is paid by the house owner. Bringing the inhouse cabling investments into the operator's sphere requires an appropriate correction at the ARPU level. Thus the ARPU has been increased by 4 € per month, but the customer mix and the product mix has been kept unchanged compared to our previous study.

Table 4: Assumptions on average revenues per subscriber in Germany

Type of subscriber	Average revenue per subscriber (in €)	Share of the total customer base (in %)
Single Play	24.0	18.2
Double Play	39.0	59.1
Triple Play	49.0	13.6
Business	54.0	9.1
Total	39.0	100.0

Source: WIK-C

Main results of the model are the critical market shares, the market shares necessary to receive a profitable business case. These critical market shares are calculated cluster by cluster in an independent manner from each other. In that respect the model of the main study is unchanged. Beside this we now point out the investments needed per home passed, per home connected and in total assuming an equal market share of 50 % in all relevant clusters, and compare the multi-fibre investments with the start case of a single fibre per home in a one operator environment. Therefore we amended the existing model by collecting the relevant inherent information to report the appropriate investment as a result.

Out of all the architectural choices we modelled the following cases:

- PON:
    - single fibre, one operator (PON SF)
    - multi-fibre to DP, one operator (PON DP MF 1Op)
    - multi-fibre to DP, two operators (PON DP MF 2Op)
    - multi-fibre to DP, four operators (PON DP MF 4Op)
    - multi-fibre to MPoP, one operator (PON MPOP MF 1Op)
    - multi-fibre to MPoP, two operators (PON MPOP MF 2Op)
    - multi-fibre to MPoP, four operators (PON MPOP MF 4Op)

- P2P
  - single fibre, one operator (P2P SF)
  - multi-fibre to DP, one operator (P2P DP MF 1Op)
  - multi-fibre to DP, two operators (P2P DP MF 2Op)
  - multi-fibre to DP, four operators (P2P DP MF 4Op)
  - multi-fibre to MPoP, one operator (P2P MPOP MF 1Op)
  - multi-fibre to MPoP, two operators (P2P MPOP MF 2Op)
  - multi-fibre to MPoP, four operators (P2P MPOP MF 4Op)
  - two fibres to MPoP, two operators (P2P MPOP 2F 2Op)

The single fibre case is modelled as efficient as possible for a single operator, thus it does not include a manhole or street cabinet at the distribution point but uses a simple buried sleeve (with a splitter in the case of PON). The multi-fibre cases are distinguished by the point of hand-over of the shared infrastructure, either at the Distribution Point (DP) or at the Metropolitan Point of Presence (MPoP).

The multi-fibre case with one operator describes the total investment needed to construct the multi-fibre infrastructure, but also describes the situation where an investor is constructing a multi-fibre infrastructure and (unfortunately) nobody is willing to share it.

In the multi-fibre cases we normally assume four fibres to be installed per home. In order to demonstrate efficiency of the model and check what impact mixed architectures of PON at DP and P2P at MPoP might have we produced one additional case where only two fibres per home were installed in the feeder segment, while the four fibres per home were installed in the drop segment as in the cases before.

The results of this modelling approach are described in the following section.

4.6 Modelling results

Since the model and its input parameters have not been changed except the variations described in the previous section the spatial distribution of the German subscribers in the different density clusters remains unchanged.

Table 5: Spatial distribution of the customer base in Germany

Germany			
Cluster Type	Customer Base		
	in mio.	in %	Accumulated %
Dense Urban	0.12	0.2	0.2
Urban	0.9	2.1	2.4
Less Urban	4.9	11.3	13.7
Dense Suburban	2	4.8	18.4
Suburban	2.85	6.6	25.1
Less Suburban	5.25	12.3	37.4
Dense Rural	14.6	34.1	71.5
Rural	12.2	28.5	100.0
Total	42.83	100.0	

Source: WIK-C

The following tables and diagrams summarise the results for PON and P2P architectures with fibre hand-over either at the DP or at the MPoP location so that in total we consider four basic scenarios. For each of these architectural approaches we generally compare the results for single fibre and multi-fibre cases where in the multi-fibre cases the number of operators sharing parts of the access infrastructure could be 1, 2 or 4.

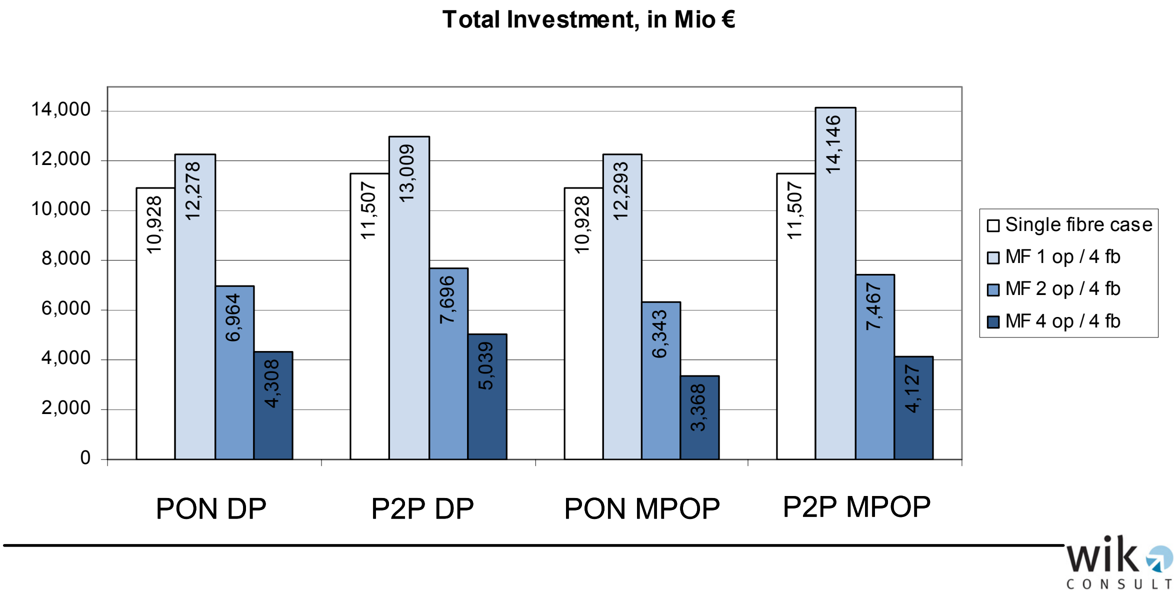
We assume that all operators share the infrastructure in equal parts, and also the investment cost of the commonly used infrastructures. That is the usually proposed model in such a context.

Our results describe the view of a single operator. In the multi-operator scenarios we calculated the view of one of the sharing partners. The total overall view has to refer to the one operator results.

4.6.1 Investment cost comparison

In order to compare the investment figures we have to define a market share to which the network is connected to the homes, since the total investment depends on the market share. We have assumed a market share of 50 % in all architectures and all clusters considered. This share does not relate to the critical market share needed and may be less or higher; it is simply set for comparison reasons. Our figures accumulate the investment for the four most dense populated clusters or for 18.4 % of population, since the investment for areas outside profitability are of less relevance.

Figure 7: Total investment per homes passed, based on the four most dense clusters, 50 % market share, in Mio €



Comparing single fibre and multi-fibre one operator cases figure 7 shows the total investment for a multi-fibre network to be between 13 % and 23 % higher than for the comparable single fibre networks. The differences are mainly driven by the higher number of fibres per customer which generally leads to additional works in inhouse cabling and splicing, digging of larger trenches and deployment of higher sized cables as well as the installation of collocation equipment. The highest increase in investment results for P2P MPoP (from 11,507 to 14,146 Mio. € or 23 %). This architecture considers four fibres per customer on the complete length between the customer's premise and the MPoP, thus in the drop and feeder cable segment. In these two segments the high number of fibres requires larger trenches and bigger cables which are able to capture the higher fibre capacity. The four fibres per customers also need customer sided OSDF and ODF ports which increases the investment

The total investment in the multi-fibre network increases if the number of co-investing operators increases either. The investment positions listed in figure 7 (and in Annex I: Investment tables) are referring to investment per operator and do not reveal the sum of all investments of FTTH operators. Therefore, the total investment of the roll-out could be approximated by multiplying the listed values with the number of operators considered. The total investment in the two operator multi-fibre case (PON DP) is at about (2*6,964.5 Mio. € =) 13,929 Mio. € which is about 13.4 % higher than the related one operator case (12,278.2 Mio. €). The total investment in the case of four operators increases to 17,230.4 Mio. €, about 40 % higher than the one operator scenario. The increase of the total investment is mainly driven by additional passive equipment to be installed at the distribution point in order to enable the fibre hand-over. The additionally required elements are e.g. splitter, larger sized manholes (or cabinets) and OSDF equipment (ports, patch cables etc). A fibre hand-over of PON at the distant MPoP level instead results in an increase of the total investment of 3.2 % (two operators) respectively 9.6 % (four operators). These values are (remarkably) lower (=1/4) than those of the PON DP case, since the feeder segment now is also shared. This result impressively demonstrates the savings being achieved by not duplicating the feeder infrastructure compared to sub-loop unbundling architectures.

While the total investment increases with every additional operator, the investment per operator decreases. A multi-fibre approach with two operators reduces investment per operator by about 40 % to 48 % compared to the same infrastructure operated by one. If the number of operators increases to four, the investment per operator is even lower accordingly (60 % to 73 %).

A look at the total investment per cluster indicates that in less dense clusters the relative investment difference between the single fibre case and the multi-fibre case with one operator decreases. For example, the P2P case with fibre hand-over at the DP indicates for the dense urban cluster a relative increase of about 20.5 % while in the dense suburban cluster the relative difference is 12.3 %. For the multi-fibre case it can be stated that the less dense the considered cluster is, the less is the investment share of the inhouse cabling segment and the distribution point equipment relative to the total investment. These positions are the main cost drivers of the multi-fibre case. Since the share of these positions decreases in less dense clusters, the total investment is less affected.[38]

Figure 8 also points out that the more network segments are shared, the lower is the investment to be borne by each operator an a stand alone basis, i.e. fibre hand-over at MPoP locations with common deployment in both drop cable and feeder segment is at about 12 % (for PON) to 16 % (for P2P) lower than the fibre hand-over at the distribution point with stand alone deployment in the feeder. The effect is higher for P2P, because the more fibres are deployed, the lower is the incremental investment per fibre, and so common deployment implies higher investment savings for P2P than for PON.

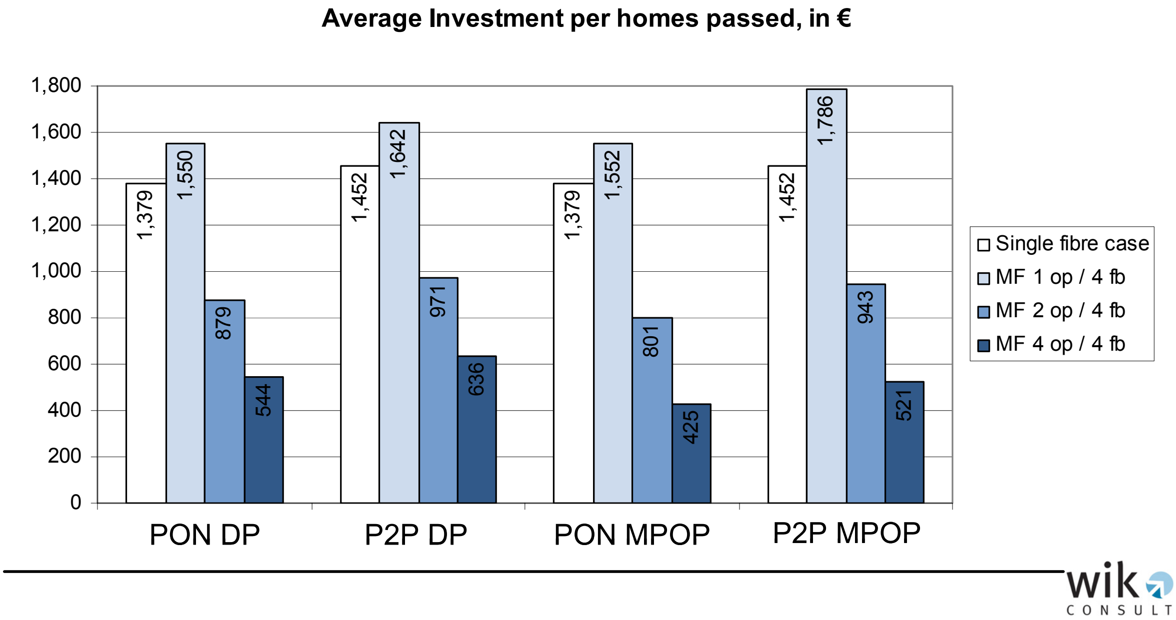
The tables of the four considered architectures[39] indicate that the investment in P2P multi-fibre architectures compared to the corresponding PON case vary with regard to the collocation point (DP or MPoP). For MPoP collocation P2P investment is about

38 A comparison of the P2P single and multi-fibre one operator case with hand-over at the DP indicates that for the most dense cluster the inhouse cabling is about 36 % of the total investment while in the fourth dense cluster it is only about 20 %. For the same clusters the DP investment share decreases from 9.1 % to 6.0 %. The decrease results from the higher investment share of the drop cable segment, the feeder cable segment and the MPoP equipment.

39 See Annex I: Investment tables:Table A I-1, Table A I-2, Table A I-3 and Table A I-4.

15 % higher than that for PON, while the same ratio is reduced to 6 % for DP collocation.

Figure 8: Average investment per homes passed, based on the four most dense clusters, 50 % market share, in €



The total investment of the four most dense clusters (see figure 7) divided by the total number of households in these clusters (=7.92 Mio., see also table 5) yields the average investment per homes passed. The result indicates that the investment per homes passed increases by 13 % to 23 % in case of multi-fibre compared to single fibre networks which is due to the additional equipment required in the multi-fibre case. If the number of operators joining the co-investment model increases, the investment per operator and homes passed decreases due to the segment sharing. The resulting values lead to the same conclusions as already drawn in description of the total investment above.

4.6.2 Comparison of critical market shares

The critical market share is the minimum market share an operator needs in order to achieve a profitable business. The model calculates it cluster by cluster independently from each other. The significance of the critical market share is the same as in the main study. The models are simply applied and amended to alternative architectural aspects of access networks. As in the main study the critical market shares typically are relatively low in the densest populated area and increase with decreasing population density. We demonstrate and compare the results of the different architectures in the same form of graphs we already used in the main study. The continuous lines are interpolations we only choose to ease comparisons – the values between the indicated points do not have any interim value meaning. The detailed results can be found in Annex II: Tables with critical market shares.

In the following interpretation we will assume that the maximum achievable market share per cluster is restricted to about 80 %. The remaining 20 % are taken for mobile only users, cable network only customers or users without any telecommunication demand and are therefore regarded as no potential customers of the fibre operator. However, potentially these customers may be addressed, so that the 80 % market share restriction may be seen as an interpretable limitation.

The single fibre cases all serve as the references describing the scenario of a single investor without any sharing intention. These are the base cases to compare with. They do not use large manholes/street cabinets to locate distribution frames to access the drop cables to the end customer homes.

The multi-fibre cases with one operator serve as a reference for the investment in a multi-fibre approach and since there is no sharing taking place with other operators it as well describes the business outcome for an investing operator who does not contract the sharing in advance and later finds no partners to share the investment with, thus it describes the economic risk of a multi-fibre investment approach in absolute figures compared to the single fibre case.

The multi-fibre cases with four operators describe the outcome of a successful sharing business case. Looking at the lower critical market shares one should keep in mind, that in this case four operators are using the installed infrastructure in order to become successful in the market. Thus the available market has to be divided between them.

In the four operator cases, it might occur that not all operators reach the critical market shares for profitability in all clusters. Some operators may subsidise that cluster by profits of other clusters in order to stay profitable over all clusters, some may get more successful in receiving a higher ARPU than the one assumed (equal for all), thus being profitable – an option that is not included in the model respectively that cannot be demonstrated within the same set of model parameters. Other operators being co-investors of a sharing agreement may fail to become profitable at all.

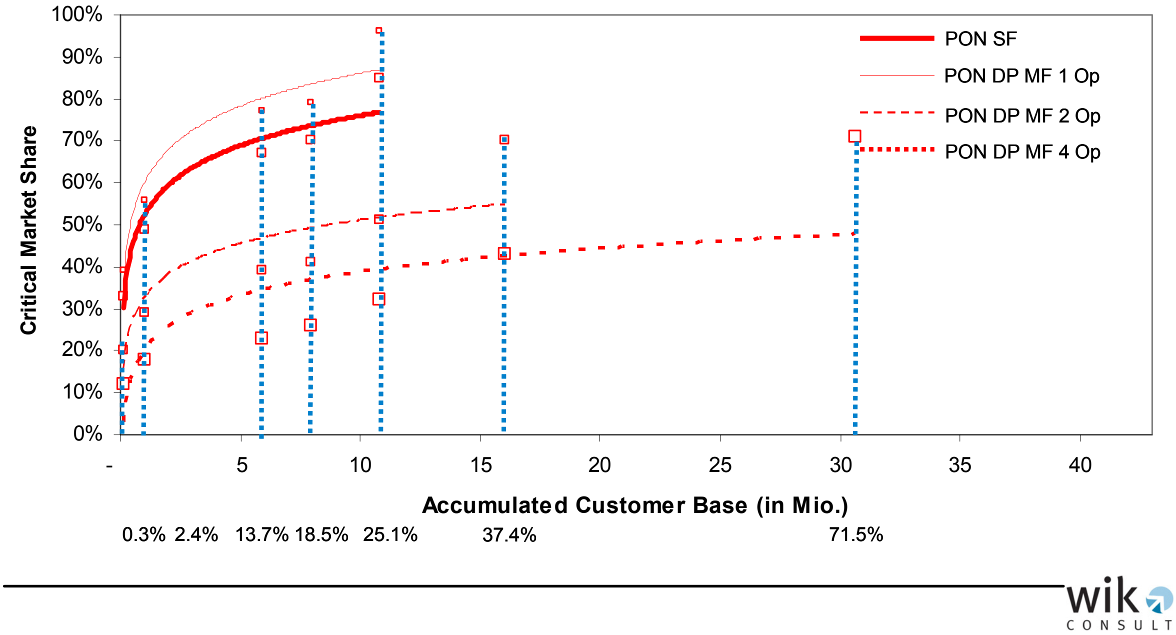
In the following sections we compare the critical market shares of the scenarios according to

1. The different numbers of operators within one architecture
2. Different hand-over points within one architecture
3. Different architectures at the same hand-over point.

4.6.2.1 Different numbers of operators within one architecture

PON with fibre hand-over at the DP

Figure 9: Critical market shares: PON single fibre and multi-fibre networks with fibre hand-over at the DP



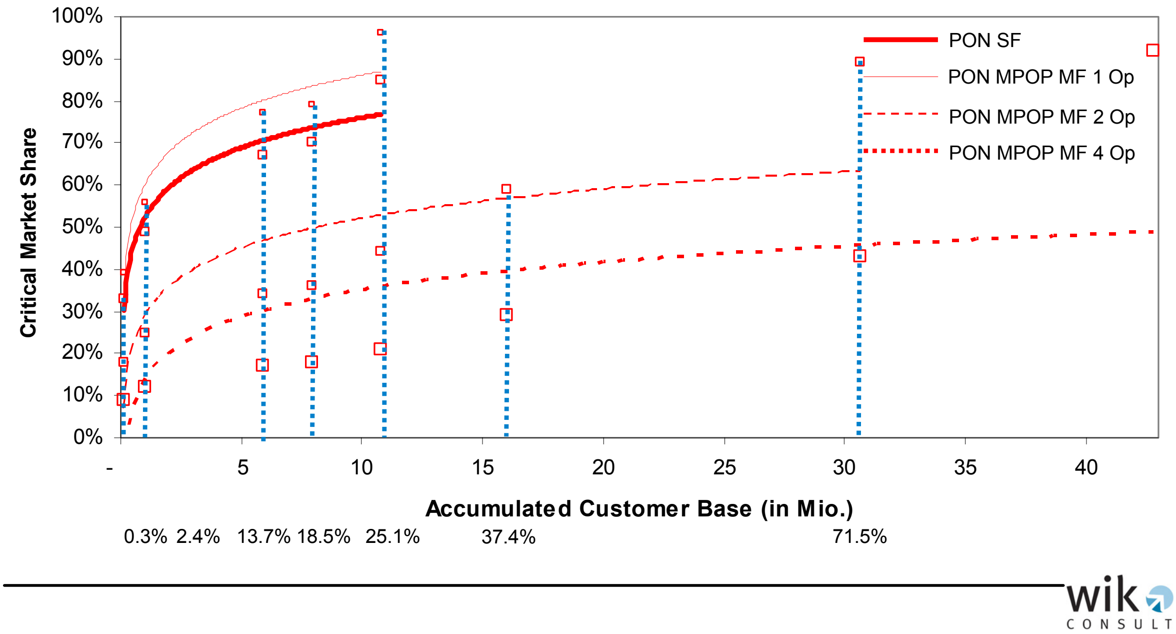
The single fibre network (SF) in our study considers a deployment of one fibre per customer between the household and the splitter location. Network sided of the splitter (e.g. in the feeder segment) the number of fibres is remarkably lower as a result of the splitting factor. The single fibre case does not consider any fibre hand-over to third operators so that no corresponding equipment needs to be installed at the distribution point. The single fibre case considers therefore only the installation of buried splitters. The costs of the considered network allow a roll-out in the four/five most dense clusters and a coverage of 18.5 % to 25.1 % of German households.

The PON multi-fibre network with one operator and a fibre hand-over at the DP (in the following PON DP MF 1 Op) considers four fibres per customer in the segment between the customer premise and the DP and collocation equipment located at the DP. The collocation equipment may be a manhole or cabinet and ODF equipment such as ports and patch cables. The equipment is installed at the ODF for potential third operators asking for fibre hand-over. On the customer side all fibres are connected to the ODF with customer sided ports, while on the network side only realised customers are connected by patch cables and network sided ports and forwarded to the splitter. The feeder cable segment is deployed separately by each operator. The aforementioned additional equipment and fibres generally lead to additional investment which is not given in the case of a single fibre operator. The higher investment costs directly imply less coverage (only 18.5 %) for the PON DP MF 1 Op case relative to the single fibre case. A further result of the higher investment cost is the higher critical market share required per cluster, e.g. in cluster one the market share for the PON DP MF 1 Op case is 39 % while the one for the single fibre case is 33 %. The one operator scenario is used as a reference for the investment needed in a multi-fibre environment and as well demonstrates the risk an investing operator is taking when he does not contract the sharing in advance of the roll-out of multi-fibre, and later on nobody is willing to share the infrastructure. His business case deteriorates compared to the single fibre roll-out.

The PON multi-fibre network with four operators and a fibre hand-over at the DP (in the following PON DP MF 4 Op) is the reference for a successful sharing agreement and is structured similarly as the PON DP MF 1 Op case. It differs mainly in the number of operators sharing the drop cable segment and installations at the DP. Each of these operators shares only parts of the installed equipment at the DP such as the manhole or cabinet and the customer sided ports of the ODF. Other parts such as the splitter, network sided ports and patch cables installed at the ODF are not shared since these elements are driven by the number of customers of each operator and the investment is directly attributable to the operator. All network components on the network side of the distribution point are not shared but stand alone realisations. Due to the sharing of some network elements the investment cost per operator decreases and so does the critical market share per operator. In cluster one the market share is at 12 %. If each of the four operators runs a viable business case in this cluster, then the total market share required is (4*12 %=) 48 %, a remarkably higher percentage than the one determined for the single fibre case (33 %). This difference is mainly driven by the additional fibre considered per customer and the collocation equipment to be installed at the DP. The market shares per cluster indicate that the less urban cluster (3) is the last cluster where four operators could get a viable business case for the fibre roll-out (4*23 %=92 %). In less dense clusters a viable business case for four operators does not exist. Activities of four operators may exist in less dense clusters, however, some of the co-investing carriers won’t reach the break-even market share and their roll-out will become unviable, at least when they consider these clusters independently from subsidies of the others.

PON with fibre hand-over at the MPoP

Figure 10: Critical market shares: PON single fibre and multi-fibre networks with fibre hand-over at the MPoP



The single fibre network considered in this scenario is the same as the one mentioned in the PON DP single fibre case. Again we assume a deployment of one fibre per customer between the household and the splitter location (and in the feeder) and the installation of a buried splitter, since no fibre hand-over is considered. This architecture allows a viable coverage of 18.5 % to 25.1 % of German households.

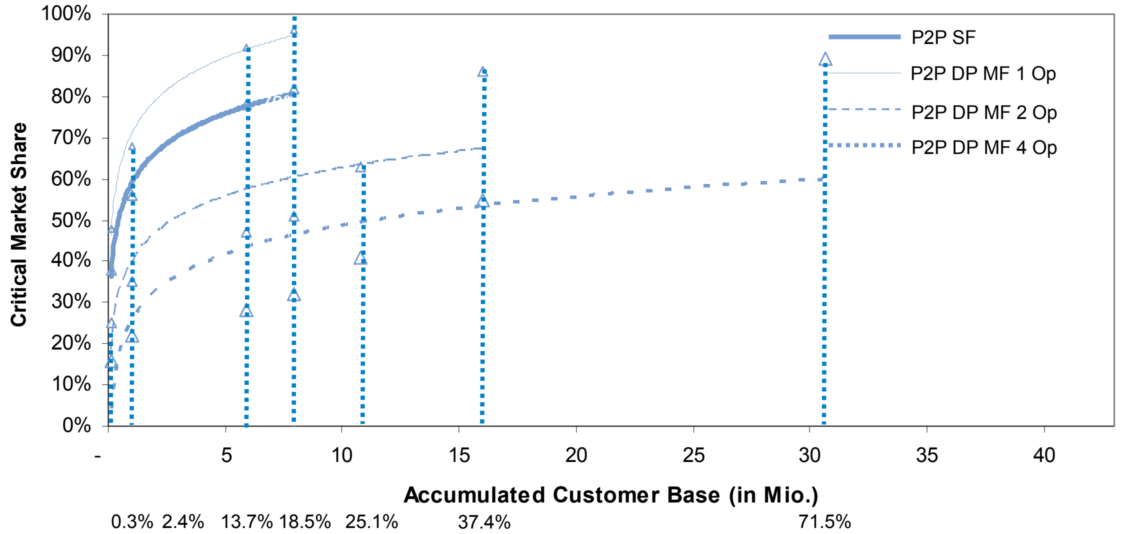
The PON multi-fibre network with one operator and a fibre hand-over at the MPoP (PON MPoP MF 1 Op) considers four fibres per customer in the segment between the customer premise and the DP and distribution frames located at the DP and the MPoP. The frame at the DP is addressed to potential operators to enable them to optimise their collocated splitters.

On the customer side all fibres are connected to the ODF with customer sided ports, while on the network side only realised customers are connected by patch cables and network sided ports and forwarded to the splitter. The collocation option at the MPoP considers equipment, such as ODF ports and patch cables. In scenarios with MPoP fibre hand-over, the feeder cable segment is shared. In the PON MPoP MF 1 Op case where only one operator exists this sharing rule is not applied, it is deployed by only one operator. The afore mentioned additional equipment implies additional investment cost compared to the single fibre case. The increase implies less coverage (only 18.5 %) for the PON MPoP MF 1 Op case relative to the single fibre case.

The PON multi-fibre network with four operators and a fibre hand-over at the MPoP (PON MPoP MF 4 Op) is structured similarly as the PON MPoP MF 1 Op case and differs mainly in the number of operators sharing the drop and feeder cable segment and the installations at the DP and MPoP. Each of these operators shares only parts of the installed equipment at the DP and MPoP (customer sided ODF ports, manholes) while other parts such as splitter and ODF equipment (network sided ODF ports, cables) are not shared and directly attributed to each operator. The sharing of network segments and elements leads to lower investment cost per operator and lower critical market shares per operator. In cluster one the market share is at 9 %. All four operators may run a viable business case in this cluster (4*9 %=36 %).. The critical market share in the single fibre scenario is 33 %. The market shares per cluster indicate that the suburban cluster is the last cluster where four operators could get a viable business case for the fibre roll-out (4*21 % = 84 %). In less dense clusters viability for four operators is not given. It could be also stated that activities of four operators may exist in less dense clusters but this implies that some of the co-investing operators won’t reach the break-even market share.

P2P with fibre hand-over at the DP

Figure 11: Critical market shares: P2P single fibre and multi-fibre networks with fibre hand-over at the DP



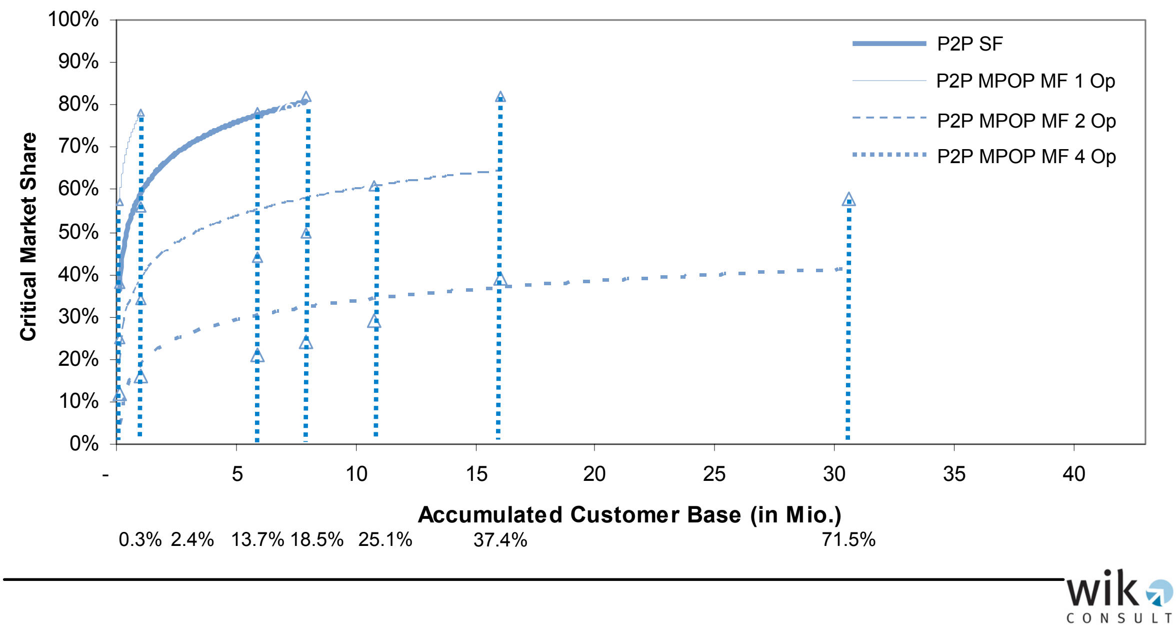
The single fibre network in the P2P scenario considers one fibre in the drop and feeder cable segment for each customer. The point-to-point connection from each customer to the MPoP implies further that neither DP nor splitter equipment has to be considered. According to the high number of fibres in the feeder segment the investment for P2P is relatively high and so is the critical market share. The considered network allows a coverage of 18.5 % of German households.

The P2P multi-fibre network with one operator and a fibre hand-over at the DP (P2P DP MF 1 Op) considers four fibres per customer in the drop cable segment and collocation equipment located at the DP. The equipment consists of a manhole or cabinet and ODF equipment (ports and patch cables). On the customer side all fibres are connected to the ODF with customer sided ports, while on the network side only realised customers are connected by patch cables and network sided ports. Each operator deploys the feeder cable segment separately. In this network segment the operator deploys one fibre per customer and so is in line with the structure assumed for the single fibre case. However, in the multi-fibre approach the mentioned additional equipment at the distribution point and the higher fibre number in the drop cable segment implies additional investment compared to the single fibre case where the DP is realised as buried fixed sleeve so that the coverage decreases to 2.4 % or (theoretically) 13.7 %.

The P2P multi-fibre network with four operators and a fibre hand-over at the DP (P2P DP MF 4 Op) is similar to the P2P DP MF 1 Op case. The main difference is given in the number of operators sharing the drop cable segment and the installations at the DP. Each of these four operators shares only parts of the installed equipment at the DP (customer sided ODF ports, manholes) while other parts such as network sided ODF ports and cables are not shared and directly attributed to each operator. The feeder segment is deployed by each operator separately and, since each operator deploys in this segment one fibre per potential customer, the investment is equal to the one of the P2P MPoP MF 1 Op case. Regarding the results it can be stated that the sharing of network segments and elements decreases the investment cost and critical market shares per operator. In cluster one the market share is at 16 %. All four operators may run a viable business case in this cluster (4*16 %=64 %). This can be compared to 38 % in the single fibre case. The last cluster where all four operators achieve a viable business case is the urban one (4*22 % = 88 %; single fibre 56 %). Less dense clusters do not permit viability to all four operators.

P2P with fibre hand-over at the MPoP

Figure 12: Critical market shares: P2P single fibre and multi-fibre networks with fibre hand-over at the MPoP



The single fibre network in this scenario is the same as the one in the P2P DP case, since both do not consider any fibre hand-over. Again each customer owns one dedicated fibre in both the drop and feeder cable segment. No DP and no splitter equipment is considered. The considered network allows a coverage of 18.5 % of German households.

The P2P multi-fibre network with one operator and a fibre hand-over at the MPoP (P2P MPoP MF 1 Op) considers four fibres per customer in the drop cable and feeder segment and collocation equipment located at the DP and the MPoP. The equipment at the DP consists of a manhole or cabinet and ODF equipment (ports and patch cables). On the customer side all fibres are connected to the ODF with customer sided ports, while on the network side only realised customers are connected by patch cables and network sided ports. The equipment at the MPoP consists of ports and patch cables but also active equipment. The deployment in the feeder cable segment is in the MPoP scenarios generally shared. However, since the P2P MPoP MF 1 Op case considers only one operator the sharing option is not applied. The operator deploys four fibres per customer in the feeder segment in order to ensure fibre hand-over at the MPoP level. The mentioned additional equipment increases the investment cost compared to the single fibre case so that the coverage decreases to 2.4 %.

While the single fibre case could cover four clusters, the multi-fibre case with one operator just covers the first two of them. Compared to the relative success of the four operator case below this result dramatically describes that an investor has to contract the sharing agreement in advance of the rollout in order not to suffer overinvestment and significant reduction of profitability in the case nobody is willing to share the infrastructure at all.

The P2P multi-fibre network with four operators and a fibre hand-over at the MPoP (P2P MPoP MF 4 Op) is similar to the P2P MPoP MF 1 Op case. The main difference is given in the number of operators sharing the drop and feeder cable segment and the installations at the DP and the MPoP. Each of these operators shares only parts of the installed equipment at the DP (customer sided ODF ports, manholes) while other parts such as network sided ODF ports and cables are not shared and directly attributed to each operator. The equipment at the MPoP is treated correspondingly. The feeder segment is shared, and in this segment the number of fibres per potential customer is four. Regarding the results it can be stated that the sharing of network segments and elements decreases the investment cost per operator and critical market shares per operator. In cluster one the critcal market share is at 12 %. All four operators may run a viable business case in this cluster (4*12 %=48 %). This has to be compared to the 38 % market share in the single fibre case. The last cluster where all four operators achieve a viable business case is the less urban one (4*21 % = 84 %; 78 %) in the single fibre case). Less dense clusters do not supply viability to all four operators under equal circumstances.

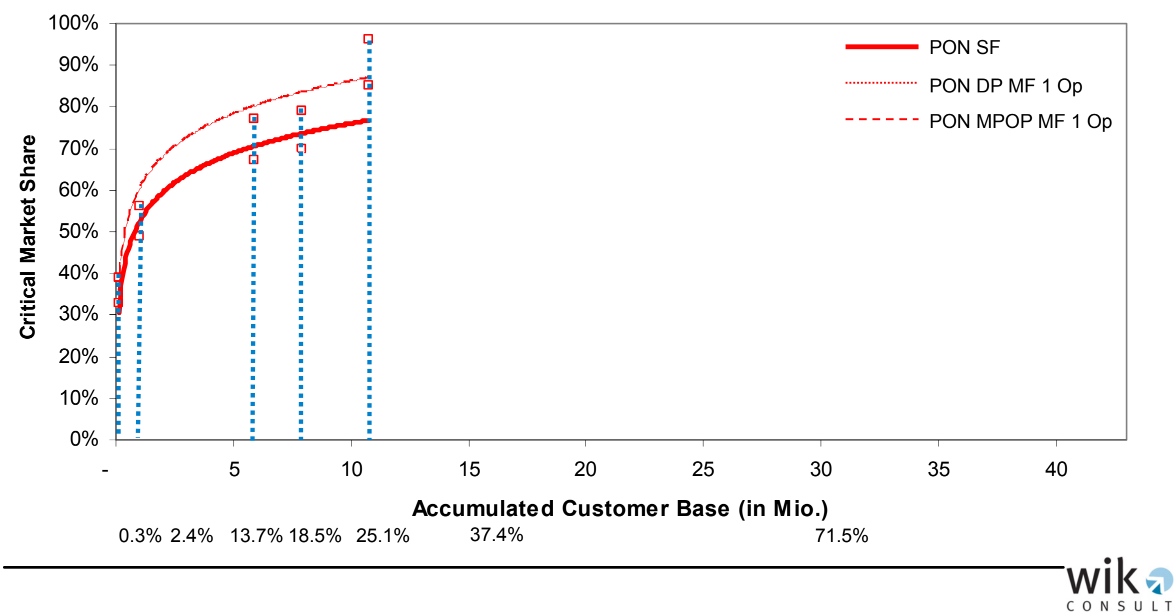
4.6.2.2 Different hand-over points within one architecture

Fibre hand-over at DP and MPoP

The network level at which the fibre hand-over takes place affects the number of shared segments and elements. Generally, the collocation point has implications on the investment cost level and on the critical market shares. The following analysis compares the fibre hand-over at the DP or MPoP level and also refers to the single fibre case where fibre hand-over is not considered at all as a reference.

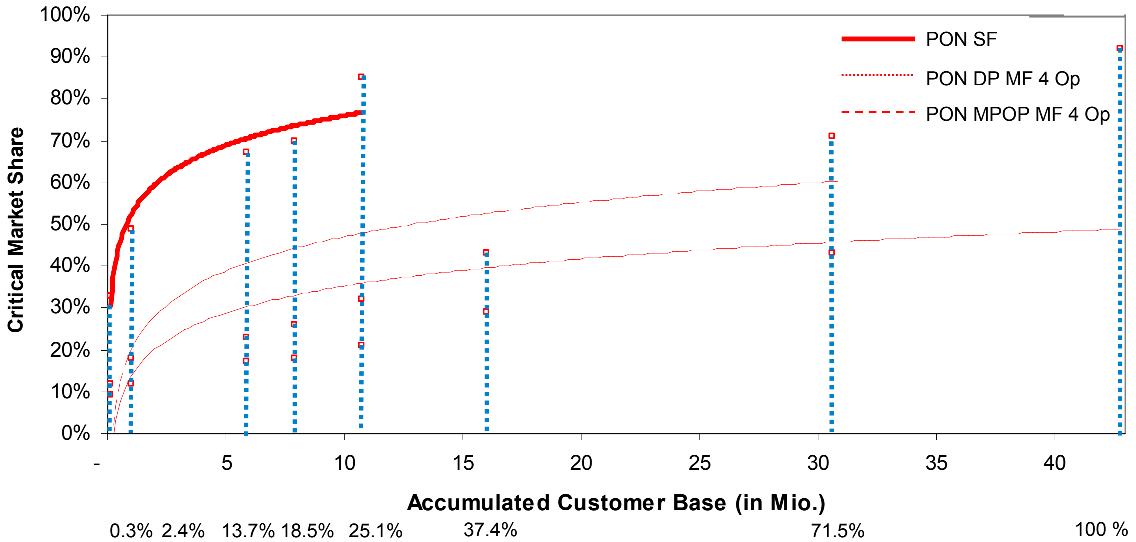
The investment in the drop segment between the customer premise and the DP is the same for both fibre hand-over at the DP and at the MPoP. The treatment of the feeder segment and the MPoP differs for these two approaches. In case of PON DP the feeder is deployed by each operator separately and each operator installs its own MPoP location. In case of PON MPoP the feeder segment and the MPoP are shared.

Figure 13: Critical market shares: One operator PON single fibre and multi-fibre networks with fibre hand-over at the DP and the MPoP



The one operator scenarios with fibre hand-over at DP and MPoP level differ only slightly in their investment level. The number of fibres deployed in the feeder and the number of customer sided ports at the MPoP is only slightly higher for PON MPoP than for PON DP. However, the difference is too small to show up as a difference in the critical market share. Thus, the critical market shares for the two approaches are the same and in the figure the two curves appear as one. There is in fact no difference if the hand-over takes place at the DP or at the MPoP. The economic risk of the investor is the same. Thus it seems to be more appropriate to bear the risk for the longer distance infrastructure from MPoP to homes than from DP to homes, lowering the barrier to entry for possible sharing partners.

Figure 14: Critical market shares: Four operator PON single fibre and multi-fibre networks with fibre hand-over at the DP and the MPoP

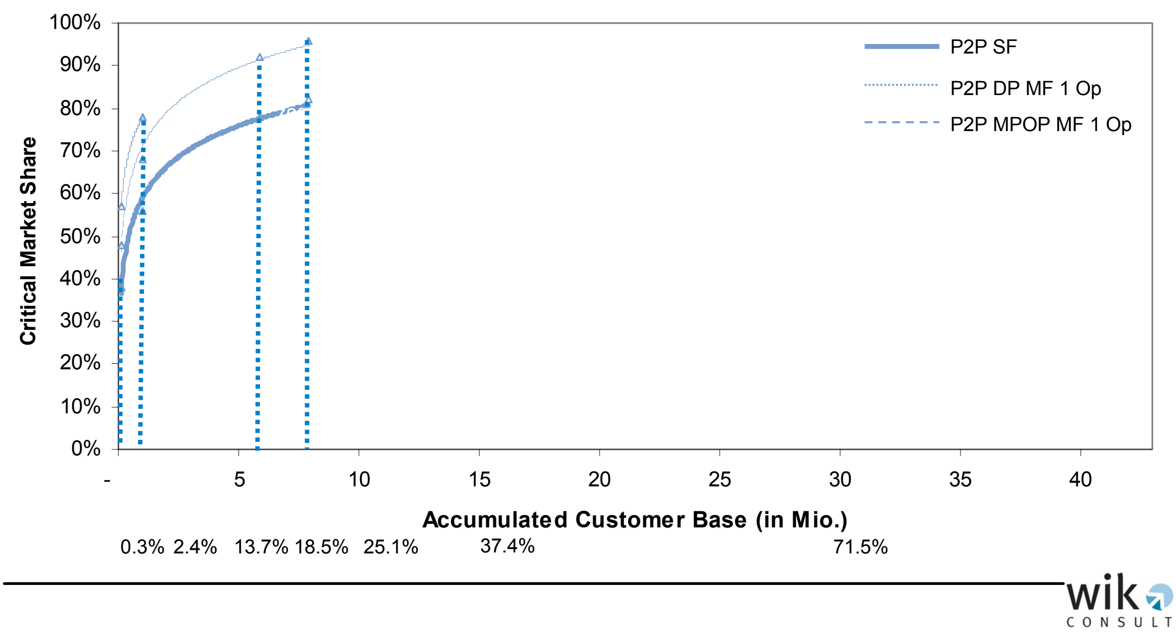


The scenarios with fibre hand-over at DP and MPoP level for four operators have the same investment for the segment between the customer premise and the DP. The sharing option in the feeder and MPoP reduces the investment and thus leads to lower critical market shares for PON MPoP MF 4 Op than for PON DP MF 4 Op. In the figure 14 the trend curve of the MPoP case is thus below the one of the DP case. In case of successful sharing of infrastructure the sharing up to the MPoP is more profitable than to the DP only. This indicates that the Commission's approach to define the multi-fibre FTTH approach such that it covers the network between MPoP and home and not only between DP and home (ARCEP, Swisscom) is of high economic value for potential co-investment partners.

P2P - Fibre hand-over at DP and MPoP

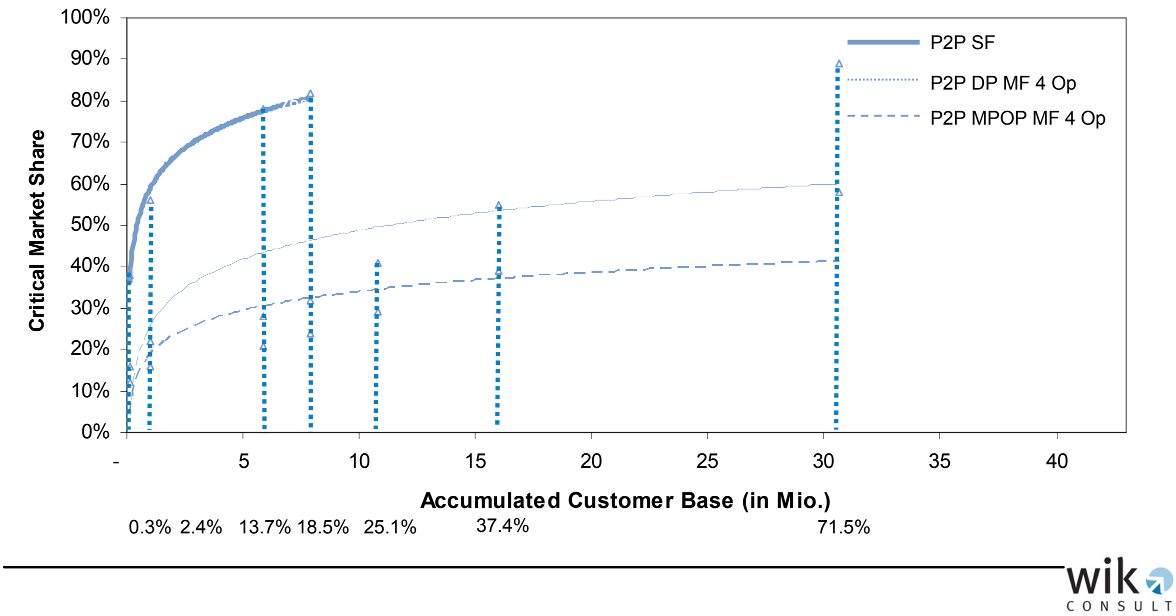
The total investment in equipment between the customer premise and the DP is the same for both P2P DP and P2P MPoP. In case of P2P DP, the model considers stand alone deployment in the feeder cable segment with one fibre per customer and corresponding equipment at the MPoP. In case of P2P MPoP the number of fibres per customer is four and all fibres are connected to customer sided ODF ports.

Figure 15: Critical market shares: One operator P2P single fibre and multi-fibre networks with fibre hand-over at the DP and the MPoP



The one operator P2P MPoP case considers a higher number of fibres in the feeder segment and requires a higher number of customer sided ODF ports at the MPoP location. The investment in the feeder segment and the MPoP is higher for P2P MPoP than for P2P DP. As a consequence, the critical market share is higher for P2P MPoP than for P2P DP. The curve of the MPoP case exceeds the one of the DP case significantly. Thus the risk for an investor rolling out a P2P architecture up to the MPoP is higher than only up to the DP. This result supports the Swisscom approach for multi-fibre access from an investor's perspective..

Figure 16: Critical market shares: Four operator P2P single fibre and multi-fibre networks with fibre hand-over at the DP and the MPoP



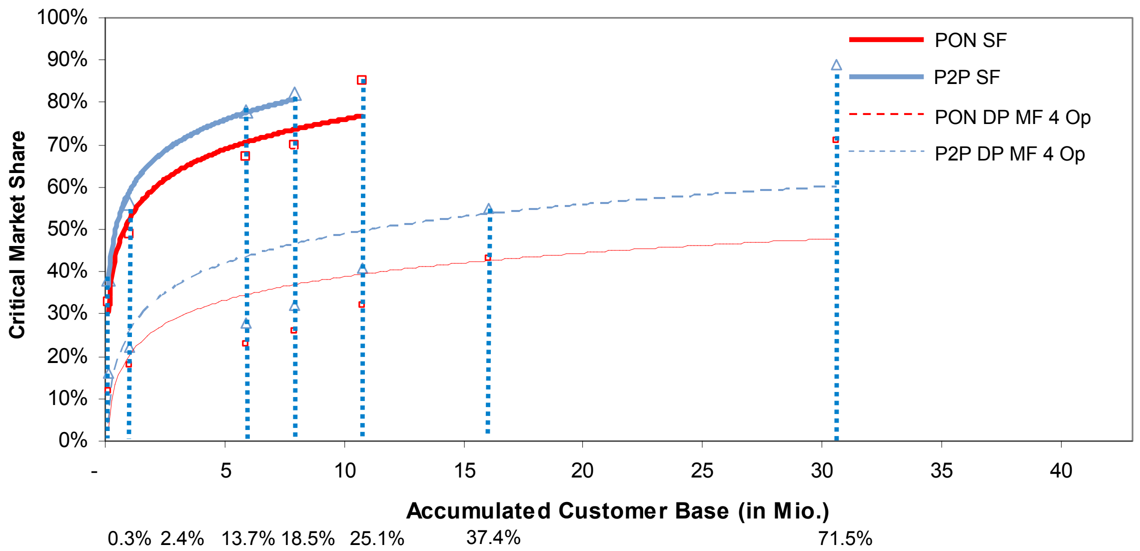
The four operator scenarios imply investment sharing in the feeder segment in case of P2P MPoP, so that for this network segment the investment per operator decreases remarkably relative to a stand alone solution. The investment in MPoP equipment for both stand alone deployment and the sharing case is the same. In total, the investment and so the critical market share is higher for P2P DP than for P2P MPoP. Thus in the successful sharing scenario the deployment of multi-fibre up to the MPoP is significantly more profitable than up to the DP. This result once again supports the Commission's definition of multi-fibre NGA networks.

4.6.2.3 Different architectures at the same hand-over point

P2P versus PON at DP

The comparison of P2P and PON multi-fibre networks indicates identical network structure in the complete segment between the customer premise and the DP. At the DP itself the investment for PON is higher than for P2P networks due to the splitter equipment. The investment in the feeder cable segment and the MPoP is higher for P2P than for PON, because of the large number of fibres to be handled. This difference is even higher in the scenario of hand-over at the MPoP. In total, the investment in P2P is generally higher than in PON networks.

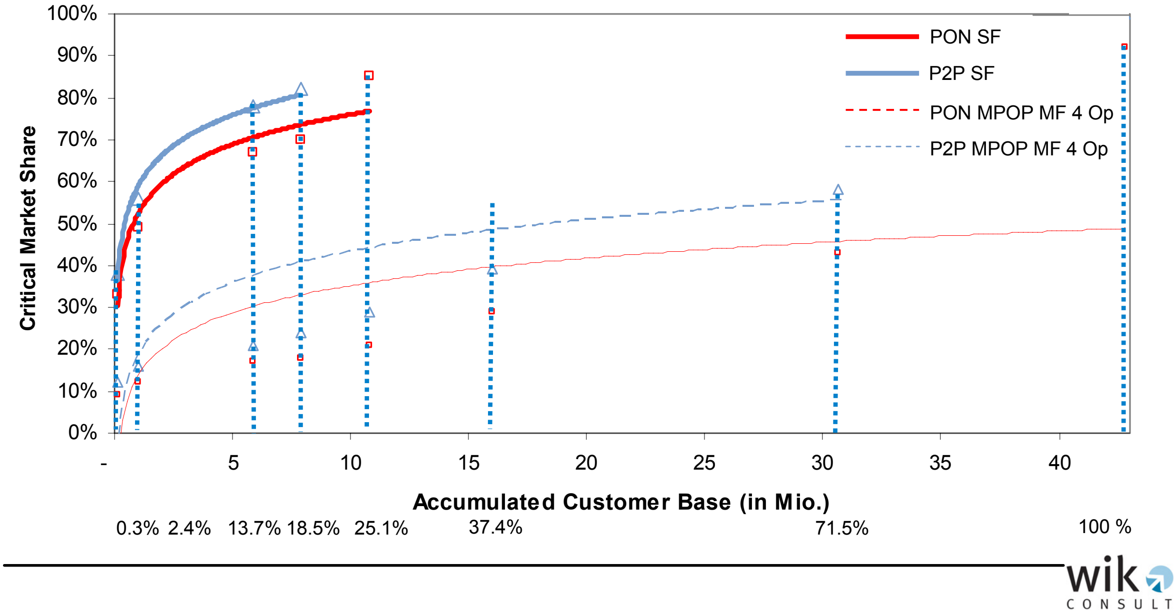
Figure 17: Critical market shares: P2P and PON fibre networks with DP fibre hand-over



According to our findings regarding the investment, the critical market share level is higher for P2P than for PON. The comparison of the average relative difference in the seven most dense clusters indicates that the critical market share is about 25 % higher for P2P DP than for PON DP.

P2P versus PON at MPoP

Figure 18: Critical market shares: P2P and PON fibre networks with MPoP fibre hand-over



The trend found for the DP fibre hand-over could also be found for the MPoP collocation. If the fibre is handed over at the MPoP level, the critical market share of the P2P network is higher than for the PON network. The relative average difference is even larger at about 33 % for the seven most dense clusters.

Thus, in successful multi-fibre investment sharing scenarios the PON architecture is more profitable than the P2P architecture. The model results indicate that the disadvantages of the PON architecture according to unbundling at the MPoP may be partly compensated by the wider choice end customers have with multi-fibre, although there is a disadvantage in the PON architecture in terms of limitations in further entry through effective unbundling competition.

4.6.3 Main Results

(1) Multi-fibre FTTH investments in the four densest clusters are 13 % to 23 % higher than single fibre architectures. This holds for all scenarios considered (PON DP and MPoP hand-over, P2P DP and MPoP hand-over). In both PON and in the P2P DP scenario this is mainly caused by the additional inhouse cabling and the distribution frame in the DP, in the P2P MPoP scenario a

significant increase is also caused by the substantially increased amount of fibres, therefore cables and wider trenches in the feeder segment.

(2) The more network segments (drop cable incl. inhouse, feeder) are shared, the higher the benefit for several operators from sharing the investment.

(3) The investment for P2P architectures is between 5 % (DP) and 15 % (MPoP) higher than for the comparable PON architecture (comparing multi-fibre one operator four fibres scenario).

(4) Viability and coverage of multi-fibre architectures decrease with PON and even more with P2P if the investor is not able to share the investment.

(5) The investor has to bear an increased risk if he cannot contract the investment sharing in advance of the roll-out of a multi-fibre infrastructure. The viability of the multi-fibre investment is therefore supported by co-investment fixed prior to the investment.

(6) In successful investment sharing scenarios (multi-fibre four operators) the critical market shares per operator decrease significantly. But one has to keep in mind, that now four operators are addressing the same market. The fourfold of the critical market share is higher than in the single fibre approach.

(7) When successfully shared (four operator scenario) the investment in MPoP hand-over results in a better profitability than the DP hand-over. Thus multi-fibre investments should for efficiency reasons not be restricted to the drop segment from the distribution points to the homes.

(8) The risk to deploy P2P multi-fibre to the MPoP is higher than only to deploy it to the DP. Thus it is even more important to contract investment sharing in advance of the roll-out for MPoP hand-over.

(9) The profitability of PON architectures in successful investment sharing constellations is higher than for P2P. The disadvantage of PON, not being able to become unbundled at the MPoP side, may be partly outweighed by the fact, that in successful sharing constellations the customers already have a wider choice between four operators. However, the potential for further differentiated market entry through unbundling would be limited.

4.7 Access-based competition by unbundling and infrastructure based competition by a multi-fibre model

In this section we will discuss comparative advantages and disadvantages of unbundling and a multi-fibre approach. For didactical purposes we assess the two approaches against each other. From a regulatory policy perspective, however, we do not see the relationship of the two approaches as mutually exclusive. Instead, as we will show, the greatest economic efficiency benefit is achieved, if both options are regarded as complementary to each other such that operators have a choice between them. Operators should have the opportunity to make their choice unconditional such that one operator can choose a multi-fibre approach and another one the unbundling approach. In the same way one operator should be able to prefer the multi-fibre approach in one particular area and unbundling in another area.

The multi-fibre model has the following advantages:

(1) The multi-fibre model generates competition at the deepest level of the network and provides a relevant model of replicability of the fibre at lower costs than the end-to-end infrastructure duplication.

(2) If the SMP operator as the investor finds partners for this model, he may have a stronger investment incentive and may expand the scope of coverage of the FTTH roll-out.

(3) The altnet has a better end-to-end control over his network infrastructure.

(4) The altnet(s) as well as the SMP operator has significant sunk cost investment and can therefore not engage in destructive hit-and-run competition. As, however, discussed in section 2.4.1, the complementary investment to be made by the altnet in the unbundling approach directly has a similar effect, but of course the overall amount and share of sunk investment becomes significantly larger under the multi-fibre model.

(5) The multi-fibre model allows for a competitive scenario where the user can get different services from different operators. In case of full unbundling (and no infrastructure competition) the user only has access to one single access line to his/her home and has to receive all line-based services from one operator, whom he/she might of course change from time to time

(6) The multi-fibre approach potentially can contribute to solve the termination monopoly problem. A user could for instance subscribe to different termination services from different operators.

(7) In cases or scenarios where the multi-fibre approach actually has achieved effective competition, regulation becomes obsolete.

Besides these advantages the multi-fibre approach is also characterised by a relevant amount of disadvantages:

(1) The significant higher requirements of sunk investment generate a significantly higher barrier to entry for non SMP operators.

(2) The number of competitors is determined by the market in the unbundling model. In a multi-fibre model unconstrained by regulation, the maximum number of competitors is determined ex ante by the investor and his decision on the number of fibres to be deployed. It is fair to say, that this restriction may be overcome by a secondary market of fibre lines, e.g. on the basis of unbundling.

(3) The overall investment costs are 13 % to 23 % higher in the multi-fibre approach compared to a single fibre approach. There are also some additional wholesale-specific investment costs related to the unbundling model (billing, reporting, …). But they are negligible compared to the incremental costs of the multi-fibre model.

(4) Depending on the distribution of market shares, the multi-fibre model can cause significant asymmetries in per customer costs and can therefore result in unsustainable competition.

(5) Although the multi-fibre model increases the replicability of the infrastructure, in most relevant cases the number of competitors is, however, limited to two, with the exception of co-investment by four operators with similar scale in dense areas. Our calculations on critical market shares needed for a profitable business model within a multi-fibre approach show that the coverage of multi-fibre is lower compared to the single fibre case regardless of the considered technology. The coverage reduction is higher for P2P than for PON which mainly results from the higher number of fibres in the feeder cable segment and at the MPoP.

(6) The dynamics of the multi-fibre model either tend to unsustainable competition or to a symmetrical market position with strong incentives for both partners to (explicitly or implicitly) collude.

Besides these comparative aspects of the unbundling model mentioned so far, there are some specific advantages of this model which still need to be mentioned:

(1) The unbundling model has a proven track record in the EU as an effective access-based competition model.

(2) The risk of market entry is lower. This is of particular relevance when a new entrant is entering the market or when the current market share in the broadband market is significantly lower than that of the SMP operator.

The major competitive asymmetries caused by the typical cost sharing rules of a multi-fibre model can best be demonstrated by a numeric example. Let us assume that the investment cost in the multi-fibre approach are 20 % higher than in the single fibre network. Two operators co-invest and share the investment cost on an equal basis. Let us further assume that the cost per line and month is 10 € in the single fibre case. Table 6 shows the resulting cost per line under various market share scenarios. The figures only relate to the shared part of the investment, which is representing around 80 % of total investment.

Table 6: Cost per line in single fibre and multi-fibre network

Single fibre + unbundling	**Incumbent**	**Market share**	100 %	80 %	60 %	50 %	40 %
		Cost per line	10	10	10	10	10
	Altnet	**Market share**	0 %	20 %	40 %	50 %	60 %
		Cost per line	0	10	10	10	10
Multi-fibre case	**Incumbent**	**Market share**	100 %	80 %	60 %	50 %	40 %
		Cost per line	6	7.50	10	12	15
	Altnet	**Market share**	0	20 %	40 %	50 %	60 %
		Cost per line	∞	30	15	12	10
	Assumptions: (1) Only shared investment considered (80 % - 85 % of total invest) (2) Two cooperation partners considered (3) Investment multi-fibre model = 120 % investment of single fibre model (4) Sharing rule: 50:50 (5) Numbers are for illustration purposes only						

In the single fibre case under cost-based LRIC pricing the incumbent and the altnet always face the same cost per line. Furthermore, the cost per line and under cost-based LRIC pricing also the price for the wholesale service is independent of the market share distribution between the incumbent and the altnet. It is only the total number of lines sold in the market which determines cost.

In the multi-fibre case and an investment cost sharing rule it is no longer the total lines sold in the market which determine the cost for each operator. Instead, it is the share in the investment cost which determines the cost per line for each operator. To reach the same level of cost an operator has to achieve a market share of at least 60 %. In this case the cost of the competing operator are higher by 50 %. In case one operator only achieves a 20 % market share it has a cost disadvantage of 300 %.

Besides these differences there are also some very relevant commonalities of a competition model based on unbundling and one which is based on a multi-fibre approach.

(1) The overall project-specific risks of the fibre investment are not too different from each other. The lower risk for the SMP operator in the multi-fibre approach results simply from the shift of parts of the investment risk to the cooperation partner(s). In sum, the investment risk remains more or less the same. It might even be higher, if the SMP operator does not find a cooperation partner. In the latter case he has to cover the higher investment costs on his own which may limit the market expectations of NGA.

(2) There are similar incentives to discriminate against access seekers and cooperation partners. Therefore the multi-fibre model is unlikely to be effective without intervention from NRAs.

We have shown that there are areas where the multi-fibre approach has advantages over an unbundling approach, because certain features of the competitive model cannot be reproduced by unbundling. This is mainly the possibility of having access line-based services by several operators. In most other areas it is more the issue of comparative advantages or disadvantages of both approaches which have to be evaluated against each other. In any case, the advantages of the multi-fibre approach not only have to outweigh its disadvantages. It has to have a significant relative advantage over the unbundling approach, because there are relevant incremental costs associated to the multi-fibre approach in terms of additional investment expenditure.

There seem to be some competitive advantages of the multi-fibre approach. On the other hand barriers to entry increase, which means that the potential for competition and market entry decreases. The unbundling model is open for a variety of market structures and supports the search for the most efficient market structure; the multi-fibre model on the other hand tends apart from some specific circumstances in dense areas to a duopoly market structure including a tendency towards collusion.

The multi-fibre approach may seem to lower the investment risk and therefore to incentivise more investment. However, this evaluation should be questioned. If the major NGA-specific risk is the risk of penetration and the risk of willingness to pay of users, this risk does not seem to be affected by the multi-fibre model. In both models operators (the investor and its competitor) have to work on penetration and on willingness to pay of users. It is not only that the investor is able under the multi-fibre model to shift parts of the investment risk to one or more altnets. The risk which is now reduced to the (primary) investor is increased for the altnet who also becomes a (secondary) investor in that model accordingly. We have shown that the risks for altnets are higher than under the unbundling model. This can mean and imply that the participation of altnets to develop the NGA market is lower under the multi-fibre model compared to the availability of unbundling. In areas where the multi-fibre approach does not find demand from altnets, the investment risk of the investor is even increasing because he has to generate higher revenues or a higher penetration compared to a single fibre architecture to make the investment profitable. To some degree this argument also holds in case there is demand for the cooperation model inherent in the multi-fibre model.

Given that a multi-fibre cooperation model can lead to less competition and to higher risks than an unbundling model (depending on relevant scenarios), it is not very likely that the (potential) benefits of this approach outweighs the additional cost of this model in terms of higher investment.

When we have to recognise that there is no overall dominance of the multi-fibre model over unbundling, but there might be certain scenarios where this economic competition model might have advantages over unbundling, is it possible to have the option of getting the best of both worlds? The best of both worlds would mean to ensure that the multi-fibre model can be used in areas or scenarios where it has the greater comparative advantages and that the unbundling model can be used where it has greater advantages. For that reason both approaches have to be regarded as complementary such that an unconditional choice is available for competitors.

Generally, it should not be the NRA which should pick a successful business model. This should be the task of market players and/or the outcome of the competitive process. If altnets have the choice between an unbundling access and a multi-fibre business model, they can choose the most efficient model for competition. This choice may not lead to the same outcome in each fibre deployment area. Generally, a multi-fibre model may have comparative advantages in areas where an altnet already has its own comprehensive feeder and backhaul network infrastructure such that, where such circumstances are fulfilled, the altne will likely look for access at the distribution point and share the drop and inhouse cable segment only. This may be a business model for a utility. These entities are by the way the only ones which show interest in the multi-fibre model Swisscom is offering. The fixed-line competitors (at least so far) are not interested in participating in the multi-fibre model.[40] Another positive prerequisite for a multi-fibre approach from an altnet perspective is a high market share in the broadband retail market. Altnets with high market shares would not suffer from the asymmetries associated with the cost sharing rules of the multi-fibre model. Furthermore, the multi-fibre model is the more attractive the lower the critical market shares for profitability are. This condition is met in the lower cost high density deployment areas.

This analysis proves that the multi-fibre model may have advantages in certain scenarios. A fibre unbundling model rests on the regulatory obligation and availability of unbundled fibre access. The multi-fibre model either requires an investor who is offering this model of access to interested market players or a group of investors (but may require regulatory intervention) which jointly develop such a model in the framework of a co-investment arrangement. In its draft NGA Recommendation, the Commission[41] has

40 See contribution of Kurt Lanz at the ECTA conference in Brussels, 25 June 2009.
41 Annex III of the Recommendation.

set some incentives for an SMP operator to offer a multi-fibre approach in the market. If certain conditions facilitating competition are met, the absence of SMP would be indicated for the joint deployment of FTTH networks by several co-investors. The critical aspect in this approach is that the pure availability of a multi-fibre approach and the subscription of several co-investors in such arrangements as such do not result in or even guarantee effective competition. We have shown that under certain scenarios co-investors may run unprofitable business models and competition may be unsustainable or lead to collusive behaviour. Therefore, it seems necessary to make major steps of deregulation linked with a multi-fibre approach dependent on the actual market structure materialised under the successful implementation of a multi-fibre approach.

5 Policy conclusions

The risk of NGA

1. The WACC used by NRAs to calculate the cost of copper ULL is an appropriate starting point to determine the return on capital allowed ex ante for investments into fibre-based NGA networks. Only if there are systematic risks of NGA investments, which are different, a supplement to the ULL WACC may be justified.

2. Relevant for determining NGA specific risks are the risk of penetration, the risk of sufficient willingness to pay by end-users, the regulatory risk and specific risks of certain business models. This should be weighed against any capital benefits and OPEX reductions resulting from fibre deployment compared with existing copper access infrastructure.

3. The risk of penetration is closely related to the supply-driven nature of any efficient FTTH network deployment. The profitability of any NGA roll-out and/or the degree of profitable coverage depends on the penetration of the potential customer base. If and as soon as the whole subscriber base of an SMP operator is migrated to the (new) NGA platform, the penetration related risk is close to zero. If and as long as a new fibre NGA competes against the (remaining) DSL platform, there might be a remaining penetration risk. The risk of penetration will be lower, if the operator offers broadband wholesale access products due to the stimulating effects of competition on retail demand.

4. The profitability and the degree of profitable coverage depends on the average revenues per access line to be generated. If the business plan of the investor entails revenue assumptions over and above the current level of revenues, the investor bears the risk to meet these demand and willingness to pay expectations.

5. Generally, risk in an NGA context has a geographic dimension. Investment in certain dense areas may not require any assumptions of increased ARPU whilst outside such areas ARPU increases may be required to make the business case viable.

6. Given the long-term nature of fibre investment, regulation can be a relevant risk factor. There is no regulatory risk related to decisions to be made before the investment is actually being made. It is more the change of the regulatory regime and of regulatory parameters over time which defines a regulatory risk. NRAs can manage this risk and keep it low. It is, however, socially not optimal, to eliminate it totally, for example by setting regulatory rules for the entire lifetime of the investment.

7. Because there is a retail-specific risk in NGA, the risk of an integrated wholesale/retail business model is higher than the risk of the wholesale business itself. It is only the latter one which should be taken care of in calculating the access prices.

8. The systematic risk of NGA depends on the asset-specificity of the NGA investments. Therefore, investment in non-replicable physical assets such as civil engineering is of less or no (additional) risk. The risk of FTTH investment is higher than the risk of FTTC/VDSL. The risk for an incumbent is further reduced by making use of existing ducts and by selling real estate and potentially other assets of the copper based network.

Mechanisms to share the risk and competitive implications

1. Risk sharing mechanisms do not necessarily reduce the overall systematic project-specific risk of NGA investments. They might, however, redistribute the investment risk from the investor to other stakeholders like co-investors, access seekers or users. This diversification of risk might also increase the level of NGA investments, if there are limitations on individual operators in bearing investment risks and if several operators have a limited capacity to make significant investments.

2. If the cost of capital of an access product is properly reflecting the project-specific risk of NGA, access seekers carry their appropriate share of the risk of the SMP operator's investments. They share the risk pro rata to their market share.

3. Telecommunications has a long history that the user directly contributes to the investments of a (new) network. This sharing mechanism should also be reactivated for NGA. It has particular relevance for those part(s) of the investment which are specific to a single user or a dedicated group of users like the inhouse cabling and the drop cable to a building. This investment and risk sharing mechanism is competitively neutral.

4. Given the economic characteristics of NGA networks and investments, co-investment arrangements under certain circumstances can have not only private but also social benefits in terms of diversifying risks and overcoming individual operators' financing constraints. However, NRAs and NCAs do have to take care that anti-competitive tendencies inherent in the incentive structure of co-investment arrangements are not unduly reducing the social value of such arrangements. Cooperation arrangements can work as collective foreclosure agreements. There is a natural tendency and incentive that the investor and its cooperation partners jointly are looking for more favourable conditions to use the infrastructure and to compete in the retail market at more favourable conditions

compared to third parties. However, an agreement which favours a limited number of operators thereby placing them in a better position as regards their retail market position and capacity to invest would tend to limit the 'penetration' benefits of competition and is incompatible with the objectives of achieving effective competition. Under the perspective of effective competition a regulator should check that the internal pricing conditions imputed to the downstream arm of an SMP operator within a co-investment arrangement reflect those available to third parties. Such checks should include internal prices reflecting long-term commitment discounts where permitted (see section 2.5) and undiscounted prices. In both cases, pricing should be consistent and no margin squeeze should apply.

5. Pricing of wholesale access products can be a proper mean of diversifying the risk between the SMP operator and the access seeker beyond the risk sharing indicated in the risk component in the cost of capital. NRAs only have to take care that such risk-oriented pricing elements are non-discriminatory and not anti-competitive.

6. Buyer specific volume discounts are a pricing tool which incentivises the increased use of a (new) network infrastructure. However, volume discounts also discriminate against smaller competitors and later entrants. They generate barriers to entry for those competitors. If the discount scheme is not provided to the number of customers per individual wholesale buyer but to the total number of fibre loops sold to all access seekers (including the SMP operator) the basic incentivisation effects can still be maintained and the negative competitive implications could be avoided.

7. Allocation of investment costs to one-off pricing elements also shifts parts of the investment cost per line and also part of the investment risk from the investor to the access seeker. The one-off fee element can, however, at the maximum cover the allocated part of the investment relating to the usual customer lifetime. Otherwise the pricing structure becomes a barrier to entry.

8. On the basis of long-term contracts and appropriate demand commitments the investor is able to sell the capacity in whole or in parts and to eliminate or reduce its risk accordingly. It is now the risk of the access seeker to fill the committed part of the network capacity. Risk sharing on the basis of long-term contracts only works, if the commitment is credible, binding and cannot be renegotiated. The risk sharing and risk reduction aspect of long-term contracts is stronger, if the contracts are concluded before the investment takes place. However, long-term contracts are not in all circumstances compatible with achieving effective competition and may increase incentives by an SMP operator to engage in discrimination. Appropriate thresholds should be set by the regulator to ensure that such arrangements are only permissible, if multiple

operators can participate given existing market positions and alongside important safeguards against discrimination. Furthermore, given that such schemes inevitably benefit mass-market (consumer) suppliers, It should be considered in this context whether for the purposes of discount arrangements, business-grade products are in the same market segment as products designed for the mass-market.

9. Where long-term contracts are permissible, agreements on access on the basis of long-term contracts should not exclude the simultaneous availability of access without demand commitment. Otherwise, risk sharing contracts would raise entry barriers and be a form of market foreclosure. On the other hand, there has to be a price incentive for access seekers who commit themselves on a long-term basis. Non committed access seekers should pay a wholesale price equal to LRIC. The price discount for long-term committed operators should exactly reflect the reduction in risk to the investor due to the demand commitment. This discount should be the same for all committed operators and be calculated on the basis of the sum of the long-term committed demand. Otherwise the investor would be overcompensated and would receive an unjustified risk reduction rent through a multiple consideration of the same risk.

Economic impacts of multi-fibre

1. There are three slightly different multi-fibre approaches under discussion in Europe: the approach of ARCEP in France, the approach of Swisscom in Switzerland and the approach of the EU Commission in its draft NGA Recommendation. Each of them has different economic impacts.

2. The ARCEP proposal defines a multi-fibre infrastructure to be implemented by the first investor in a mandatory manner (building-by-building on demand of competitors) in very densely populated areas which are explicitly listed. The distribution point may be within the building or very close by. Thus the shared part of the network (inhouse network up to the distribution point) is relatively short. A distribution frame in the distribution point has to be provided on demand, an alternative option is a fixed splice of the fibre. Sharing of the feeder infrastructure is not mentioned or foreseen. The assumption is that very densely populated areas may allow several separate feeder infrastructures to be economically viable.

3. The Swisscom approach is a voluntary unregulated attempt to achieve mutual agreements between competitors in Switzerland addressing a region, a city or a district. The investor is installing four fibres per home being concentrated in a manhole as the distribution point. The distribution point comprises a larger amount of buildings and is located outside of the buildings in the street. Thus the shared part of the network seems to be larger than in the ARCEP

approach. The multi-fibre areas are not restricted to very densely populated areas, rather the approach is intended to be used in major parts of the country. The distribution point only houses splices between the fibres to the homes and the feeder networks of the different operators. Distribution frames are not planned. There is an option to also share the feeder infrastructure up to the MPoP.

4. The EU Commission's approach is a voluntary approach, but may be an obligation on SMP operators in the drop cable or terminating segment, if that is feasible from a regulatory and legal perspective. It defines a distribution point comprising several buildings with an amount of homes which enables a viable access opportunity for competitors to collocate. The distribution point in any case houses a distribution frame enabling easy mutualisation of the drop fibres. Standard element of the Commission's approach also is the investment sharing of the feeder infrastructure up to the MPoP, thus enabling a major part of the network investment to be shared between the operators. Our NGA modelling approach examines both the Commission's approach of access at the MPoP and hand-over at the distribution point as one variation.

5. Multi-fibre with hand-over at the MPoP is the only multi-fibre architecture which allows one or even all of the participating co-investment partners to offer a wholesale unbundled fibre local loop service. A fibre hand-over at the DP implies wholesale sub-loop unbundling only.

6. A multi-fibre network roll-out requires higher investments compared to a single fibre approach. Swisscom expects an increase of investment in the range of 10 % to 30 %. ARCEP assumes only a moderate increase of 5 %. Our own calculations for Germany indicate an increase of 13 % to 23 %. These numbers are in line to each other, when bearing in mind that these approaches consider different shared cable segment length.

7. According to our calculations for Germany the differences in investment depend on subscriber density, fibre architecture and the degree of sharing. Multi-fibre FTTH investments in the four densest clusters are 13 % to 23 % higher than single fibre architectures. This holds for all scenarios considered (PON DP and MPoP hand-over, P2P DP and MPoP hand-over). In both PON and in the P2P DP scenario this is mainly caused by the additional inhouse cabling and the distribution frame in the DP; in the P2P MPoP scenario a significant increase is also caused by the largely increased amount of fibres and therefore the requirement for more cables and wider trenches in the feeder segment. In both PON scenarios additional splitters cause an increased investment.

8. The basic economic advantage for the individual operator is that under a multi-fibre approach he only has to bear a certain proportion of the investment, but still can reach 100 % of the potential customers. Our empirical results show that the more network segments (drop cable incl. inhouse, feeder) are shared, the higher the benefit for several operators from sharing the investment. The investment savings for the individual operator amount up to 40 % if two operators share the relevant investment and up to 70 % if four operators share the relevant investment.

9. The higher the shared part of infrastructure, the more attractive the successful sharing approach gets. Thus hand-over at the MPoP is more efficient than at the DP. The greatest sharing benefits are generated by the Commission's approach; it is followed by Swisscom's approach and then by ARCEP's proposal. For efficiency reasons multi-fibre approaches should not be restricted to the drop cable segment only.

10. Fibre investments in a multi-fibre sharing arrangement increase replicability. The competition by several operators in the market is viable in a larger coverage area compared to single fibre end-to-end network duplication. The critical market shares for an individual operator for profitability therefore are lower.

11. Nevertheless, the areas where each of two or even four operators reach the critical market shares for profitability are rather limited. The coverage of a successful infrastructure sharing with four operators is less than in a single fibre case (due to the higher investment needed). This coverage could be expanded, if higher ARPU is achieved than assumed in the model or if customers buy services from several operators in parallel and in total spend more than assumed in the model.

12. The investor has to bear an increased risk if he cannot contract the investment sharing in advance of the roll-out of a multi-fibre infrastructure. The viability of the multi-fibre investment is therefore supported by co-investment arrangements negotiated prior to the investment.

13. From a regulatory policy perspective, we do not see the relationship of unbundling and multi-fibre as mutually exclusive. Instead, the greatest economic benefit is achieved, if both options are regarded as complementary to each other such that operators have a choice between them. Operators should have the opportunity to make their choice unconditional such that one operator can choose a multi-fibre approach and another one the unbundling approach. In the same way one operator should be able to prefer the multi-fibre approach in one particular area and unbundling in another area.

14. The multi-fibre model has the following advantages:

    a. The multi-fibre model generates competition at the deepest level of the network and provides a relevant model of replicability of the fibre at lower costs than the end-to-end infrastructure duplication.

    b. The altnet has a better end-to-end control over his network infrastructure.

    c. The multi-fibre model allows for a competitive scenario where the user can get different services from different operators.

    d. The multi-fibre approach potentially can contribute to solve the termination monopoly problem. A user could for instance subscribe to different termination services from different operators.

    e. In cases or scenarios where the multi-fibre approach actually has achieved effective competition, regulation becomes obsolete.

15. Besides the additional investment a multi-fibre approach has some further relevant disadvantages:

    a. The significant higher requirements of sunk investment generate a significantly higher barrier to entry and generate increased penetration risks for non SMP operators.

    b. The number of competitors is determined by the market in the unbundling model. In a multi-fibre model unconstrained by regulation the maximum number of competitors is determined ex ante by the investor and his decision on the number of fibres to be deployed. It is fair to say, that this restriction may be overcome by a secondary market of fibre lines, e.g. on the basis of unbundling, in particular, if unbundling is mandated.

    c. Depending on the distribution of market shares, the multi-fibre model can cause significant asymmetries in per line costs and therefore in competition which can result in unsustainability of competition.

16. Unbundling allows as many competitors to directly connect end customers via physical passive infrastructure as competitors are willing to collocate at MPoPs. In Germany there are more than four operators collocating at the MDF in a significant amount of MDFs today and they are addressing more than 70 % of the German households and businesses. The multi-fibre infrastructure only allows up to four operators to directly address end customers, unless one or more of them offer fibre LLU by themselves or the SMP operator is obliged to do so.

17. The major competitive asymmetries of the multi-fibre approach result from the inherent cost sharing rules. The usually proposed sharing rule requires an equal sharing of investment costs. In the single fibre case under cost-based LRIC pricing the incumbent and the altnet always face the same cost per line. Furthermore, the cost per line and under cost-based LRIC pricing also the price for the wholesale service is independent of the market share distribution between the incumbent and the altnet. It is only the total number of lines sold in the market which determines cost. In the multi-fibre case and an investment cost sharing rule it is no longer the total lines sold in the market which determine the cost for each operator. Instead, it is the share in the investment cost which determines the cost per customer served for each operator.

18. There are certain aspects where the multi-fibre approach has advantages over an unbundling approach, because certain features of the competitive model cannot be reproduced by unbundling. This is mainly the possibility of having access line-based services by several operators (e.g. operator A sells TV services to one customer and operator B sells broadband double play services to the same customer). In most other areas it is more the issue of comparative advantages or disadvantages of both approaches which have to be evaluated. In any case, the advantages of the multi-fibre approach not only have to outweigh its disadvantages. It has to have a significant relative advantage over the unbundling approach, because there are relevant incremental costs associated to the multi-fibre approach in terms of additional investment expenditure.

19. There seem to be some competitive advantages of the multi-fibre approach. On the other hand barriers to entry increase, which means that the potential for competition and market entry decreases. The unbundling model is open for a variety of market structures and supports the search for the most efficient market structure; the multi-fibre model on the other hand often tends to a duopoly market structure including a tendency towards collusion.

20. The best solution would be to ensure that both options are available. Generally, it should not be the NRA which should pick a successful business model. This should be the task of market players and/or the outcome of the competitive process. If altnets have the choice between an unbundling access and a multi-fibre business model, they can choose the most efficient model for competition. This choice may not lead to the same outcome in each fibre deployment area. Generally, a multi-fibre model may have comparative advantages in areas where an altnet already has a high market share and its own comprehensive feeder and backhaul network infrastructure such that, where such circumstances are fulfilled the altnet will likely look for access at the distribution point and share the drop and inhouse cable segment only.

21. The multi-fibre option could be a useful model for a multi-operator co-operative arrangement in some circumstances, if agreed before investments are made. In order to meet conditions for competition such a model should involve joint control of the co-investment vehicle and also address the availability of an unbundling option. The ARCEP approach of multi-fibre per building on demand presents an alternative scenario where fibre hand-over is realised at the lowest network level and optimises a decentralised decision making for network efficiency. The potential efficiencies of the multi-fibre sharing approach are, however, maximised, if access to shared network elements is available at the MPoP as the EU Commision is suggesting.

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Annex I: Investment tables

Total investment for the first four clusters:

Table A I-1: Total investment PON – hand-over at distribution point

Total investment, 50 % market share, in Mio.€					
PON - DE - DP					
Cases		Single fibre case	Multi fibre case		
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Dense Urban	0.3%	**100.7**	**120.7** (+ 19.86 %)	**67.6** (- 32.87 %)	**41.1** (- 59.19 %)
Urban	2.4%	**1,007.6**	**1,159.3** (+ 15.06 %)	**660.4** (- 34.46 %)	**411.0** (- 59.21 %)
Less Urban	13.7%	**6,873.2**	**7,710.0** (+ 12.17 %)	**4,352.5** (- 36.67 %)	**2,673.7** (- 61.10 %)
Dense Suburban	18.5%	**2,946.9**	**3,287.7** (+ 11.56 %)	**1,885.0** (- 36.03 %)	**1,183.6** (- 59.84 %)
Total		**10,928.4**	**12,278.2** (+ 12.35 %)	**6,964.5** (- 36.27 %)	**4,307.6** (- 60.58 %)

Value in brackets: Relative change compared to single fibre case.

Table A I-2: Total investment P2P – hand-over at distribution point

Total investment, 50 % market share, in Mio.€					
P2P - DE - DP					
Cases		Single fibre case	Multi fibre case		
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Dense Urban	0.3%	**109.0**	**131.3** (+ 20.46 %)	**78.2** (- 28.26 %)	**51.7** (- 52.57 %)
Urban	2.4%	**1,065.7**	**1,237.0** (+ 16.07 %)	**738.2** (- 30.73 %)	**488.7** (- 54.14 %)
Less Urban	13.7%	**7,208.1**	**8,133.4** (+ 12.84 %)	**4,775.8** (- 33.74 %)	**3,097.1** (- 57.03 %)
Dense Suburban	18.5%	**3,123.7**	**3,507.3** (+ 12.28 %)	**2,104.6** (- 32.62 %)	**1,403.2** (- 55.08 %)
Total		**11,506.5**	**13,009.5** (+ 13.06 %)	**7,695.9** (- 33.12 %)	**5,039.1** (- 56.21 %)

Value in brackets: Relative change compared to single fibre case.

Table A I-3: Total investment PON – hand-over at MPoP

Total investment, 50 % market share, in Mio.€					
PON - DE - MPOP					
Cases		Single fibre case	Multi fibre case		
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Dense Urban	0.3%	**100.7**	**120.8** (+ 19.96 %)	**63.2** (- 37.24 %)	**34.4** (- 65.84 %)
Urban	2.4%	**1,007.6**	**1,160.7** (+ 15.19 %)	**602.9** (- 40.16 %)	**324.1** (- 67.83 %)
Less Urban	13.7%	**6,873.2**	**7,717.5** (+ 12.28 %)	**3,976.7** (- 42.14 %)	**2,106.3** (- 69.35 %)
Dense Suburban	18.5%	**2,946.9**	**3,294.0** (+ 11.78 %)	**1,701.2** (- 42.27 %)	**904.8** (- 69.30 %)
Total		**10,928.4**	**12,293.5** (+ 12.49 %)	**6,342.8** (- 41.96 %)	**3,367.6** (- 69.19 %)

Value in brackets: Relative change compared to single fibre case.

Table A I-4: Total investment P2P – hand-over at MPoP

Total investment, 50 % market share, in Mio.€						
P2P - DE - MPOP						**P2P - DE**
Cases		Single fibre case	Multi fibre case			Multi fibre case
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres	2 Operators 2 Fibres
Dense Urban	0.3%	**109.0**	**144.9** (+ 32.94 %)	**78.3** (- 28.17 %)	**45.1** (- 58.62 %)	**73.7** (- 32.39 %)
Urban	2.4%	**1,065.7**	**1,347.6** (+ 26.45 %)	**718.9** (- 32.54 %)	**404.6** (- 62.03 %)	**681.8** (- 36.02 %)
Less Urban	13.7%	**7,208.1**	**8,698.7** (+ 20.68 %)	**4,591.7** (- 36.30 %)	**2,538.2** (- 64.79 %)	**4,397.1** (- 39.00 %)
Dense Suburban	18.5%	**3,123.7**	**3,954.4** (+ 26.59 %)	**2,079.0** (- 33.44 %)	**1,141.3** (- 63.46 %)	**1,932.4** (- 38.14 %)
Total		**11,506.5**	**14,146.4** (+ 22.94 %)	**7,466.9** (- 35.11 %)	**4,127.3** (- 64.13 %)	**7,083.9** (- 38.44 %)

Value in brackets: Relative change compared to single fibre case.

Average investment for the first four clusters for all homes passed and 50 % market share:

Table A I-5: Average investment PON – hand-over at distribution point

Av. Investment per homes passed, 50 % market share, in €				
PON - DE - DP				
	Single fibre case	Multi fibre case		
	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Investment per homes passed, in €	**1,379**	**1,550** (+ 12.35 %)	**879** (- 36.27 %)	**544** (- 60.58 %)

Table A I-6: Average investment P2P – hand-over at distribution point

Av. Investment per homes passed, 50 % market share, in €				
P2P - DE - DP				
	Single fibre case	Multi fibre case		
	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Investment per homes passed, in €	**1,452**	**1,642** (+ 13.06 %)	**971** (- 33.12 %)	**636** (- 56.21 %)

Table A I-7: Average investment PON – hand-over at MPoP

Av. Investment per homes passed, 50 % market share, in €				
PON - DE - MPOP				
	Single fibre case	Multi fibre case		
	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Investment per homes passed, in €	**1,379**	**1,552** (+ 12.49 %)	**801** (- 41.96 %)	**425** (- 69.19 %)

Table A I-8: Average investment P2P – hand-over at MPoP

Av. Investment per homes passed, 50 % market share, in €					
P2P - DE - MPOP					**P2P - DE**
	Single fibre case	Multi fibre case			Multi fibre case
	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres	2 Operators 2 Fibres
Investment per homes passed, in €	**1,452**	**1,786** (+ 22.94 %)	**943** (- 35.11 %)	**521** (- 64.13 %)	**894** (- 38.44 %)

Annex II: Tables with critical market shares

Table A II-1: Critical market share PON – hand-over at distribution point

Critical market share					
PON - DE - DP					
Cases		Single fibre case	Multi fibre case		
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Dense Urban	0.3%	**33%**	**39%**	**20%**	**12%**
Urban	2.4%	**49%**	**56%**	**29%**	**18%**
Less Urban	13.7%	**67%**	**77%**	**39%**	**23%**
Dense Suburban	18.5%	**70%**	**79%**	**41%**	**26%**
Suburban	25.1%	**85%**	**96%**	**51%**	**32%**
Less Suburban	37.4%	n.v.	n.v.	**70%**	**43%**
Dense Rural	71.5%	n.v.	n.v.	n.v.	**71%**
Rural	100.0%	n.v.	n.v.	n.v.	n.v.

n.v. = Not viable

Table A II-2: Critical market share P2P – hand-over at distribution point

Critical market share					
P2P - DE - DP					
Cases		Single fibre case	Multi fibre case		
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Dense Urban	0.3%	**38%**	**48%**	**25%**	**16%**
Urban	2.4%	**56%**	**68%**	**35%**	**22%**
Less Urban	13.7%	**78%**	**92%**	**47%**	**28%**
Dense Suburban	18.5%	**82%**	**96%**	**51%**	**32%**
Suburban	25.1%	n.v.	n.v.	**63%**	**41%**
Less Suburban	37.4%	n.v.	n.v.	**86%**	**55%**
Dense Rural	71.5%	n.v.	n.v.	n.v.	**89%**
Rural	100.0%	n.v.	n.v.	n.v.	n.v.

n.v. = Not viable

Table A II-3: Critical market share PON – hand-over at MPoP

Critical market share					
PON - DE - MPOP					
Cases		Single fibre case	Multi fibre case		
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres
Dense Urban	0.3%	**33%**	**39%**	**18%**	**9%**
Urban	2.4%	**49%**	**56%**	**25%**	**12%**
Less Urban	13.7%	**67%**	**77%**	**34%**	**17%**
Dense Suburban	18.5%	**70%**	**79%**	**36%**	**18%**
Suburban	25.1%	**85%**	**96%**	**44%**	**21%**
Less Suburban	37.4%	n.v.	n.v.	**59%**	**29%**
Dense Rural	71.5%	n.v.	n.v.	**89%**	**43%**
Rural	100.0%	n.v.	n.v.	n.v.	**92%**

n.v. = Not viable

Table A II-4: Critical market share P2P – hand-over at MPoP

Critical market share						
P2P - DE - MPOP						**P2P - DE**
Cases		Single fibre case	Multi fibre case			Multi fibre case
Cluster	Accumulated Customer Base	1 Operator 1 Fibre	1 Operator 4 Fibres	2 Operators 4 Fibres	4 Operators 4 Fibres	2 Operators 2 Fibres
Dense Urban	0.3%	**38%**	**57%**	**25%**	**12%**	**22%**
Urban	2.4%	**56%**	**78%**	**34%**	**16%**	**31%**
Less Urban	13.7%	**78%**	n.v.	**44%**	**21%**	**41%**
Dense Suburban	18.5%	**82%**	n.v.	**50%**	**24%**	**45%**
Suburban	25.1%	n.v.	n.v.	**61%**	**29%**	**55%**
Less Suburban	37.4%	n.v.	n.v.	**82%**	**39%**	**75%**
Dense Rural	71.5%	n.v.	n.v.	n.v.	**58%**	n.v
Rural	100.0%	n.v.	n.v.	n.v.	n.v.	n.v

n.v. = Not viable