Do NGAN Economics Allow for Network Competition?

Bruno SORIA & Félix HERNÁNDEZ-GIL
Telefónica

Abstract: This article analyses whether the economics of Next Generation Access Networks for broadband services allow for the market to be competitive in Europe in absence of *ex ante* regulation of wholesale network access. This is done by two methods: cost modelling of operators with different technologies and market shares, and the review of market entry decisions by European operators. Both methods arrive at the same conclusions: a) network economics allow competition in most geographic areas between two to four operators; b) the economics of NGANs will lead to different industry structures in different geographic areas; c) even where there is not a pre-existing cable operator, other entrants can successfully deploy their networks and challenge the incumbent telecommunications operator; and d) price levels and availability of ducts greatly increase the degree of potential competition.

Key words: regulation, competition, broadband, access networks, fibre optic.

In this article, we intend to discuss the feasibility and sustainability of network competition between several fibre-based telecommunications access networks. Given that previous research has proved that competitive conditions (and therefore, expected industry structures) will be very different in different geographic settings [1], this analysis, to be relevant, has to be conducted in geographically homogeneous areas, thus usually requiring to divide a country into several sub-markets [2].

Infrastructure competition exists in most of Europe with current broadband technologies (DSL, cable, UMTS, satellite and other wireless). This is not surprising, for in free markets competition is in general feasible where no legal limitations to entry and exit are in place. However, sometimes economic entry barriers may impede competition because they grant to the

[1] As an example, see SORIA & HERNÁNDEZ-GIL (2008).

[2] This has led several European National Regulatory Authorities to define several geographic sub-markets to analyse competition in broadband markets. This has already happened in the United Kingdom and Portugal and to a lesser extent in Austria, and is the ordinary practice in the USA (SORIA, 2008).

incumbent provider insurmountable advantages. There is fear in some circles that the renewal of access networks with NGN technologies may be such a case, for it might modify the economics of the business to the degree of making platform competition impossible in many places of Europe.

Therefore, we will focus on finding an answer to the question: *is there any economic obstacle that prevents more than one network operator from operating a fibre-based network with a sustainable business plan* [3] *in the same geographic area?* We have analysed this issue in Telefónica's regulatory team. This article presents a summary of our findings:

- In the first part, we perform a cost modelling analysis of several technologies to explore the conditions under which the cost advantage of the largest player is contestable by smaller players or new entrants.
- In the second part, we check whether the actual behaviour of players in the markets in which NGAN deployment has already begun is consistent with the patterns that we can infer from the conclusions of the cost modelling.

To finish, we extract some conclusions and implications for the economic and regulatory debates underway.

We follow a technology neutral approach, thus defining a given service performance and after that modelling the costs of an operator that wishes to provide this service using any technology that supports it. We consider three wireline technologies: FTTH, VDSL (FTTN) and HFC with DOCSIS 2.0 or 3.0 cable modems. When considering NGAN services in the range of 20 Mbps, we also take into account wireless technologies (such as WiMAX [4]). To ensure that the results do not depend on specific know-how from a company, we have chosen COSTA, a cost model that uses publicly available network modelling algorithms and prices from public sources (manufacturers or consultant reports). The analysis covers a number of the most representative scenarios in Europe, and their conclusions are valid for these scenarios. It is not intended to be comprehensive, and it cannot be ruled out that in other geographic or service scenarios the results be different.

---

[3] We consider a business plan to be sustainable if the ordinary operations of the company can generate, over the lifetime of the network assets, a return on the capital invested that is equal or higher than the cost of capital.

[4] We have used WiMAX because LTE economics are not yet well known. Since most of the network elements are the same or very similar, we expect LTE costs to be quite in line with WiMAX ones. However, this point will need an update in one or two years' time.

■ Network cost modelling [5]

Analysis of cost functions

Analytical tools: the COSTA model

There are several potential analytical approaches to the assessment of the prospective industry structure after the introduction of NGN technology. We have chosen the analysis of potential end games after the full replacement of current networks by NGN technologies. To assess the impact of NGANs in market structure, the cost functions of operators running NGAN networks of different technologies at different penetration and market share points have been obtained using the COSTA model, an engineering model developed by Universidad Politécnica de Madrid [6] with support from Telefónica. Cost data for different scenarios have been afterwards fed into simple profitability analyses to assess the sustainability of operators with different market shares and technologies. COSTA model calculates the monthly network cost of a broadband access connection using one of three NGAN technologies: fibre (FFTH –GPON- or FTTN[7] -VDSL2-), cable (DOCSIS 2.0 and 3.0) or wireless (WiMAX). Current non-NGAN technologies like ADSL or GPRS are not included in the current version. Capex and Opex data are also produced. COSTA model calculates cost functions for five different geographic settings, defined by their population density: Dense urban, Urban, Suburban, Rural and Sparse rural. It assumes flat terrain and a uniform distribution of homes within an area comprising 65,000 customer premises. All homes are passed, but the cost of vertical connection and in house equipment is only incurred when the customer is connected. Since these hypotheses are very favourable, but affect in a very similar manner all technologies, the results usually explain correctly the relationship between technologies in real world situations, but underestimate to a certain degree the actual costs.

---

[5] We summarise in this section the analysis that we already presented in SORIA & HERNÁNDEZ-GIL (2008) and our contributions to the economic annexes of ETNO (2008) and ETNO (2009).

[6] Specifications and definitions of COSTA model (*COSTes de redes de Acceso* –COST of Access networks) can be found at http://www.gtic.ssr.upm.es/costa/costa.html.

[7] We refer to VDSL2 technology as FTTN in general, because depending on home density and service penetration the node where VDSL equipment is hosted could be located in the building's basement (FTTB), in the curb close to the building (FTTB) or in any other place.

Relevant unit of analysis

Differences between geographic areas

The first result that the model yields is that the economics of NGAN are very different in different geographic areas, to the extent that the expected industry structures are very different. Cost leaders are not likely to be the same, for they use different technologies, and the different inflection points at which economies of scale exhaust allow for a different number of operators to be in a position of cost parity. If the case of standard speed Internet connections is considered, fixed networks are likely to be more successful in high density areas, whilst wireless are best suited for rural ones. The main conclusion is that, since the economics of NGANs are so different from area to area, every kind of geographic area has to be analysed in a separate way.

Differences driven by service or connection speed

The type of service that users demand also impacts on industry structure. In addition to different cost functions for the same technology when delivering different services, the platforms available for different speeds are not the same. For example, wireless technologies can deliver speeds below 20 Mbps, but not (yet) higher. Therefore, markets in which customers demand different speeds should also be analysed separately.

■ Specific analysis: very high speed services in urban areas with uniform customer demand

The analysis of the sustainability of infrastructure competition has to be done separately for different geographic areas and service features. For the sake of brevity, one area and service type will be analysed. We find urban and dense urban areas to be the most relevant, since together they amount for more than one half of the European population and are the ones in which infrastructure competition has usually existed for the longer time (normally between DSL and cable), and therefore the ones in which any eventual threat of diminished competition because of NGAN deployment could have the highest impact. Dense urban areas [8] need not a thorough analysis, for competition between several fibre networks already exists in many European cities, where metropolitan fibre operators like Colt, Verizon or utility-backed city carriers compete with the incumbent telephone operator and usually also with one cable. Our analysis will therefore focus in urban areas [9]. As for service speeds, we have seen that medium and basic speeds leave room for more competition because of wireless networks. Since very high speed services are the ones in which fewer platforms could compete, very high speed services (100 Mbps connections) were selected to be sure that the most difficult scenario was covered. We have also assumed that all customers demand the same speed. As can be seen in SORIA & HERNÁNDEZ-GIL (2008), when customer demand is more heterogeneous, there is room for more operators than otherwise. Therefore, we can also assume that if there is room for competition at high speeds with homogeneous demand, the degree of competition will be equal or higher as demand becomes less demanding or more heterogeneous. Of course, additional analyses have to be conducted for other geographic and service scenarios in due time.

Greenfield scenario

The scenario of full infrastructure construction (greenfield) will be analysed as the base case. As we showed in SORIA & HERNÁNDEZ-GIL (2008) cable reaches minimum cost at a penetration /market share lower than fibre networks. This suggests that cable operators can have a first mover cost advantage if they deploy their networks before the incumbent telephone operator or the unbundlers. We can also see that price is an important driver of the number of operators that can profitably compete in a market at any given service take up rate. Because of economies of density [10] in the left part of the cost curve, low prices will increase the minimum size needed to make a profit.

---

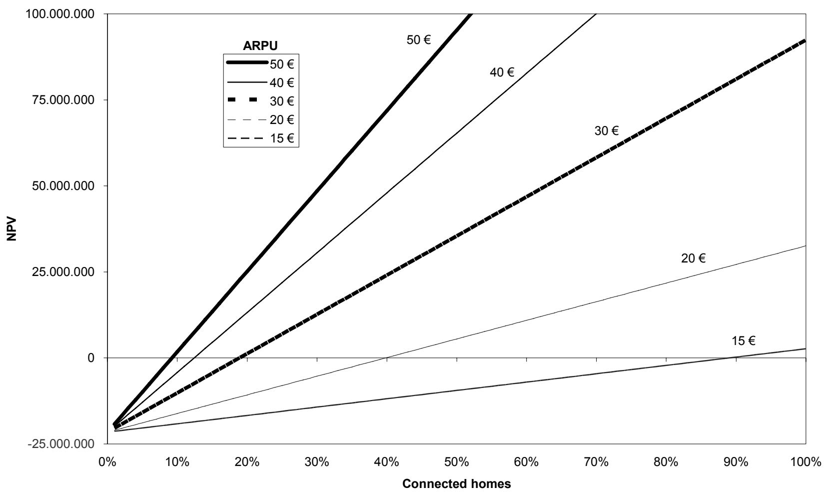
[8] COSTA model, following the criteria of the European project MUSE, takes a density of 7,187 user locations per km^2 for dense urban areas.

[9] COSTA model, following the criteria of the European project MUSE, takes a density of 3,116 user locations per km^2 for urban areas

[10] Density economies are a particular case of scale economies, which are constrained to a given area. Within this area, the highest the number of customers, the lowest the unit cost, but having a large scale in one area does not confer any cost advantage in another one.

When we model the impact of price levels in the market structure, we see that the maximum potential number of profitable operators decreases sharply with average revenue. Next figure shows the NPV of full infrastructure-owning fibre operators in an urban area that offer 100 Mbps service at different wholesale ARPU levels [11] over a 15 year period. The minimum number of connected homes [12] that an operator needs to get to be able to break even is not very high for wholesale ARPUs of 30 euros and above, but increase sharply below those revenue levels.

Fig. 1 - Break even analysis – Urban FTTH operators 100 Mbps



This means that the maximum number of competing operators (assuming equal market shares and 100% service penetration), depending on the revenue per connection, is not only greater than one, but might be very high. Since penetration is not likely to be universal nor market shares to be equal, when the penetration rate of the service is taken into account, a potential number of market structures arise. It may be seen in figure 2 that, the higher the total penetration rate, the higher the number of potential profitable network competitors. However, it should not be forgotten that, a low penetration rate of high speed services means that there are many customers purchasing lower speed services, which in turn can make profitable other operators running cheaper, lower performance technologies.

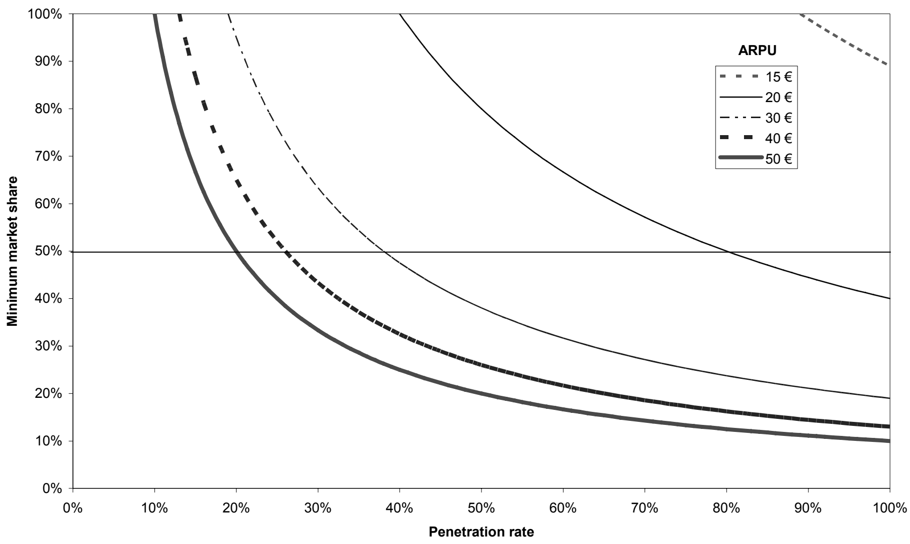
---

[11] Assuming a WACC of 10%, thanks to no regulatory risk.

[12] This number is related to market share and total service take up by a simple formula: *Connected homes$_i$ = Total connected homes * Market share$_i$*.

Infrastructure competition in the case of low penetrations will then be more inter-modal than intra-modal. It can be concluded that, for realistic penetration rates and ARPU levels, cost functions do not impede sustainable competition between *several* fibre operators in a Greenfield scenario.

Fig. 2 – Profitability threshold for FTTH operators – Urban area, 100 Mbps



The impact of duct ownership and access to third party ducts

Up to this point, we have analysed a Greenfield case. However, this is rarely the case. There is usually some infrastructure in the ground that can be used or re-used to build the NGN. This is especially true for passive infrastructure: ducts, poles, manholes, street cabinets, base station sites and antennae masts, that count for most of the investments needed. Operators deciding to build a new network are motivated to use existing passive infrastructure to reduce their investments, willing to reimburse the passive infrastructure's owner for the use. [13] A market for passive infrastructures can develop without regulatory intervention simply because of the economics of their owners' businesses: (i) ducts are a capital intensive asset with (ii) strong economies of density, and in which, provided there is spare capacity, third party fibre cables can be roomed at (iii) a very low incremental cost.

---

13 By "reasonable" we mean a price that allows the infrastructure owner to cover all its costs (including costs of capital), but not to make a monopoly profit on infrastructure leases.

Therefore, any lease revenue will have a strong beneficial impact in the duct owner's margins. Ducts that have already been used to deploy fibre optic cables include electricity cables and poles, sewers, service galleries, water, oil and gas pipes, railway and road tunnels, etc. For example, Fastweb deployed its fibre optic network in Milan by using the rights of way of utility company AEM, and Free is using municipal ducts alongside tramway tracks in Montpellier.Telecommunications regulatory authorities may also impose the mandate to lease space in their ducts to competing fibre operators as a remedy to operators that have been found to have SMP in a relevant market. For the sake of the economic argument, it makes no difference whether this offer is a commercial one or has been imposed to telephone operators or other utilities by regulators.

When the availability of existing civil infrastructure is taken into account, relevant changes in the cost and profitability of operators happen with relation to the Greenfield base case. Two different situations are analysed: that of an incumbent operator that already owns the ducts needed to deploy an NGN, and that of a new entrant that leases the ducts it needs. In this case, in order to perform a robust analysis, a lease price of 6 euro/metre of duct is considered, which is well above the lease prices that are charged in most markets.

To simplify the presentation of the results, three revenue scenarios were considered: (i) a premium, (ii) a medium and (iii) a basic ARPU [14]. In the case of premium ARPU, it can be seen that the financial prospects for both incumbents and new entrants are a great improvement over the Greenfield scenario (figure 3). Cable operators consolidate a very advantageous position, whilst incumbent and alternative fibre operators have very similar business cases, as leasing ducts allows new entrants to reap significant savings in capital and/or interest cost because they have to finance a much smaller upfront investment, even if they incur some increase in their operational expenses. When this data is used to calculate the profitability threshold for competitors to be viable, the competitive conditions also improve. In the premium scenario, the minimum market share for a FTTH operator (incumbent or new entrant) to become profitable falls from 37% to 23% at penetration rates as low as 30% (figure 4).

14 "Premium" (customers which make full use of advanced services enabled by fibre) are assumed to yield a wholesale ARPU of 50 euro; "Medium" (customers that value the enhanced performance of fibre to deliver the current broadband service suite) at 40 euro; "Basic" (other customers) at 30 euro.

Fig. 3 – Break even analysis – Urban area 100 Mbps, Premium ARPU

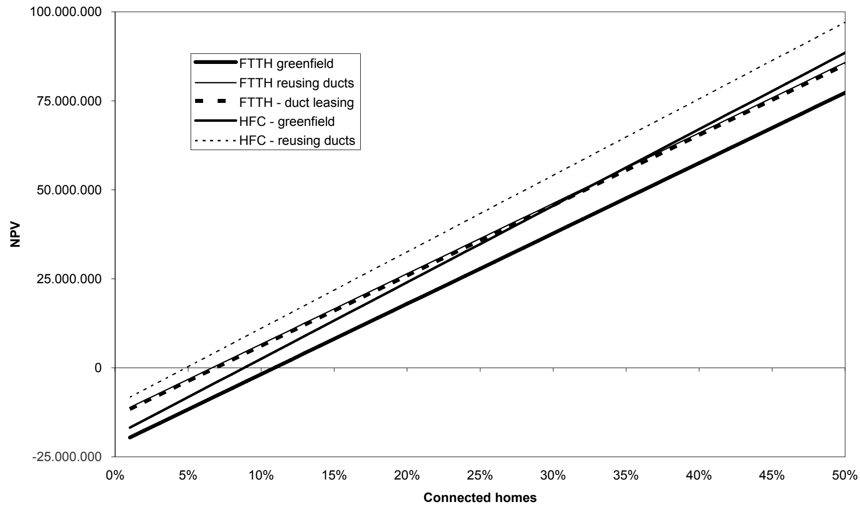
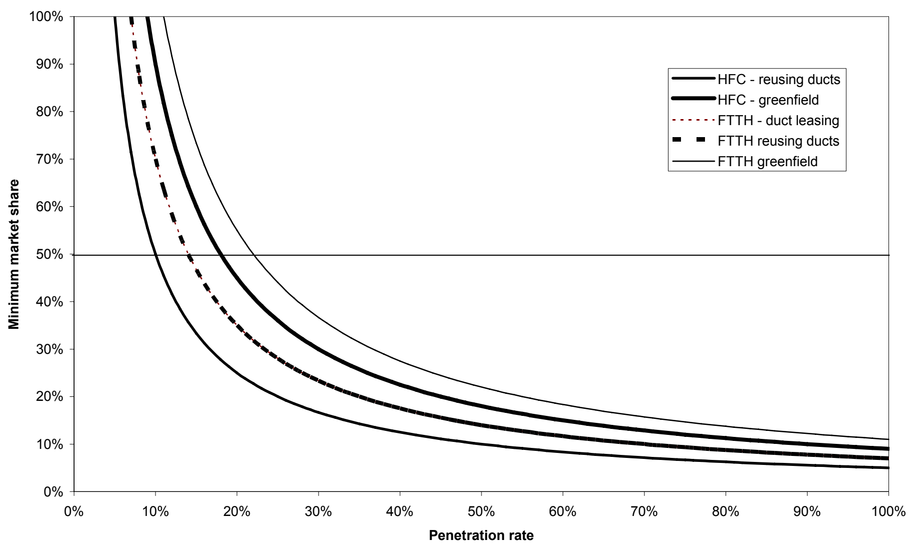
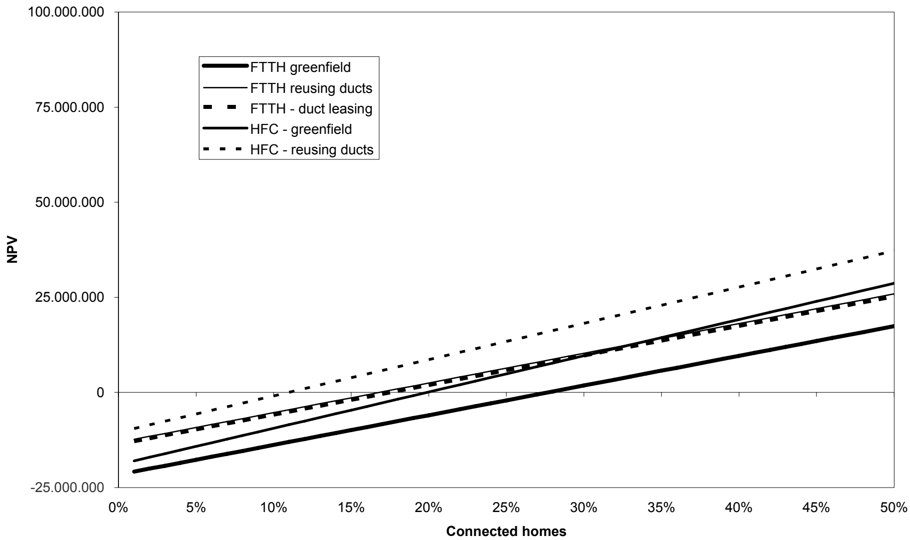


Fig. 4 – Profitability threshold – Urban area, 100 Mbps, Premium ARPU



Of course, lower revenues would diminish the number of competitors, but not necessarily impede competition. The analysis for basic monthly revenues (figure 5) shows that the availability of ducts greatly enhances the profitability of all operators and lowers the market share to break even. This makes room for competition at penetration rates around 40%, especially where there is already competition between cable and DSL.

Fig. 5 – Break even analysis – Urban area 100 Mbps, Basic ARPU



We shall now provide an estimate about by how much the number of sustainable competitors can increase when access to ducts is available. For the sake of simplicity; we assume all operators use FTTH GPON network architecture. Potential supply by other operators is taken into account by considering a total FTTH service take up of 50%, which is similar to the current average broadband penetration levels in Europe. The rest of households are supposed to either use cable modem access using DOCSIS 3.0, mobile-only broadband access, legacy DSL access where available, or to not use broadband at all. To consider the impact on competition of those other providers, we add 0-1 operators to the FTTH ones in the "other" column. This gives us a low threshold of the number of operators.

To test the impact of duct access in the degree of competitive rivalry in the market, the COSTA model was run to find the break even point of fibre operators, i.e. the minimum percentage of premises in a given area that an operator needs to have as customers in order to become net present value (NPV) positive in a 15 year period in different geographic settings and average revenue per user (ARPU) levels. After this result, the maximum number of operators [15] that a service area can sustain is calculated for several service take up levels. The results from the COSTA model show that the number of operators significantly increases with access to duct leasing in

15 Assuming that all operators have equal market shares.

all cases. For premium ARPU (Table 1), duct leasing increases the number of competitors across the board, bringing markets that already had the potential to be competitive to a high degree of intra-modal competitiveness. In the medium ARPU scenario (Table 2), duct access may bring competition to suburban areas where fibre would have otherwise competed only with high speed cable and wireless broadband, and may also greatly enhance the competitive effectiveness of urban areas. In the basic ARPU scenario (Table 3), the business case for investing in fibre networks would be more difficult to be profitable, but the competitive impact of having ducts for lease would be greater than in the previous cases. Urban areas would sustain several fibre operators (in addition to the cable one) and dense urban areas could justify investment by three fibre operators.

Table 1 – Maximum number of operators – 100 Mbps, premium ARPU, 50% penetration

Area	*Built ducts*				*Leased ducts*			
	Market share threshold	FTTH	Other	Total	Market share threshold	FTTH	Other	Total
Dense urban	18%	5	0-1	5-6	14%	7	0-1	7-8
Urban	24%	4	0-1	4-5	18%	5	0-1	5-6
Suburban	38%	2	0-1	2-3	28%	3	0-1	3-4

Table 2 - Maximum number of operators - 100 Mbps, medium ARPU, 50% penetration

Area	*Built ducts*				*Leased ducts*			
	Market share threshold	FTTH	Other	Total	Market share threshold	FTTH	Other	Total
Dense urban	24%	4	0-1	3-4	20%	5	0-1	5-6
Urban	34%	2	0-1	2-3	24%	4	0-1	4-5
Suburban	52%	1	0-1	1-2	38%	2	0-1	2-3

Table 3 - Maximum number of operators - 100 Mbps, basic ARPU, 50% penetration

Area	*Built ducts*				*Leased ducts*			
	Market share threshold	FTTH	Other	Total	Market share threshold	FTTH	Other	Total
Dense urban	40%	2	0-1	2-3	32%	3	0-1	3-4
Urban	52%	1	0-1	1-2	40%	2	0-1	2-3
Suburban	84%	1	0-1	1-2	60%	1	0-1	1-2

Discussion of other studies

These findings are in line with those of other recent studies, especially when one adjusts for the different geographic and market scenarios analyses. For example, ISDEFE (2009), a study commissioned by CMT, the Spanish NRA, assuming that duct leasing was in place, found that:

- Up to six infrastructure-based fixed NGA operators could compete in the two largest cities (Madrid and Barcelona): Telefónica, the cable operator and up to four alternative fibre operators;
- Two to four infrastructure-based fixed NGA operators could compete in cities and towns down to 1,000 inhabitants: Telefónica, one fibre alternative, the cable operator, and a second fibre alternative in large cities.

An older study by NEUMANN *et al.* (2008), commissioned by ECTA, the association of service providers over leased local networks, arrives at more restrictive conclusions about the potential for infrastructure competition in NGANs in several European countries. However, it should be noted that their results are based in very narrow assumptions, and therefore could not be valid if one or more of those assumptions are not met. In particular:

- It only considers one price scenario. As we have seen, the number of potential networks is highly dependent to variations in ARPU.
- It ignores cable networks. Since they are the best placed to migrate to NGAN, this understates the number of networks and the extension of competitive areas.
- It applies different parameters to evaluate the profitability incumbent telephone operator and the unbundlers' business plans:
  - Even when they correctly analyse different geographic areas separately, they assume the incumbent's market share to be the average national one in all areas. Since incumbents usually have a much higher share in rural areas and much lower in urban ones, this understates the potential for urban competition.
  - Instead of assessing all business cases on their own merits, they also consider the sources of financing of the incumbent, but not the unbundlers'. Deducting from the incumbent's investment the proceedings of the sale of central office buildings understates their investments.
  - They assume that the incumbent's WACC is lower than the unbundlers'. This is not always the case, especially when they face a strong cable company, unbundlers that subsidiaries of other countries' incumbents, or a big utility. By depressing the profitability of entrants, this arrives at a smaller number of alternative operators.

■ Analysis of actual deployment data

We would like to check with empirical data whether the conclusions of our cost model were correct. Because of the early stage of market development, no complete data about NGA market structure exist yet. Industry structure is the result of the interaction between supply (entry decisions plus subsequent commercial competition) and demand. At this stage, only the entry decisions can be observed. Therefore, we will review in this section whether the entry decision pattern is consistent with the pattern that can be inferred from the results of our cost modelling. Of course, this does not prove or disprove our conclusions about the endgame industry structure, but at least it shows whether our conclusions about the prospects for network competition are shared by players in the industry when they decide whether, where and when to invest their money.

Expected investment behaviour of different industry players

After the findings of our cost modelling, we can infer some patterns that one will expect to see in any given market, assuming all players are rational and regulation does not favour one specific business model or operator class over the others. Our first inference is that **investors will see the market as competitive**. Therefore, several companies will invest in each area, the final number depending on geographic and market conditions. Even more, first movers will not be perceived as having an enduring advantage, and when the number of operators in a market is lower than the maximum estimated, new entrants will come to the market and invest to deploy their own networks. In second place, we infer that, given that ownership of some assets gives advantage over brand new entrants, **deployment of NGANs is likely to be done in most cases by companies that already own infrastructure assets**. However, where ducts are available for lease, or not enough industry players enter the NGAN turf, brand new entrants have an opportunity to deploy their networks and build a sustainable business case. Our third inference is that **the investment behaviour of players of different natures is likely to be different**. Different players have different assets, which deliver different synergies with different NGA technologies, which in turn offer different performance to customers. Because of that, some of them may take advantage of being first movers, whilst others might prefer to be reactive.

- Cable operators are likely to be first movers. They can achieve a better cost position than FTTH/FTTN operators and deploy NGAN services in a much shorter time. Moreover, services over DOCSIS 3.0 have lower performance at very high speeds than FTTH, especially in the uplink. Cable operators have therefore a window of opportunity to grab market share before their competitors have had material time to deploy their services.

- Since DOCSIS 3.0 equipment was available only late in 2007, cable operators in areas where other players had already deployed fibre networks by that date are likely to react quickly and upgrade their networks soon.

- Utilities will invest soon to compensate with an early entry the lead of cable and DSL operators' broadband customer base.

- Incumbent telecoms companies have no incentive to be proactive, for they suffer asymmetrical regulation and in many cases regulatory uncertainty. One would expect, therefore, that they wait before investing, until either they are deregulated [16] or they need to match the service offers of competitors that have already deployed their networks.

- Other players that do not own infrastructure assets, like broadband providers over LLU or pure start-ups, may also consider entering the market. They are likely to do so either as very early first movers, to leverage their customer base if they have access to ducts, or if only one or two infrastructure-based operators have deploying NGANs, so that the assetless operator has a good chance to be second or third in the market.

Empirical evidence of patterns of NGAN investment

As we have noted before, the only empirical data we have available at this time is the entry decisions of operators. We have reviewed the evidence of the launch of NGAN deployment in 11 European countries. Specifically, we have used the number of operators in each market, their initial business and the launch dates to check whether:

- there are several operators competing in each area,
- companies entering the market own assets reusable to NGANs,
- the time of entry of the players of each type is consistent with the generic strategies identified in the previous section.

16 This could be observed in the USA, when the biggest incumbent telcos (Verizon and AT&T) began the massive deployment of their NGANs just after the FCC deregulated their broadband offers and fibre networks in 2003.

Table 4 - Summary of entry decisions

	Several operators	*No entrants w/o network assets*	*Cable/utility first movers*	*Incumbent telco reacts*	*Incumbent cable reacts*
Germany	√	√	√	√	X
Portugal	√	X	X	X	√
Italy	√	√	√	√	N/A
France	√	X	√	√	N/A
Switzerland	√	√	√	√	√
Netherlands	√	X	√	√	√
Denmark	√	√	√	√	N/A
Belgium	√	√	X	X	√
Spain	√	√	√	√	N/A
United Kingdom	√	√	√	√	N/A
Czech Republic	√	√	√	√	√
Total	11/11	8/11	9/11	9/11	5/6

The results from this analysis are summarised in Table 4 (the detailed data tables for most countries can be seen in Annex). According to these results, NGAN deployment in most countries is happening in a way consistent with the patterns predicted by our cost model. In addition to the finding that there is competition in areas of all countries, it should be noted that several cities have already more than two NGAN operators. In addition, we can also note that several operators have deemed entry to be feasible even when there is (or are) other ones already in the market, for they have deployed NGANs one or more years later than their competitors.

Table 5 - Selected European cities with more than 2 NGAN networks

City	*Operators*		
	FTTX	*Cable*	*Total*
Paris (France)	3	1	4
Hamburg (Germany)	2	1	3
Lisbon (Portugal)	2	1	3
Amsterdam (NL)	2	1	3
Porto (Portugal)	2	1	3
Pilsen (Czech Rep.)	2	1	3
Brno (Czech Rep.)	2	1	3

■ Conclusions and implications

The economics of NGANs allow for competition between several very high speed broadband operators, each of which with its own network, at least in geographic areas where most of the European population lives, even absent any access regulation. Industry structure is expected to vary greatly with population density, ARPU, service take-up, user demand requirements and the availability of civil infrastructure.

- Population density and user requirements will drive which technologies have the best cost position, thus allowing very different industry structures in different areas
- The higher the ARPU, the service take-up and the availability of civil infrastructure, the more potentially competitive a market becomes.

The availability of ducts greatly increases the room for competitive rivalry in a given market. This is valid both when ducts are reused from existing activities (telecommunications or non-telecommunications) of the NGAN operator, and when the ducts can be leased in reasonable terms from their telecommunication or non-telecommunication owners.

These conclusions may have implications in the regulatory processes:

- Differential regulatory treatment to different geographic areas will be in line with the underlying economics of NGNs. Market analyses should therefore be performed separately for sub-national markets with homogeneous competitive situations.
- Regulatory authorities should expect market analyses to arrive at the conclusion that there is not any operator with significant market power in many sub-national markets.
- In the cases when a market analysis considers to have found significant market power in a broadband operator, imposing to it (and eventually to other duct owners) the obligation to lease them in reasonable terms to other NGAN operators could be a sufficient remedy to make the market competitive enough in most areas. Where there are no ducts and/or population density is very low, the competitive potential of wireless networks should also be taken into account.

* * *

Annex: data on NGAN deployment in Western European countries

Germany

In some areas, like Hamburg, three networks compete: FTTH (Hansenet), FTTN (DT) and HFC (Kabel Deutschland). Late entry by cable operator, in some cases as the third player, shows that investors do not see two existing players as an insurmountable entry barrier.

Table 6 - NGAN deployments in Germany

Entry order	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover	Telephone	DT	FTTN-VDSL	2005	8,300,000	600,000
2nd mover (*)	Utility	Net Cologne	FTTB	2006	150,000	23,000
	Utility	Wilhelm Tel	FTTH	2005	100,000	25,000
	Utility (**)	Hansenet	FTTH	2007	50,000	5,000
	Municipality	M-Net	FTTB	10/2007	110,000	9,000
3rd mover	Cable	Kabel Deutschland	HFC	02/2010	n/a	n/a

(*) We treat all those entrants as second movers because their coverage areas do not overlap in general, with minor exceptions in Hamburg.
(**) HanseNet Telekommunikation GmbH's original shareholders were e.Biscom S.p.A., Milan holding 80% and Hamburgische Electricitäts-Werke (HEW) holding 20% of the shares. It was subsequently sold to telecommunications operator Telecom Italia and afterwards to Telefónica.

Source: IDATE, company websites

Portugal

Table 7 - NGAN deployments in Portugal

Order of entry	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover	Telephone	PT	FTTH	2007	70,000	5,000
2nd mover	ULL	Sonaecom	FTTH	9/2008	60,000	6,000
3rd mover	Cable	Zon	HFC	02/2009	100,000	8,000

Source: IDATE, company websites

Italy

Alternative operators made a very early bet on FTTH technologies to compete with the incumbent Telecom Italia, which took several years to react.

Table 8 - NGAN deployments in Italy

Order of entry	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover (*)	Utility	Fastweb	FTTH	2003	2,000,000	300,000
	Municipality	TerreCablate	FTTB	2004	91,000	20,000
2nd mover	Telephone	Telecom Italia	FTTN – VDSL	2007	30,000	3,000
3rd mover	ULL/mobile	To be defined (**)	FTTH	TBD (announced 2010)	0	0

(*) We treat both entrants as first movers because their coverage areas do not overlap.
(**) At present time, this project is just an announcement from Fastweb, Vodaphone and Wind.

Source: IDATE, company websites

In 2010, the main alternative operators in Italy (Fastweb fixed, Vodafone and Wind mobile) announced a plan to jointly build a FTTH network to compete with Telecom Italia's. Since no final plan has been unveiled, no financial commitment has been made by current partners, and the project is still open in principle to the participation of Telecom Italia, it cannot be assessed at this time what the potential impact of this project will be in the market. We can nevertheless conclude that alternative operators consider that there is a positive business case for a second/third NGA network in several parts of Italy.

France

Availability of third-party ducts for lease has eased the entry of two ULL players. Investors consider that a city like Paris can sustain four fibre network operators.

Table 9 - NGAN deployments in France

Order of entry	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover	Cable	Numéricable	HFC	06/2006	4,100,000	175,000
2nd mover	ULL	Iliad	FTTH	09/2006	350,000	15,000
3rd mover	Telephone	France Télécom	FTTH	12/2006	582,800	30,700
4th mover	ULL	SFR/Neuf	FTTH	2007	350,000	30,000

Source: IDATE, company websites

Switzerland

In some areas, like Zurich, three networks have been deployed. It is interesting to note that Swisscom has first deployed VDSL as a quick, but temporary solution to countervail the threat from alternative operators, and has afterwards undertaken the building of a more performing FTTH network.

Table 10 - NGAN deployments in Switzerland

Order of entry	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover	Utility	TV Sierre Vario	FTTH	3/2007	6,200	3,000
2nd mover	Telephone	Swisscom	VDSL FTTH	7/2007 7/2008	2,740,000	336,000
2nd mover (*)	Utility	ewz.zürinet	FTTH	10/2007	15,000	1,500
3rd mover	Cable	Cablecom	HFC	2009	1,000,000	0 (**)

(*) We consider ewz.zürinet as second mover because the absolute first mover (TV Sierre Vario) has no coverage in Zürich, and therefore in its coverage area Swisscom was actually the first mover.
(**) Cablecom's Fibre Power service was only launched in September 2009.

Source: IDATE, company websites

The Netherlands

Interestingly, first movers in the Dutch market were companies from outside the broadband and utility markets. This is not contradictory to our modelling; as cables are not conveyed through ducts in the Netherlands, but usually just buried in the ground, existing ducts or cables do not bring such a large cost advantage as in the rest of Europe. Cable and telecommunications incumbents reacted, and it should be noted that KPN chose to acquire a stake in new entrant Reggefiber rather than upgrading its existing copper network.

Table 11 - NGAN deployments in The Netherlands

Order of entry	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover	Start-up	Reggefiber	FTTH	2005	400,000	120,000
2nd mover	Other	Portaal (*)	FTTH	2006	55,000	15,000
3rd mover	Municipality	Amsterdam CityNet	FTTH	2007	44,000	N.a. (**)
4th mover	Cable	UPC	HFC	03/2008		
5th mover	Telephone	KPN	FTTH	05/2008 (***)	400,000	120,000

(*) Portaal is a Dutch social housing association
(**) Amsterdam CityNet sells only wholesale services.
(***) KPN did not launch FTTH services using its preexisting network assets, but by entering an agreement with Reggefiber. Figures for both companies are those of Reggefiber.

Source: IDATE, company websites

Denmark

There are also several players, although the fact that TDC owns both the copper pair and cable networks reduces the number of potential entrants.

Table 12 - NGAN deployments in Denmark

Order of entry	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover	Utility	TRE FOR	FTTH	2006	60,000	15,000
2nd mover	Utility	SEAS-NVE	FTTH	07/2006	52,000	10,500
3rd mover	Utility	Dong Energy (*)	FTTH	2007	150,000	22,000
4th mover	Telephone/Cable	TDC	FTTN-VDSL	1/2008	80,000	30,000

(*) TDC acquired Dong Energy operations in 2009

Source: IDATE, company websites

Belgium

As in the case of Swisscom, Belgacom has decided to upgrade its network in two stages: a first, quick upgrade to VDSL, and eventually a migration to FTTH.

Table 13 - NGAN deployments in Belgium

Order of entry	*Existing business*	*Operator name*	*Technology*	*Date of launch*	*Homes passed (Jun '09)*	*Subscribers (Jun '09)*
1st mover	Telephone	Belgacom	FTTN-VDSL FTTH	02/2008 10/2008	65% 800	N/A (*) 50
2nd mover (**)	Cable	Telenet	HFC	2008	2,000	1,950
	Cable	Brutélé/VOO	FTTH	2009	1,000	400

(*) Belgacom does not disclose the technology it uses to deliver services to its customers
(**) We consider both cable operators as second movers because their coverage areas do not overlap

Source: IDATE, company websites

Bibliography and References

Analysys (2007): Analysys Consulting, *The business case for sub-loop unbundling in the Netherlands*, report for OPTA, 26 January 2007.

Analysys Mason (2008): *The business case for fibre-based access in the Netherlands*, final report for OPTA, July 24.

AMENDOLA, G.B. & L.M. PUPILLO (2008): *The economics of Next Generation Access networks and regulatory governance: Towards geographic patterns of regulation*; in: *Communications & Strategies*, no. 69, 1st quarter 2008, p. 85.

BAUMOL, William J., PANZAR, John C, & WILLIG, Robert D. (1982): *Contestable Markets and the Theory of Industry Structure*, Harcourt Brace Jovanovich, New York, 1982.

EISENACH, Jeffrey A. (2008): *Broadband Policy: Does the US Have It Right After All?*, The Progress & Freedom Foundation, Washington DC, 2008.

ETNO (European Telecommunications Network Operators' Association):

- (2008): *ETNO Reflection Document in response to the Commission Recommendation on regulated access to Next Generation Access Networks (NGA) – RD295*, Brussels, November 2008.
- (2009): *ETNO Reflection Document in response to the Commission Recommendation on regulated access to Next Generation Access Networks (NGA) – RD307*, Brussels, July 2009.

IDATE (2009): *FTTx Watch Service 2009 - Database Markets*, Montpellier, 15 November 2009

ISDEFE (2009), "Final report on the results of the deployment model for FTTH/GPON networks in Spain. Deployment model for FTTH/GPON networks in Spain", Madrid, May 2009.

KATZ, Raul L. (2008): *La competencia entre plataformas: Teoría y resultados (Facilities-based competition: theory and results)*, ENTER, Madrid, 2008. http://www.enter.ie.edu/enter/cms/en/informe/4979/1

MUELLER, Milton L. (1997): *Universal service: competition, interconnection and monopoly in the making of the American telephone system*, AEI studies in telecommunications deregulation, The MIT Press, Cambridge (Mass).

NEUMANN, Karl-Heinz *et al.* (2008): *The Economics of Next Generation Access: Final Report*, WIK-Consult GmbH, Bad Honnef, Germany.

SORIA, Bruno:

- (1999): *Viabilidad de la competencia en las telecomunicaciones locales del mundo (Viability of competition in local telecommunications around the world)*, doctoral thesis, Universidad Autónoma de Madrid, Madrid.
- (2008): "La diferenciación geográfica de la regulación en Europa y los Estados Unidos" (Geographic differentiation of regulation in Europe and the United States),

Regulatory and Economic Policy in Telecommunications Review, issue 1, Madrid, September 2008.

SORIA, Bruno & HERNÁNDEZ-GIL Félix (2008): *Exploring Potential Natural Monopoly Properties of Broadband Access Networks* (September 20, 2008). 19th European Regional ITS Conference, Rome, Italy. Available at SSRN: http://ssrn.com/abstract=1557843

VOGELSANG, Ingo & MITCHELL, Bridger M. (1997): *Telecommunications competition: the last ten miles*, The MIT Press, Cambridge (Mass).