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Carlo Cambini, Michele Polo and Antonio Sassano

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IEFE - The Center for Research on Energy and Environmental Economics and Policy at Bocconi University
via Guglielmo Röntgen, 1 - 20136 Milano
tel. 02.5836.3820 - fax 02.5836.3890
www.iefe.unibocconi.it – iefe@unibocconi.it

Fiber to the People:
the Development of the Ultra-broadband Network in Italy

Carlo Cambini (Politecnico di Torino)

Michele Polo (Bocconi University, Milan)

Antonio Sassano (University of Rome, la Sapienza)

Abstract

In this paper, we firstly revise the main technological solutions for ultra-fast broadband connections and summarize the main economic literature (both theoretical and empirical) on the role of regulation to support infrastructure investment in broadband networks We then move to the core of our analysis, that is to assess the relative positioning of the Italian market today in terms of deployment and penetration of broadband access, and then analyse the main relevant policy issues involved in the current Italian plans for broadband deployment. Our goal is to propose a policy framework for fostering the deployment of the Italian ultra-fast broadband network and evaluate the Government master plan. The analysis will also give the opportunity to provide our contribution to the current debate and to suggest how industrial policies in a market-oriented perspective should be re-considered.

Keywords: Broadband network, regulation and investment, state aids

JEL Codes: L51, L52, L96

1. Introduction

Since the start of the millennium, the broadband market has been characterized by a high degree of innovation, which has led to a rapid increase in broadband adoption, and the introduction of new innovative services. While "traditional" broadband over copper or cable TV lines continues its expansion in many countries, telecommunications operators have started deploying the so-called "next generation networks" (NGNs), that is, fiber-optic access networks, to provide high-speed broadband services to consumers.

Fiber-based deployment of new broadband networks has become a major issue for regulators and telecoms companies. However, investments for upgrading the infrastructure are extremely costly and characterised by high uncertainties as regards future demand and regulatory policies. NGNs can be considered as a general purpose technology (Bresnahan and Trajtenberg, 1995), which may trigger productivity gains and growth across major economic sectors such as health, electricity and transport on a massive scale. Indeed, numerous studies support the view that investment in broadband infrastructures creates positive effects on the economic system leading to an increase of GDP growth. In particular, Czernich et al. (2011) show that a 10% increase in the broadband penetration rate in OECD countries results in 1-1.5% increase in annual GDP per-capita.

The European Commission (EC) has defined specific targets for the development of broadband services across Europe. The Digital Agenda for Europe (DAE) specifies goals in terms of network coverage and service adoption: the DAE "*seeks to ensure that, by 2020, (i) all Europeans have* *access to much higher internet speeds of above 30 Mbps and (ii) 50% or more of European households subscribe to internet connections above 100 Mbps*" (European Commission 2010, p. 19). Both these policy goals are strongly interrelated, since investment in next generation communications networks, i.e. network coverage, will also depend on (expected) adoption, i.e. (future) demand, which in turn will be determined by the attractiveness of NGN specific services and applications. Only if consumers consider NGN services attractive enough in terms of innovations or quality improvements compared with old broadband services, consumers will migrate to NGN.

In Italy ultra-fast broadband deployment has started on very small scale. Many operators still focus on much less cost-intense upgrades to the traditional copper technology. At the same time, the perceived benefits from those connections are not very clear to consumers and their willingness to pay to migrate to the new infrastructure remain extremely low with respect to the price of the service. In turn, this implies that also adoption, and not only coverage, of NGNs in Italy is extremely low. Hence, the Digital Agenda's goal for connection speeds above 100 Mbps is still far from being realised.

To foster NGNs' coverage and adoption, in 2015 the Italian government introduced policies to sustain investment in ultra-fast broadband connections among its top priorities. This plan was characterized by a 6,5 billion of euros state funds over the 2016-20 period to support deployment of new infrastructures across the country. This resources would also stimulate new private investment of a similar amount, for a total of 12,5 billion €.

In this paper, we firstly revise the main technological solutions for ultra-fast broadband connections (Section 2) and summarize the main economic literature (both theoretical and empirical) on the role of regulation to support infrastructure investment in broadband networks (Section 3) We then move to the core of our analysis, that is to assess the relative positioning of the Italian market today in terms of deployment (Section 4) and penetration (Section 5) of broadband access, and then analyse the main relevant policy issues involved in the current Italian plans for broadband deployment (Section 6). Our goal is to propose a policy framework for fostering the deployment of the Italian ultra-fast broadband network and evaluate the Government master plan (Section 7). The analysis will also give the opportunity to provide our contribution to the current debate and to suggest how industrial policies in a market-oriented perspective should be re-considered (Section 8).

2. Ultra-broadband connections: technological solutions

As we will better discuss in the paragraph devoted to the demand side, it is a common and widespread belief that a large percentage of traffic carried by the NGN's will be high quality Video traffic (shows, user generated contents, surveillance video, etc.) which will require an increasing number of bits to be delivered to an increasing number of High and Ultra High resolution receivers. Hence it is not surprising that the quality of NGN's is always measured in terms of capacity, i.e. the bits or megabits per second (Mbit/s) that the network will be able to deliver to each individual user.

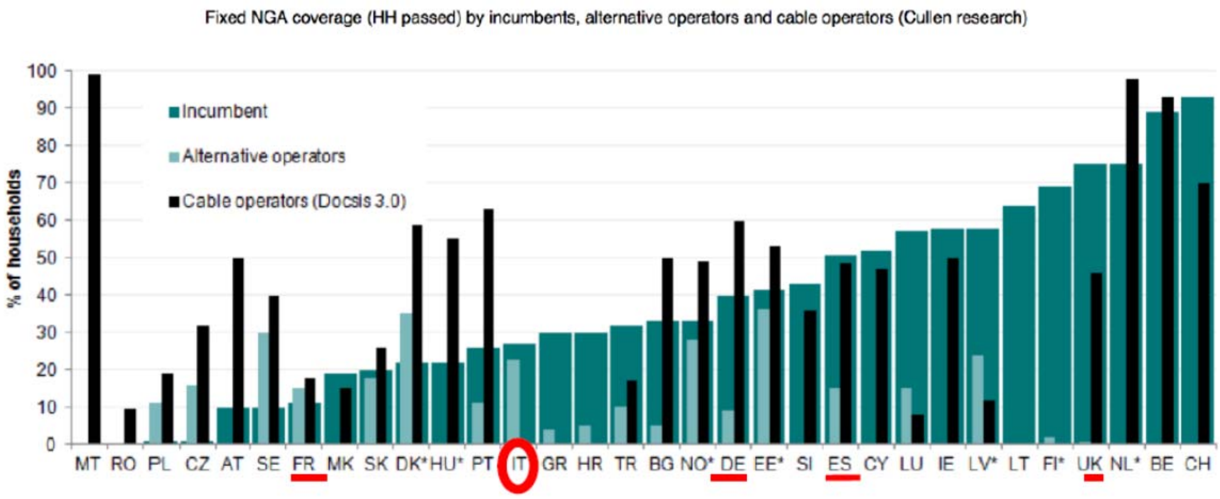
The last 15 years have seen a steady increase of the capacity deliverable over the copper legacy network. Technologies like ADSL and, more recently, VDSL2 have obtained on the old copper network, capacities that were unimaginable at the end of the last century. Today's technology is able to deliver 500 Mbit/s on copper over distances of 50/100 meters and 100 Mbit/s at 200/250 meters. As the numbers we are showing clearly indicate, the legacy copper network can sustain high capacities only on relatively short distances. Hence, the use of legacy networks as a "last mile" delivery medium requires the use of coding/decoding (active) devices in locations "not too far" from the user premises. On the contrary, the *fiber technology* allows the delivery of billions of bits per second (10 Gbit/s) to the user premises by means of long distance *glass fiber* connections. Fiber is a disruptive alternative for the legacy networks. It changes the very structure of the network. There is no more need of a high number of hierarchical structured central offices; the ideal NGN network is "flat", with a limited number of central offices directly connected by long fiber tendrils to the user premises. The so called *Fiber to The Home (FTTH)* solution is certainly future proof but also requires high investments and is disruptive for the incumbents, since the value of the "useless" legacy network is largely reduced by the advent of the NGN.

The role of drastic "game changer" of the FTTH solution has rapidly stimulated the development of an alternative technology that requires lower investments and is less disruptive for the incumbent by making a clever use of the last mile of the legacy network. The rationale behind this alternative idea is simple: let us bring the fiber to a flexibility point which is "not too far" from users premises, install active devices in the flexibility point to code/decode the digital traffic and route it through the last mile of copper (*secondary network*) by means of the VDSL2 technology (100 to 500 Mbit/s) up to the user's premises. The key question, then, becomes: where to install the active devices of this mixed copper/fiber NGN?

Indeed, within the legacy networks there is a natural candidate to this role: the *street cabinets*. In the legacy network, the street cabinet had the role of *passive flexibility point* where copper wires leading to the user premises could be properly managed and flexibly connected to a central office and, from there, to the rest of the network. The number and topology of street cabinets differ from country to country. For example, Scandinavian legacy networks, due to the harsh climatic conditions, make a limited use of street cabinets. On the contrary, Italy, Germany and UK have a fairly dense distribution of street cabinets. In Italy there are 150.000 cabinets, with an average of less than 400 users per cabinet and an average length of the secondary network around 2-300 meters. France, on the contrary, has longer secondary networks and a higher average distance between street cabinets and the users' premises.

Street cabinets are the ideal "jump off" location for the NGN last mile: they are already accepted in the urban landscape and connected to the power network and to the central offices by means of efficient ducts where fiber could be laid down at minimum cost. This development requires re-engineering the cabinet to accommodate the active coding/decoding devices. However, these additional investment costs are drastically inferior to that of bringing the fiber up to the user premises. Indeed, the *Fiber to The Cabinet* or *Fiber To The Node* (*FTTCab, FTTN*) alternatives have been adopted in recent years in several European countries like Germany, Italy and UK and, partially, in Australia where an original *FTTH* scheme, extended to the whole population, was reverted to a more rational and cheaper mixed *FTTN-FTTH* scheme.

The technological scenario is not restricted to the sole *FTTH-FTTC* feud. The cable infrastructure, widely present in US but also in Germany, Belgium, Holland and, partially, in UK had been for many decades the preferred medium to distribute TV programs. Technology, as in the case of legacy copper network, immediately answered to the “*need of survival*” of the main cable operators (like Comcast in US) by turning the coaxial cable into a powerful broadband channel, able to deliver (with Docsis 3.0 protocol) hundreds of megabits per second to the user in an effective *triple pay scheme* (*TV+telephone+Internet*). Countries like Holland, Belgium or Malta have easily reached a 100% broadband coverage of the population also thanks to their legacy cable infrastructure. On the contrary, countries where the privileged TV distribution channel has always been *wireless broadcasting*, like Italy and France, developed a limited cable infrastructure and, hence, had to rely only to the legacy telecommunication network to reach the targets of European 2020 Agenda.



The fixed network infrastructures based on different mixtures of cable, fiber and copper and in different topological scenarios like FTTH or FTTCab face a relevant weakness: *the high cost incurred by the operators in serving sparsely populated areas*. The issue is not necessarily that of areas where the average population income or the “willingness to pay” is low. Overly costly investments arise also in areas where the classical topology of the fixed networks (all of them, including NGN), based on a structure of main central offices hierarchical connected to smaller central offices and street cabinets has a roll out cost that is not recoverable on the basis of “reasonable” monthly tariffs paid by the users. These areas are often called “market failure areas” or areas in “digital divide” and it is tacitly accepted that only the public intervention can lead to the coverage of these areas with high speed broadband.

The advent of wireless technologies both *mobile* (LTE and 5th generation) and *fixed* (*Fixed Wireless Access* network that connect fixed points with wireless link) is changing this point of view. LTE (Long Term Evolution) technology makes use of larger and larger amounts of spectrum to deliver through smartphones hundreds of megabits per second in each cell. This capacity has to be shared among hundreds of users in densely populated areas but only by few users covered by a single cell in a rural or sparsely populated area. Hence, in the “market failure” areas LTE can be considered a feasible substitute of fixed copper or fiber network in terms of capacity performance, provided at a sensibly lower cost. The issue to be solved, in this perspective, will be that of finding enough spectrum and designing innovative network topologies, with the fiber brought to the transmitting antennas in a FFTAS (*Fiber To The Antenna Site*) scheme.

3. The role of regulation to stimulate ultra-broadband investment and adoption: evidence from the literature

The deployment of fiber infrastructures does not immediately replace the copper or cable legacy networks, suggesting that the transition from old infrastructures to new infrastructures will move on smoothly rather than in a jump. Replacement will be gradual for several reasons, such as: {i} the regulatory constraints on copper networks, which rule out an immediate switch-off of the old network; {ii} the uncertainties about demand and investment costs, which call for a progressive investment strategy; and {iii} the financial market constraints that imply that roll-out must be phased. Consequently, during the transition phase two different infrastructures will operate and will allow offering broadband and ultra-broadband services that are, at least in part, substitutes. Moreover, each network will be regulated with a different set of rules and access prices, affecting the commercial conditions applied to end users and the rate of migration between the old and the new infrastructure. Therefore, the incentives to invest in fiber infrastructures will be also influenced by the terms of access set for the legacy copper and new networks.

The recent theoretical literature (Bourreau, Cambini and Dogan, 2012 and 2014; Inderst and Peitz, 2012) has focused on how access regulations on the existing old network affect infrastructure investments in new networks and favour the migration at retail level form the “old” to the “new” broadband infrastructure. In particular, the analysis by Bourreau, Cambini and Dogan (2012 and 2014) points out that that the fiber coverage varies non-monotonically with the access price of the copper network. This result is due to the coexistence of three different effects. First, the *replacement effect* hinders NGN investment by alternative operators when the access price to the legacy network is low. Second, the *wholesale revenue effect* discourages the incumbent to invest in NGN when the access price to the legacy network is high (since the entrant may invest in reaction, and the incumbent will then lose some of its wholesale profits). Finally, the *business migration effect* arises when the access price to the copper network is low. In this case, indeed, the retail prices of the services which rely on the copper network are also low. Therefore, in order to encourage customers to switch from copper to fiber, operators should also offer low prices for fiber services. This effect reduces the profitability of the fiber infrastructure, and hence, the incentives to invest in it. To sum up, a low access price to the legacy network (for instance, a low price for ULL) reduces the incentives of the competitors to invest in their own new infrastructures but may induce the incumbent to invest in NGN (when the *business migration effect* dominates the *wholesale effect*). At the same time, the low access price to the legacy network allows selling basic broadband services at a low price, in turn inducing operators to reduce also the price of ultra-broadband services to final users and hence the profitability of the new infrastructure.

The related empirical literature on NGN investment (coverage) is relatively scant. Minamihashi (2012) examines whether unbundling regulations imposed on the Japanese incumbent operator prevent entrants from self-deploying new broadband infrastructure using municipal level data from 2005 to 2009. The author finds that unbundling regulations hinder entrants from investing in own NGN infrastructure. During the years analysed the incumbent’s NGN investments, however, are not discouraged by the unbundling regulations, though most of the NGN investments received public support from the government. Bacache et al. (2014) examine the incentives embedded in the EU regulatory framework on migration from old to new broadband infrastructures using biannual data from 15 European member states over the period from July 2002 to July 2010. The authors relate the number of broadband lines based on new infrastructure to the number of unbundling lines and find that unbundling regulations do not foster entrants to invest in NGN. Briglauer (2015) examines the impact of broadband regulations, including the unbundling price, on NGN investment using EU27 panel data from 2004 to 2013. The author finds that as the unbundling price increases with respect to the EU average, so does the average incentive for NGN investment.

With respect to NGN adoption, instead, academic research shows that, *inter alia*, competition and regulation in broadband markets play a crucial role. Existing empirical literature presents several contributions related to broadband markets, but only a few NGN-related publications.

Regarding broadband markets, there exist several but relatively old papers studying the determinants of broadband adoption in OECD countries. Bouckaert et al. (2010) examine the determinants of broadband adoption for the years from 2003 to 2008. They find that infrastructure-based competition has a positive impact on broadband adoption, whereas service-based competition has an opposite effect. Lee et al. (2011) analyze the determinants of broadband adoption from 2000 to 2008. The authors also show that the presence of unbundling obligations has a positive and significant effect on adoption, but they might have a negative impact on long-term investment and the broadband saturation level.

The first paper using EU data is Distaso et al. (2006) who find that infrastructure-based competition is the main driver of broadband adoption and plays a more important role than service-based competition, especially in the longer term. Höffler (2007) also examines data for sixteen Western European countries for the years from 2000 to 2004. He concludes that broadband deployment was predominantly triggered by infrastructure-based competition, with service-based competition playing a secondary role. More recently, Nardotto et al. (2015) employ disaggregated broadband data related to the old infrastructure for the UK for the quarters from December 2005 to December 2009. The authors show that unbundling in the UK resulted in no increase in broadband adoption but positively affect service quality.

The papers mentioned above shed some light on the impact of infrastructure-based competition and access regulation on standard broadband adoption. Though interesting, they are of limited interest, however, for a better understanding of NGN adoption where the presence of a relative good "legacy" infrastructure may represent a constraint to the development of NGN adoption. The papers looking at NGN demand adoption are very scant. Wallsten and Hausladen (2009) estimate the effects of broadband regulations on NGN adoption with data from EU27 countries for the years from 2002 to 2007, thus covering the very early market phase. They find that countries where unbundling is more effective experience lower NGN adoption. In this paper the authors only examine the presence of unbundling regulation but do not provide any evidence on the possible impact of unbundling access price on NGN adoption. Samanta et al. (2012) examine the demand-side determinants of high-speed broadband deployment using International Telecommunication Union (ITU) and OECD data for 25 countries for the years from 1999 to 2009. The authors employ a dummy variable to capture the extent of unbundling regulation and find that this variable has no significant impact. Jeanjean (2013) investigates the impact of unbundling access charges and the share of wholesale access lines to the total number of retail DSL lines using quarterly data covering 15 European countries for the years from 2007 to 2012. The author finds that tight copper access regulation diminishes migration towards FTTx-based broadband services. More recently, Briglauer (2014) investigates the determinants of NGN adoption for EU27 member states and finds that the more effective previous broadband access regulation is, the more negative the impact on adoption, while competitive pressure from mobile networks affects adoption in a non-linear manner implying the presence of substantial substitution between fixed and mobile connections. Finally, the author also finds evidence for substantial path dependency on ultra-fast adoption implying that the more the users switching to the new broadband infrastructure the higher is the effect of attraction for the basic broadband users.

Note that none of the above papers analyse the cross price effect of "old" network, through a change in the local loop unbundling price, on NGN adoption. This analysis is extremely important since, as the theoretical models show, consumers' migration at retail level from the standard copper infrastructures to fiber connections depends on the relative price difference between NGN retail services and standard (DSL) ones. The *business migration effect*, that is low DSL retail prices forcing cheap pricing of the NGN retail services, reduces the profitability of the new infrastructure, and hence, the incentives to switch to the new technology and invest in it (Bourreau, Cambini and Dogan, 2012 and 2014).

This implies that the access charge on copper networks (i.e. the local loop unbundling price) may considerably affect NGN adoption: assuming that the retail market for copper-based broadband services is substantially competitive, any increase in the cost of ULL price would be translated in a higher cost of the basic broadband connections, making it less attractive with respect to the new fibre based connections.

This effect is also supported by recent companies' evaluation. Telefónica de Espana – the Spanish incumbent - submitted a report to the EU investigating the effect of a reduction in wholesale prices on retail prices for DSL.[1] The study aims at estimating the "pass-on-elasticity" of a change in the wholesale price of loop access with respect to the price of broadband, considering the different ADSL connection speeds. The study shows that pass-on elasticity is always positive (as expected), but it is greater for higher broadband connection speeds. Pass-on elasticity is 0.45 for low-speed connections (144kb – 1.99MB), 0.60 for medium-speed (2MB – 9.99MB) and 0.91 for high-speed connections (10MB or more). This evidence suggests that for high-speed connections – in the analysis mostly DSL connections – changes in access prices will pass through almost entirely into changes in retail prices.

The economic literature presents limited evidence on the existence and the value of cross price elasticity of fiber adoption with respect to standard (DSL) retail price. In the paper by Srinuan et al. (2012), the authors analyze the direct and cross-price elasticity among different types of broadband technology (xDSL, cable, Fibre, mobile BB). Data was obtained from a random nationwide postal mail survey of Swedish households during August and September 2009 with around 2038 respondents. Results show that the cross-price elasticity of demand for fibre in relation to DSL price is 3.289.

[1] Solchage Recio & Asociaos (Strategic & Economic Consulting) Nov 2011, "Analysis of the relationship between wholesale and retail internet access prices". Submitted as Annex 3 of Telefónica's response to the EC Costing Methodologies Questionnaire, as cited in Dot.Econ (2012).

A recent study by Grzybowski et al. (2015) uses a large database from a survey of 6,446 households in Slovakia during April – July 2011 to estimate own- and cross- price elasticity of demand for 5 broadband technologies (DSL, fibre, cable, FWA, and mobile BB). Results show that a 1% increase in DSL price would increase demand for fibre by between 0.66% (at country level) and 0.96% (at municipality level), indicating a cross-price elasticity of demand for fibre in relation to DSL of 0.66-0.96.

These values are consistent with some recent research we carried out on the effects of migration on the incentive to adopt fibre connections by EU citizens (Briglauer, Cambini and Melani, 2015). Using data from EU27 over the period 2004-2014, their results show cross-substitution between a change in the DSL unbundling price and the adoption of fibre connection: an increase of the 1% unbundling price, our proxy for an increase in standard broadband retail price, increases NGN adoption by ~0.45%. This also implies that relaxing ULL price regulation may positively affect not only NGN investment, as expected, but also NGN adoption. However, the effect of an increase of the ULL access price appears bigger for NGN coverage than for adoption, enhancing the gap between adoption and coverage and therefore reducing the take-up rate. In other words, though it positively affects adoption and coverage of fibre connections, an increase of ULL prices may generate extra-capacity without enhancing too much ultra-broadband demand implying that, on the demand side, additional policies are needed to sustain both demand expansion and coverage.

4. Where do we stand: the supply of broadband access in Italy

The deployment of the NGN in Italy is lagging behind compared with the other major European partners. The table below, based on the Digital Agenda Scoreboard of the European Commission, reports the recent trend in the deployment of broadband and ultra-broadband networks in Italy and its relative position with respect to the EU27 average. Coverage refer to the availability of broadband and ultra-broadband connections as allowed by the deployment of the networks, and it is therefore a measure of the supply of access. In the next section we consider the demand side, based on take-up rates and penetration, discussing the evolution of customers that, having available a broadband or ultra-broadband access, indeed subscribe for access.

Table 1 shows that while on broadband coverage Italy is in line with the EU27 average, the gap is substantial once we move to NGN's, available in 2014 to 36% of the households, about half of the EU28 average.

Table 1 – Coverage of the broadband and ultra-broadband networks in Italy

	Italy				EU27	Italy ranking among EU28
	2011	2012	2013	2014	2014	2014
Fixed Broadband coverage (% of HH)	*99*	*99*	*99*	*99*	*97*	*11*
Ultra-broadband coverage (% of HH)	*11*	*14*	*21*	*36*	*68*	*27*

The development of the NGN in Italy has been mainly based on the investments of private operators and has benefited by an effective use of the European funds in the southern regions. In the city of Milan (and more recently in the cities of Genova and Bologna) there exists a *FTTH* network operated by *MetroWeb*. For its nationwide plan, the incumbent operator *Telecom Italia* has opted for the *FTTCab* topology. In the last three years it has connected more than *40.000* street cabinets with a primary fiber network, re-equipped the cabinets with active devices and connected the users served by these cabinets with the VDSL2 technology.

We can compute in extreme detail the areas and corresponding population that is covered by the NGN of the incumbent operator using a proxy model of the legacy and NGN developed by one of the authors. This model reproduces the topology of the networks and, thanks to the geo-localization of the different nodes (stations, street cabinets, etc.), allows to match the areas reached by the networks with the cells of the census of the population. Moreover, since the proxy model approximates the actual topology of the primary and secondary networks and estimates their length, it provides an approximate evaluation of the theoretical capacity at each and every single node of the network. The figures reported in this paragraph are based on this proxy model.

Thanks to this new generation network, today **21.5%** of Italian population is potentially served with at least *30 Mbit/s,* a lower figure compared with Table 1, that refers to households rather than inhabitants. To this number we have to add the users covered by the NGN networks of the OLO operators. In particular, *Fastweb* and *Vodafone* have also opted for the FTTCab technology and today more than *13.500* street cabinets have been reached by the first operator and around *5.000* by the second. We have to point out that in most cases the NGN networks developed by the OLO's up to the street cabinets, a solution called Sub Loop Unbundling (SLU) cover areas that are served also by the incumbent's ultra-broadband network, improving infrastructural competition between different networks more than an overall expansion of the coverage.

These data suggest that in Italy the FTTCab technology is not the incumbent's defensive strategy but appears to be also the strategic choice of two of the main competitors of Telecom Italia. This behaviour is certainly motivated by the fact that a *progressive roll-out strategy* (FTTCab first and FTTH when demand of higher capacity becomes stronger) is the natural way to proceed when OLO's are not pursuing the more radical strategy of completely replacing the incumbent's legacy network with a brand new NGN. We observe that his pattern of investment is confirmed by similar strategies chosen in Germany, UK and Australia by incumbents and OLO's. In addition, the rapid evolution of wireless networks (both LTE and FWA) in terms of coverage and capacity, poses a strong threat to a timely return of the investments needed to lay down brand new fiber networks in the "market failure" areas.

There is, however, also a country-specific motivation that explains the predominant role of the FTTCab option: Italy has a *very short secondary network*: **65.7%** of the Italian population, according to the results of the proxy model, resides at less than *200 mt.* from a street cabinet. This structural characteristic of the legacy copper network guarantees, as we have already said, a coverage of 21.5% of the population with a capacity of at least 30 Mbit/s from 40.000 street cabinets passed in fiber. Indeed, the effectiveness of Italian legacy network is also testified by the observation that, by using the modern *vectoring* technology (used both in Germany and UK), *90%* of the *30 Mbit/s* connections active today could be upgraded to 100 Mbit/s (***18.7%*** of the whole population).

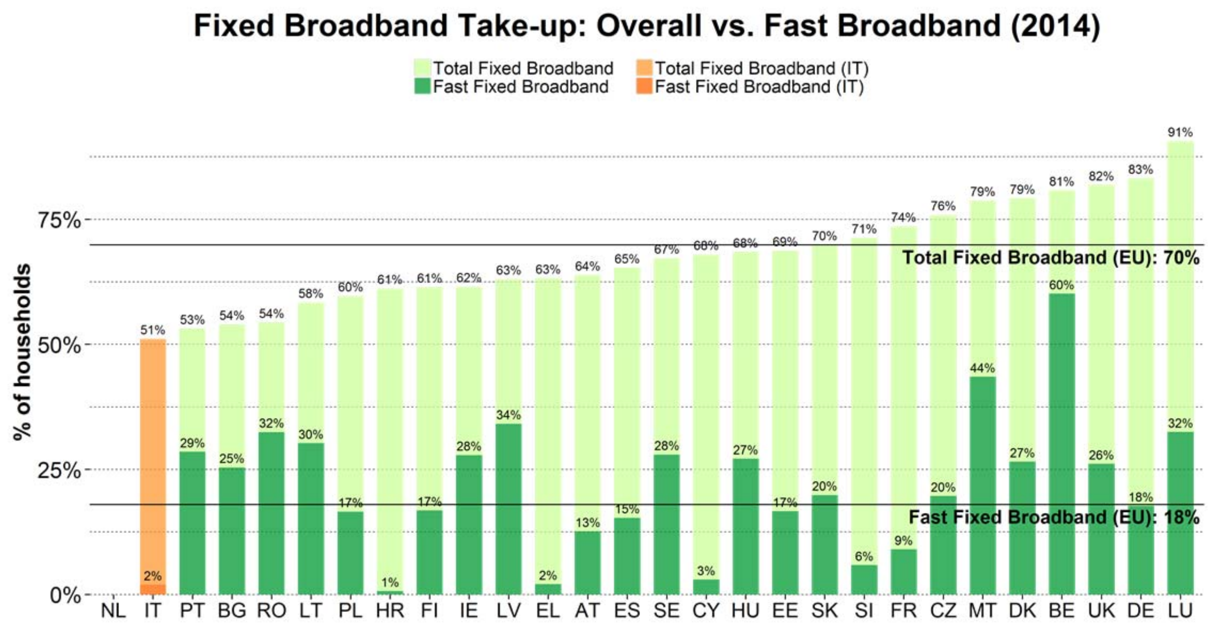
Additional evidence can be drawn looking at the areas where the central offices are opened to the so called *Unbundling of Local Loop* (ULL). This form of access to the legacy local network gives the OLO operators full control over the direct connection from the Central Office to the user premises (primary and secondary networks). These areas can be considered the most interesting from a commercial standpoint and include, in Italy, around **31.5** millions users (52.8% of the Italian population). Today, in the ULL areas, the FTTCab technology potentially serves ***38%*** of the users with a capacity of 30 Mbit/s and ***33%*** with a capacity of 100 Mbit/s. These numbers confirm that the FTTCab networks are growing faster in the areas where demand and competition are stronger.

The FTTCab technology (although very effective) is not sufficient to achieve the *2020 Agenda* goal of 50% of the population using a connection with a capacity of at least *100 Mbit/s.* This target refers to penetration, that is on the percentage of customers that, being reached with a 100 *Mbit/s* connection, do subscribe ultra-brand internet service. Since not all the customers covered by ultra-broadband connection choose ultra-broadband services, a 50% percentage of take-up requires a higher coverage of the population with *100 Mbit/s* connection. However, even in the theoretical case of all the street cabinets being reached by fiber and equipped with active devices using the *vectoring* technology (generalized FTTCab deployment), only **65.7%** of the Italian population could be served with such a capacity, presumably falling short of the 50% take-up threshold required to meet the third European target.

This circumstance suggests that, before 2020, the FTTH technology should complement the FTTCab if Italy aims at meeting the 50% ultra-broadband penetration target. There are presently two main projects that seem to go in this direction. Enel, the Italian electricity incumbent, has recently announced its intention to develop its own NGA network, exploiting the infrastructures of the electricity distribution network, with a focus on the areas in digital divide. At the same time, Telecom Italia is planning the deployment of the FTTH topology in the 100 main Italian cities. The two developments seem complementary: the Telecom Italia FTTH plans aim at developing infrastructural competition in the most profitable areas of the country, whereas Enel project points towards the 35% of Italian population in sparsely populated or less developed areas. Both developments may contribute to increase the take-up rate, hitting the third European target.

5. Where do we stand: the demand for broadband access in Italy

In this section we move to the demand side and present some evidence on the penetration of broadband and ultra-broadband access in Italy. According to the evidence of the Digital Agenda Scoreboard recorded by the European Commission, the take-up rate, referred to actual subscribers of broadband access, falls short (51% of households) of the European figures (70%), positioning Italy at the bottom of the member countries. The figures on ultra-broadband take-up (2%) are extremely tiny compared with the EU27 average (25%), confirming that most of (92%) the broadband connections are in the DSL option, delivered through the legacy network rather than the NGN. Italy, instead, perfectly matches the EU27 average if we consider the mobile broadband (3G and 4G) take-up rate. Adding together, 71% of households subscribe a fixed or mobile broadband access contract in Italy, positioning the country 21st in the EU27. The weak performance of the country in terms of take-up rates is not only an issue of levels, but also of a significantly lower growth in the last decade. Italy was close to other major European countries in 2004 but these latter have improved substantially their take-up, contrary to the weak growth rate of our country. These figures suggest that the potential expansion of broadband access in the traditional DSL option has reached its ceiling, and a further increase in the take-up may be realized only if the richer ultra-broadband services will push up the community of Internet users.



There are several demand-side factors that explain the poor penetration of broadband and ultra-broadband access in Italy. First of all the country suffers a serious problem of digital literacy: according to Eurostat figures, 32% of the population has never used the Internet, against a EU27 average of 18%, and only 54% of the citizens has basic IT skills, ten percentage points below the European average. The limited use of the Internet, in turn, is related also to the demographic structure of the population, with a larger share of aged cohorts, and to the low level of instruction that characterizes certain areas of the country.

A recent survey of Eurobarometer[2] on the reasons why Italian citizens do not subscribe for broadband access reports that the lack of network access is a minor (2%) reason, as well as the price (7%), whereas 2/3 of those that do not subscribe explain their choice with the lack of interest in Internet services.

Turning to the business users, the picture is not that different. Italian SME subscribe for broadband and ultra-broadband access less than those of the other major European economies, a weakness that is even more serious considering the larger share of small firms in Italy. Among the small firms, only 1/3 subscribes the fixed/mobile contracts designed for business, in many cases using instead the contracts proposed to households. The share of SME that sell on line (5.1%) is the lowest among EU28 countries, ten points below the European average. e-Commerce turnover of Italian small/medium (4.8%) and large (11%) enterprises is around half of the European average.

A limited level of digitalization characterizes also the relationship of Italian citizens with the Public Administration: only 18% has exchanged filled forms online with public offices, compared with the 33% average, according to the Digital Agenda Scoreboard. Italian public administrations, instead,

[2]TNS Opinion & Social (2013), E-Communications Household Survey (November 2013), special Eurobarometer 396. survey conducted for the European Commission, field work February-March 2013

rank better when we consider the supply of digital services, as the level of sophistication in the online services provided, open data and e-health services. Hence, these figures may suggest that it is, once more, the citizens' demand, more than the supply of digital public administration services the weak element in the picture.

6. How are we moving: the Master plan of the Italian Government

Following an extensive review of the broadband networks in Italy [3], the Italian government on March 2015 has approved a Master plan for the development of ultra-broadband networks[4] and has started the implementation phase by allocating 2.2 bln € and setting up procedures and phases.

In this section we present an overview of the main points of the Master plan and of the initial phases of implementation. Two main pieces of regulation have set the boundaries and inspired most of the framework adopted in the Italian plan. First, the three objectives of the DAE, and second the Community guidelines for the application of the state aid discipline to the deployment of broadband networks.

The first of the three objectives of the DAE, that requires the full coverage of the population with basic (<2Mbps) broadband services by 2013, is met in Italy and does not require any further policy measure. Ensuring a 100% coverage with fast broadband (at least 30Mbit/s) access by 2020, the second target of the DAE, instead, can be reached only through additional policy efforts, as the most ambitious, third target of a 50% penetration of ultra-fast broadband access (at least 100 Mbit/s) by 2020.

The Master plan has translated these target into a pair of thresholds: *a coverage of 85% of the population with ultra-fast (100* Mbit/s*) broadband networks and of the residual 15% with fast (30* Mbit/s*) broadband networks*. We can observe that these two targets and not completely aligned with the ones in the DAE. In particular, while DAE's target 2 is met according to the thresholds set in the Master plan, DAE's target 3 is spelled out in terms of penetration whereas the ultra-fast coverage of 85% of the population is still in terms of deployment. This latter, indeed, would allow to meet the 50% ultra-fast penetration target if the take-up rate would be around 60%, a figure that is far above the present situation. In other words, it is not obvious that the threshold of ensuring a 100 Mbit/s access to 85% of Italian citizens will produce a penetration consistent with the third target of the DAE.

The second set of rules that has conditioned and shaped the Master Plan is the Community discipline on state aids, and its specific characterization for the deployment of broadband networks. The guidelines specify a set of conditions that must be met in order to provide public support to the investment in NGA networks. Among the conditions, the contribution to the achievement of objectives of common interest (Services of General Economic Interest – SGEI) is clearly satisfied with reference to the DAE goals. The crucial issue refers to the absence of market delivery due to market failures, that requires a careful analysis. The positive externalities of broadband networks on the economic system and growth, then, may explain under-investment and justify public subsidies. As we discuss in more detail below, given the heterogeneity in access

[3] V. F. Caio, J. Scott Marcus e Gérard Pogorel (2014).

[4] Presidenza Consiglio dei Ministri, La strategia italiana per la banda ultralarga (2015).

supply and demand conditions at the local level, this assessment must be run at an appropriate level of geographical disaggregation. State aids may be justified as an additional policy tool whenever the incentives that regulation may create through access pricing are insufficient to boost investment, as shown in the theoretical and empirical literature reviewed above. At the same time, a close coordination between public subsidies and regulatory measures is a cornerstone for a successful policy aimed at limiting the aid at the minimum necessary, reducing as much as possible distortions of the competitive process.

The EC Guidelines translate these general principles into an approach that distinguishes the local conditions according to the stage of development of broadband networks. Three situations are envisaged: '*White areas'*: an area where NGA networks do not at present exist and where they are not likely to be built within 3 years. '*Grey areas*' where only **one** NGA network is in place or is being deployed in the coming 3 years and there is *no further plan by any operator* to deploy a NGA network in the coming 3 years. And finally '*Black areas*' where at *least* ***two*** NGA networks of different operators exist or will be deployed in the coming 3 years. We can notice that the classification is based on a distinction between areas where infrastructural competition is, or is expected to be, taking place and areas where, instead, a single NGA network is being deployed, with the residual ones in digital divide.

In cases in which the area for which the SGEI is entrusted is not limited just to the 'white spots', because of their size or location, the SGEI provider may need to deploy a network infrastructure also in the profitable areas already covered by commercial operators. In such situation, any compensation granted should only cover the costs of rolling out an infrastructure in the non-profitable white spots, taking into account relevant revenue and a reasonable profit

Finally, when public support is released, the operator that benefits of the contribution is selected in line with the spirit and principles of the EU Public Procurement Directives. In particular, the support is granted to the '*most economically advantageous offer'*, that is identified looking at both the technical features of the bid and the requested aid. Adopting a beauty contest set up is intended to preserve technological neutrality, giving the participants the freedom to articulate their bid according to their specific technological solution.

Coming back to the Government Master plan[5], it is entrenched on 4 different territorial clusters defined ex-ante, identified by different levels of actual and prospective networks. Cluster **A** includes those areas where at least one operator has, or has planned to deploy ultra-fast broadband networks in the coming 3 years with no need of a public support. In these areas the only admitted form of public support is on the demand side, to incentivize the migration to ultra-fast access. Areas included in cluster **B**, instead, are served presently by just one 30 Mbit/s network (e.g. FTTCab+Vdsl2), and private operators are not planning an upgrade to 100 Mbit/s without public support. The existing broadband network in Cluster **C** areas does not reach 30 Mbit/s (e.g. DSL), and the upgrade to 100 Mbit/s requires a stronger public support. Finally, Cluster **D** includes areas with basic broadband connection where no public support may induce private operators to promote an upgrade to 30 Mbit/s.

When supply side support is justified (Clusters B, C and D), the tools available differ according to the different local situation. In Cluster B the public subsidies may take the form of a direct

[5] See also CIPE, Del 65/2015, Piano di investimenti per al diffusione della banda larga.

contribution to cover investment costs, tax credits, public guarantee funds together with PPP schemes where the public operator is directly involved as a partner in the project. Cluster C entails the same instruments, the main difference between the two being that the threshold of a public support up to 70% of the overall investment cost is presumably reached in Cluster C whereas areas in Cluster B should remain below this maximum level. Finally, Cluster D requires the direct intervention of the public operator to realize the 30 Mbit/s broadband networks. Cluster A and B includes 65% of the Italian population, and Cluster D a residual 15%.

Although the Master Plan is based on a territorial framework and different clusters that may remind the white-grey-black classification of the State aids Guidelines, there are some important differences between the two classifications. The EC framework distinguishes areas with infrastructural competition (black), those served by one NGA network (grey) and the ones in digital divide (white). The Master plan, instead, focusses on the targeted deployment of a 100 Mbit/s ultra-fast network and considers private incentives and the gap to be filled upgrading the existing networks. While Cluster A reminds the black areas, the grey ones should likely correspond to Cluster B and C.

The Government has also allocated relevant resources to finance the plan. In August 2015 a first tranche of 2.2 bln € has been approved to cover projects in Cluster C and D over the 2016-20 period, and an overall amount of 6.5 bln € coming from European and national funds will contribute to the realization of the plan. The investments financed by private operators in the same period should amount to a similar figure, covering the 12 bln € costs expected.

A Committee (COBUL) that includes the relevant Ministries and ministerial bodies, coordinates the various phases and initiatives. The implementation of the Master plan has started along the lines set in the document CIPE 65/2015.

The first and crucial step requires to identify which areas belong to the different Clusters. To proceed, the Government has divided the Italian territory into 94.645 different cells that represent the baseline geographical framework. The Ministry of Industry and Economic Growth (MISE) has issued a public consultation to assess, at the level of each of the individual cells, where the private operators had planned to intervene with their investments before 2018 and what goal, in terms of capacity delivered (30 or 100 Mbit/s) and percentage of final user covered, they have the intention to reach.

Matching the realized and planned investments of the operators with each of the areas, the individual cells are assigned to one of the Clusters, specifying the associated targets (Mbit/s) and policy tools available. The operators, then, confirm or modify their investment plans by committing to their realization, and participate to the public procurement for public support. In Clusters B and C, if in a given cell no operator is willing to participate for the upgrading of the network, no support is released and the area is reconsidered in the next round of consultations, that should take place every six months. In Cluster D, if no operator is willing to participate in a partnership, the direct public intervention is the only form of realization of the 30 Mbit/s network, and the agenda is phased directly by the Ministry of Industry and Economic Growth (MISE).

What is still not fully specified within this general framework is how the different procurement auctions will be organized. Indeed, the 94.645 individual cells are the input of the process and each of them is assigned to one of the four Clusters. However, it seems hard to organize a different auction for each of them, and therefore *they must be grouped into larger territorial unit.* If they are aggregated with other cells of the same type, however, at the end of the process, it may end up that the geographical composition of the Clusters is very fragmented, putting together individual cells that are not contiguous. If, alternatively, the individual cells are grouped together at the level of municipalities, or areas covered by a given network station, the resulting territorial units may include cells belonging to different clusters, with different support schemes available. We discuss this delicate issue later on.

After the approval of the Master plan in March 2015 the strategies of the operators have evolved in a complex game that is worth summarizing to complete the picture. Beyond the telco's that are already active in the market for telecommunication services, there are two additional players that entered the playing field. One is *Metroweb*, an infrastructural operator that has deployed NGA networks in Milan and is developing them also in Turin, Bologna and Genoa. *Metroweb* is controlled by *Cassa Depositi e Prestiti (CDP),* the financial branch of the postal service, a state owned company. *Metroweb*, in the policy discussions, has been pointed out as one of the key players in the process, with an ambiguous role of challenger or partner with the private operators that are already investing in the ultra-broadband networks, namely *Telecom Italia, Fastweb and Vodafone*. More recently, *Enel*, the incumbent electricity operator, still with an important stake owned by *CDP*, has moved into the game by creating a Newco for the development of a NGA infrastructure by exploiting its diffused network of ducts and cabinets running the electricity distribution service.

We mention these two new players at the end of the description of the Government policy since it is apparent, in our view, that the public control on the two companies may give the Government an additional tool to intervene, putting pressure on private operators and conditioning the pace of their investment plans.

7. How should we move: an evaluation of the Government Master plan

An evaluation of the Master plan and of the first implementation steps has to start by recognising the strong push of the Government to qualify the development of the broadband network as one of the policy priorities. This is for sure a positive approach that may play a crucial role in accelerating the process and trying to close the gap with the other European countries.

Another important characteristic of the Master Plan refers to technological neutrality[6]. The classification of the areas in Clusters and the design of public support schemes are referred to the Quality of Service (QoS) provided in terms of capacity, rather than on the adoption of a specific technological solution to ensure that capacity. In the above mentioned market consultation, based on an extremely detailed decomposition of the Italian territory (94.645 elementary cells), the operators have been in fact required to specify the percentage of population in each cell that will be served at 30 Mbit/s or 100 Mbit/s. Independently of the specific technology used or the very topology of their network. Thanks to this choice, the market consultation allows, for instance, a *Fixed Wireless* operator or an operator who has opted for the *FTTCab* topology and the *VDSL2*

[6] On the desirable properties of a policy package see Cambini, Polo and Sassano (2914).

technology to declare its 2018-goal of serving a certain percentage of the population of a specific cell with a capacity of 100 Mbit/s. This is a *crucial improvement* with respect to old versions of the Master Plan in which the choice was explicitly declined in term of alternative technologies (FTTH vs. FTTCab).

This new target-setting strategy of the Master Plan allows the operators to define a more flexible and technology neutral roll-out plan which could effectively put in operation an important characteristic of the NGA networks: their *scalability*. Scalability is the possibility to move from one technical solution to a more advanced one when the latter becomes profitable, without incurring substantial adjustment costs. In this perspective, the path from FTTCab to FTTB, and then further to FTTdp and, finally, to FTTH represents a natural pattern in which the fibre is moved closer and closer to the final user as the value of the access and the services justify it. Analogously, the dimension of the cells in the architecture of the LTE mobile network may be narrowed, requiring an increase in the backhauling component of the network, as the number of 4G users grows and the average density of active customers in a single cell therefore increases. These patterns of development allow the attainment, when the market is sufficiently developed to sustain it, of future proof solutions without excessively accelerating the investment.

The third principle that the Master Plan has correctly taken into account is the *complementarity* of private investment and public support. Under this respect, the State aid scrutiny allows to use public funding as a residual tool when the market fails to deliver. It is implicit in this approach that a primary role is assigned to private operators, with the public support entering when needed. The use of public resources, in general and, even more, when public finance is tight, then should be addressed to the areas where a suboptimal level of investment would otherwise realize. This general argument has relevant implications that go beyond the use of the direct tools of support.

The first refers to a possible role of state owned companies in the process. As long as this firms are managed with a set of goals that is wider than pure profit maximization, they may contribute to the deployment of broadband networks in areas where a pure private return motivation would suggest not to invest. Hence, an active role in Cluster D and, perhaps, Cluster C areas may complement the adoption of direct support instruments for private operators. We have, however, to mention that in this case the level of transparency in the forms and size of public support, a cornerstone in the evaluation of State aids, is much weaker. Direct intervention of state owned companies, instead, is less desirable to envisage an active role, in competition with private operators, in those areas where the latter are already planning the deployment of ultra-fast broadband networks. The advantages of state ownership, for instance in terms of the cost of capital, could in this latter case distort competition.

The second implication refers to regulation, that is part of public policies and has a strong impact, as already discussed, on the incentives to invest in the new NGA network. Since the tools of public support vary in the different Clusters, it seems natural that regulation as well be adapted to the local competitive conditions, admitting a geographical differentiation. When the main feature is the development of NGA networks by private operators, as in Cluster A, regulation can help sustaining the investment. Where the private incentives are weaker, as in Cluster B or C, regulatory incentives should compensate being more powerful.

Under this respect, however, the classification of the different Cluster seems less fit than the EC one in terms of black, grey or white areas. Indeed, black areas are those that entail some form of infrastructural competition, where more than one operator is constructing NGN's, whereas in the grey area only one operator deploys the ultra-fast broadband network. Regulation, accordingly, should be different when there is some form of infrastructural competition and when, instead, there is only one NGA infrastructure. Cluster A, instead, is not defined according to infrastructural competition, but rather on operator(s) willing to deploy a 100 Mbit/s network. Analogously, Cluster B and C are those in which operators would not, without public support, upgrade the broadband networks to the policy target. It is less obvious how regulation should be shared in the different cases, since Cluster A might include areas where there is infrastructural competition and others in which just one operator upgrades the network to the 100 Mbit/s target. To sum up, while different cluster require different regulation, the way they are designed does not generate well defined different regulatory problems.

Finally, the choice to define a very large number of territorial cells, assigning them to the different Clusters and then merging them in geographical aggregates on which public procurement auctions are organized is a solution that must be handled with care. Indeed, even in large and developed towns as Milan or Rome there are areas where the operators are not planning to invest. According to the rules adopted, those cells should be assigned to Cluster D. But then, if the geographical aggregates of the public procurements must include only cells belonging to the same Cluster, they might be full of holes and discontinuities, making the investment plans very cumbersome to realize. In other words, it is much easier to induce an operator that is planning to deploy a NGN's in a large part of a city to reach full coverage by giving public support in those parts that are otherwise not reached, rather than extrapolate and merge them with other similar white areas and assigning them through a procurement to a different operator.

An alternative solution might be to create *geographical aggregates* for the procurement auction on the basis of territorial continuity, for instance the municipalities (more than 8000) or the areas covered by the network station (more than 10.000). These are typically the geographical references on which the operators base their investment plans and marketing activities. A similar approach, being closer to the logic of the operators, should incentivise the participation to the auctions. However, the resulting aggregates would be heterogeneous, including cells of different clusters and posing, therefore, an issue of cross-subsidies.

To avoid undue subsidies and make the process transparent we propose the following procedure. The information available at the end of the public consultation (http://www.infratelitalia.it/) specifies for each of the 94.645 cells the capacity presently supplied and the one expected by 2018 distinguishing the percentage of population covered. Hence, for instance, a given cell, according to the initial situation and the investment plans submitted by the operators, might be presently served with x% of the inhabitants at or above 100 Mbit/s, (1-x)y% between 30 Mbit/s and 100 Mbit/s and the residual below 30 Mbit/s. The planned investment, then, would change the percentages to x'% and y'%.

If x'=1, that is the planned investment by 2018 will cover at 100 Mbit/s the entire population in the cell, then it is included in Cluster A. If, however, x'<100, in order to meet the Master plan target some sort of public support is envisaged and the cell must be included in one of the other Clusters. The Master plan has set a total percentage of population of 15% that will be served at 30 Mbit/s, whereas the remaining areas have to reach the 100 Mbit/s target. Hence, in order to assign the target, and in particular, to identify the areas in digital divide that must be upgraded to 30 rather than 100 Mbit/s we have to find an ordering of the different cells, assigning the lowest ones up to a total percentage of population equal to 15% to Cluster D. The remaining ones, that do not belong to Cluster A or D, have to be further distinguished in Cluster B and C. We further distinguish how to proceed below.

First we assign the different cells to different Clusters. Then we aggregate them into larger geographical units (say, municipalities) that may be heterogeneous in terms Clusters but manageable when we look at investment plans. Since the target for the first three Clusters is to reach a generalized 100 Mbit/s capacity and for Cluster D to provide a 30 Mbit/s access, notwithstanding heterogeneity we can identify clearly at the level of each cell the investment gap between planned investments and the target, as well as the technological solution adopted. Hence, the bids of the participants to the procurement auction will have to carefully describe the technological solution (e.g. FTTH in some cells and FTTCab in others) and the incremental investment costs and support schemes that have to be used to meet the target. Consequently, even if the procurement auctions are organized for geographical aggregates larger than the single cells, the public support tools can be clearly associated to filling the gap, at the level of each of the cells in the larger aggregate, between the capacity deployed absent any support, as specified in the plans of the operators, and the target to be reached. This bottom-up approach allows to ensure transparency and avoid undue cross subsidies, coherently with the state aid discipline.

To be more precise and to give a quantitative outlook of the classification we have described in the above paragraphs, we have partitioned the 94.654 elementary areas into four classes and *aggregated them into two geographical entities:* municipalities and central offices. In order to precisely define the four classes, let us define x the percentage of population of an individual cell covered by 2018 at 100Mbit/s and y the percentage of the residual population not covered at 100 Mbit/s that will be covered at 30 Mbit/s.

The four classes are defined as follows:

(α) the areas where the operators have planned to cover 100% of the population with capacity 100 Mbit/s; these areas, therefore, are characterized by $x = 1$.

(β) the areas where the operators have planned to deploy *only* 100Mbit/s networks to a percentage of the population lower than 100%, and no one covered at 30Mbps; in this case, therefore, $x<1$ and $y=0$. The particular pattern of investment in these areas is likely to derive from specific features of the secondary network and/or being included in specific experimental projects and local administration initiatives. In our opinion, areas of class β are a strong signal of commitment of the operators and the local administrations, in particular when the declared percentage of 100 Mbit/s is significant, in favour of a FTTB/FTTH solution.

(γ**)** the areas where he operators have planned to deploy 30Mbit/s networks and any percentage lower than 100% at 100 Mbit/s; they are identified by $x<1$ and $y<1$.

(δ) the areas where no operator has planned a NGN (neither 30 Mbit/s nor 100 Mbit/s) before 2018. In these areas, therefore, $x = y = 0$.

The aggregation of the elementary areas into larger geographic entities has been performed by summing up, for each municipality and each central office, the population of each *section* of the

Italian census multiplied by the percentage declared in the corresponding *Infratel area* (each *Infratel area* is the union of census sections). The results are summarized in the following table:

Table 2: Clusters according to the operators plans

Aggregate Type	α		β		γ		δ	
	Population	*Number*	*Population*	*Number*	*Population*	*Number*	*Population*	*Number*
Municipalities	**1.634.586**	**12**	**1.369.570**	**227**	**41.792.445**	**2.780**	**14.637.143**	**5.073**
Central Offices	**1.788.686**	**77**	**1.092.031**	**230**	**38.669.975**	**4.996**	**13.066.910**	**5.515**

Evidently, all areas of class α there should be included in Cluster A. Analogously, there is no doubt that the areas of class δ are those in "*digital divide*" where the State subsidy is mandatory to achieve the DEA target. However, having observed the operators' plans, the areas in class δ contain slightly less than ***25%*** of total population, a percentage much higher than the one (15%) set in the Master plan targets to be covered at 30 Mbit/s. Hence for at least ***10%*** of the population residing in these areas, the Master Plan must set a capacity target of 100 Mbit/s (otherwise it would not be possible to achieve the target of covering 85% of the population with 100 Mbit/s). As observed above, the choice of these *100 Mbit/s areas* of class δ should be based on *endogenous criteria*. For example, the Government could choose the areas with *longer* secondary copper network, where FTTCab+Vdsl2 is unable to go beyond 30-50 Mbit/s.

We are thus left with the areas of type β and γ that, together, should encompass Cluster B and C with a capacity target of 100 Mbit/s. A sensible clustering strategy could be that of assigning to Cluster B *all the areas* of classes β and those areas of class γ above a suitable threshold of population covered at 30 Mbit/s (by 2018). The remaining areas should be inserted in Cluster C. In these latter, therefore, we find the cells where the deployment of the NGA network, although moving on, is lagging behind.

We have tried to figure out the dimension of Cluster C both in term of number of areas and in term of population while the above mentioned threshold varies from 10% to 100%. The results are summarized in the following table:

Threshold	***Municipalities γ - 100 Mbit/s***		***Central Offices γ - 100 Mbit/s***	
	Population	*Number*	*Population*	*Number*
<10%	***20.517.188***	***2.457***	***18.812.005***	***3.728***
<20%	***3.073.943***	***87***	***3.662.012***	***381***
<30%	***2.270.545***	***64***	***2.424.757***	***183***
<40%	***953.845***	***43***	***1.116.978***	***67***
<50%	***590.400***	***30***	***965.211***	***77***
<60%	***4.251.289***	***48***	***3.179.770***	***167***
<70%	***8.210.199***	***44***	***3.465.980***	***165***
<80%	***1.381.499***	***6***	***2.684.594***	***125***
<90%	***51.688***	***4***	***1.324.916***	***57***
<100%	***491.849***	***6***	***1.033.752***	***46***

8. Some policy conclusions

In this paper we evaluate the recent *Ultra Broadband Plan of the Italian Government* and the response of the operators to the public consultation issued by the Ministry of Economic Development (MISE). The choice of the Italian Government, coherent with the general guidelines issued by the European Commission, is that of fostering the development of the New Generation Network in the areas where the private infrastructure initiative is weaker and where only the State intervention can help reaching the Agenda 2020 goals. The Italian government presents an innovative experiment in the design of public policies with a great opportunity to improve and refresh industrial policies. At the same time, the procedure that are expected to be implemented especially for the allocation of public subsidies appears to be extremely complex.

From an economic point of view the key aspect is to understand what might be the expected outcome of this plan and what kind of regulatory interventions might suit better the emerging market structure.

First of all, and inevitably, the Italian government assumes the EU targets as given, though they have been defined in an unique way for 27 countries which present a high degree of heterogeneity in terms of infrastructure endowments and degree of competition. Assuming these targets may create expectations in the operators that politicians will find the resources to meet those targets. Therefore, private operators may play a very peculiar "regulatory game" resulting in a waiting game where private operators may under invest, or understate their true investment plans maybe even in profitable areas, in order to have a larger access to public support resources. Two effects could arise: either investments do not happen at all or they follow too late, in case of scarce public funds, or investments do occur but simply with public money crowding out private investments. Clearly, since lower planned investment triggers more public support, the incentives to declare the areas where to invest might be largely reduced, especially in areas with a low level of expected profitability.

Second, from a regulatory perspective, a complicating feature is that competition among high-speed broadband networks is likely to emerge only in specific regions of the country, mostly in very dense metropolitan areas, while in the rest of a country infrastructure competition will probably not materialize. For the least densely populated areas, only government subsidies will turn private investment viable. But even within the areas that will be covered without the need for subsidies, the number of operators rolling out their network will differ. This calls for ex-ante access rules to differ across areas characterized by different degrees of infrastructure competition. Indeed, regulatory practice has changed and a transition from country-wide uniform measures to more locally tailored regulation is taking place. In this way, entrants and incumbents may have more incentive to invest in NGN and spread the deployment of NGN. Hence, geographical remedies may be a new regulatory intervention to foster investment and to speed the process of convergence towards the targets set by the Digital Agenda for Europe. Though complex to implement and to assess, the adoption of geographically differentiated regimes could be a new regulatory tool that can foster the deployment of NGN's[7] and speed up the process of convergence towards the EU Digital Agenda's targets. The European Commission is forcefully asking for the adoption of new regulatory schemes aimed to provide a better environment for risky investments. That's why in the next future telecoms NRAs might probably face the need to revise their market analysis, define new markets considering the competitive and geographic differences among areas and then adopt ad hoc remedies.

[7] Indeed, recent theoretical analysis (Bourreau et al, 2015) finds that the adoption of geographically differentiated remedies positively affect ultra-fast broadband investment.

A final comment is deserved. Public support schemes designed for the development of NGN's have moved the policy debate in the area of industrial policy, a chapter not very active in the last two decades dominated by liberalization and hands-off approaches. The Master plan has followed a process, for the first draft in November 2014 to the discussion with the EC and, finally to the final version in March 2015. Further steps of implementation are now in the agenda. During this process, the Master plan has been slightly adjusted, changing some elements that might seem irrelevant, but that, to a closer inspection, clearly show different approaches to industrial policy. The first draft was explicitly pointing out a technological solution, bringing the fiber to the buildings (FTTB) as the favourite one, in breach of the principle of technological neutrality, and posing serious problems to the scalability of the process. Moreover, in the early phases, the policy was tuned through a carrot, the public resources, and a stick approach, the role of state owned companies as a substitute for the too timid efforts of the private operators.

The filter of state aids in the interaction with the EC has proved to be quite effective in correcting these excessively interventionist moves, bringing the process back to a complementary role of public institutions and private firms, reintroducing technological neutrality and, this way, allowing to manage a progressive roll-out process according to scalability. The detailed comments we have provided show how complex it is to combine non distortionary public tools and private incentives. The result, however, seems promising.

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