Vodafone Non-Confidential Version

October 2015

Annex 4: The Impact of Effective Passive Infrastructure Access

Strategic Review of Digital Communications

1 Contents

Executive Summary

As other European countries are accelerating their roll-out of ultrafast broadband networks, the UK is falling behind. This is not due to lack of interest in network investment by operators. The current regulatory regime inhibits operators' ability to innovate and invest. To reverse this trend, Ofcom has to change its current approach and introduce a new, comprehensive, and effective passive infrastructure access (PIA) regime that will support the development of fibre-to-the-home (FTTH) networks.

An effective PIA regime is a key foundation which enables infrastructure-based competition, accelerates the deployment of ultrafast broadband networks and supports product and service innovation for the benefits of consumers.

We have had very positive experiences with PIA-enabled FTTH roll-outs throughout Europe. In Spain Vodafone's ultrafast network covers around 7.9 m premises (about 36% of total premises passed) as of June 2015 and, of these, around 1.2m are self-built or co-invested FTTH. We now have 2.85m Spanish broadband subscribers. In Portugal, we have reached 2m premises through self-build and co-investment (42% of the total premises passed) and have 357,000 broadband subscribers.

The rapid rollout and take-up of our FTTH networks has been dependent on our ability to access existing ducts and poles via the PIA regimes. Our co-investment schemes with other operators in these countries have also helped us increase our network coverage while avoiding unnecessary duplication of infrastructure.

Our experience of building networks using passive infrastructure is not limited to these countries. In Ireland we have created a wholesale-only and structurally separate joint venture company together with the electricity line company, ESB, to roll out FTTH to 500,000 homes in 50 rural towns using their infrastructure.[1]

A well-functioning PIA regime will encourage FTTH network deployment and competition. This will directly benefit customers through more innovation, better quality of service and increased competition in the broadband market.

Benefits of PIA for consumers

In the countries where we have deployed FTTH networks via PIA we provide superior services along multiple dimensions to our customers. For instance, in Spain we offer a package of fixed and mobile telephone, IPTV, and a guaranteed broadband speed of 300 Mbps for £1 less than the price of a package of only 76 Mbps broadband connection and fixed telephony via VULA in the UK. And while in Spain and Portugal we can still innovate and improve further, in the UK we have already hit the maximum that BT's wholesale active service can support.

[1] https://www.esb.ie/main/press/pressreleaseWS.jsp?id=4074

But there is more to ultrafast broadband than just speed, lower latency and more consistent performance. In Spain we allow our customers to select the time of installation because we believe we should provide convenience to them and not the other way around. We are able to connect them to our fibre network twice as quickly as we can connect our ADSL customers because these ADSL customers are receiving their services over the network of the incumbent who also controls the installation process. Services provided on our network have more than 50% fewer incidents than those provided on the incumbent's network, and we fix 87% of incidents on our network within 24 hours. All this is the result of being able to control our own processes and network. This would be simply impossible without an effective PIA regime.

PIA gives us the ability to innovate and respond to consumer demands faster. We can introduce new services and increase speed profiles right away without the involvement of the incumbent, which benefits the consumer and stimulates competition in the industry.

Impact of PIA on competition

An effective PIA regime stimulates competition and investment in the industry. The ability to use existing passive infrastructure dramatically decreases costs associated with deployment and allows operators to direct the savings into further expansion instead of duplicating infrastructure. In Spain, FTTH deployment using PIA has lowered our capital expenditures by more than 40% compared to non-PIA deployment. Access to infrastructure also makes it possible for operators to deploy networks in areas where it would not be economical in the absence of the PIA.

Moreover, PIA enables co-investment and network sharing among operators, ultimately resulting in more customers being reached while maintaining the incentives for co-investors to compete with one another. We were able to roll out FTTH to twice as many households in Spain thanks to our co-investment agreement with Orange. In Portugal, we were able to achieve similar results through our co-investment deals with NOS and Portugal Telecom.

Increased infrastructure based competition leads to more sustainable competition, lower dependency on the incumbent and more focused regulation. These benefits are not limited to urban areas. In rural areas, PIA has enabled operators other than the incumbent to compete for government funds for the expansions of fibre based broadband networks. In Portugal, public tenders have been won by wholesale-only operators who are deploying FTTH networks.

Competition among operators results in better services to all customers. It also gives the incumbent an incentive to improve its network and customer service. Telefonica in Spain had to invest over €6.7 billion in network infrastructure, much of it into its FTTH network, in order to remain competitive. In the UK the lack of competitive pressures has led BT to do the opposite, making only incremental upgrades to its copper network and slowing down its FTTH rollout to an "on demand" basis only in limited areas.

What should Ofcom do?

The know-how from Spain and Portugal provides Ofcom with a template for success. The new regulatory regime in the UK has to be both comprehensive and dynamic. Experience from Portugal shows that overlooked areas of regulation create bottlenecks if not addressed. Both in Spain and

Portugal, PIA has been effective because it was able to adapt to market and technological changes since its first introduction.

In the UK, the unsatisfactory status quo of dependence on BT's network can be turned around if the regulatory regime improves. International evidence shows it can be done. We therefore urge Ofcom to update its PIA regulation with the following key recommendations:

- **Streamline the process for access to infrastructure and establish comprehensive SLAs and SLGs.**[2] This reduces the complexity, costs and uncertainty associated with access.
- **Set cost-based prices for core and ancillary services.** Current gaps in regulation have led to UK charges for ancillary services, in particular, that are substantially higher than comparable services elsewhere in Europe.
- **Create a database of infrastructure and make it accessible to all operators.** An up-to-date source of location, status, and availability of infrastructure is a low-cost initiative with high return through faster deployment.
- **Reserve duct space for alternative operators with no restrictions on the purpose for which access to the infrastructure is requested.** BT must be obliged to reserve space to access seekers or arrange alternative routes, clear dead cables, or provide dark fibre where duct is unavailable. There should be no restrictions on the services that can be provided through the use of PIA.
- **Enable effective use of poles.** Deployment to single family houses in the UK should be facilitated through comprehensive regulation of poles.
- **Codify the rules for in-building wiring and wayleaves** This would create conditions for infrastructure-based competition in existing high-rises as well as newly-built multi-dwelling units.

The benefits for the market and UK consumers will far outweigh the regulatory effort required to make the PIA regime effective and we urge Ofcom to take action now.

[2] Service Level Guarantees

2 Introduction

The performance of the UK's broadband networks is beginning to lag behind the leading countries in Europe because of the absence of any significant fibre-to-the-home (FTTH) network rollout. FTTH is the only network architecture that is capable of delivering the high bandwidths and reliable performance that are needed for future broadband applications. But, unlike many other European countries, the UK has no FTTH deployment on any significant scale and there are no immediate prospects of it happening under the current regulatory system.

Unless something changes in this system to encourage investment into FTTH networks, the broadband performance gap between the UK and the leading European countries is therefore likely to continue to widen - to the detriment of British customers and the national economy.

BT's fibre-optic network investment has focused almost exclusively on fibre-to-the-cabinet (FTTC) deployments. With the exception of Virgin Media, all significant competing operators are dependent on regulated access to active wholesale services provided over BT's network to provide superfast broadband to their customers. This dependence on BT inhibits innovation, limits competition in the broadband market and constrains investment by operators. Ultimately this leads to higher prices, lower speeds and worse service for the UK consumers than could be achieved under a more competitive market structure.

However, we are convinced there are alternatives to the status quo. Other countries in Europe have shown that it is possible to have greater competition at the infrastructure level, driving technological and service innovation. Ofcom's Digital Communications Review (DCR) provides an ideal opportunity for Ofcom to consider the state of fixed network competition and to stimulate it by implementing an effective system for regulated access to PIA.

Ofcom has identified PIA as a key regulatory instrument for achieving this outcome.

"*There is evidence that access-based competition, especially that based on access to passive infrastructure, can drive network innovation….Today, some European countries have seen competitive investment in ultrafast broadband supported by passive infrastructure access (e.g. duct, poles, in-building wiring)*"[3]

PIA regulations were introduced into the UK in 2010 but it has not been a success with minimal uptake and almost no significant market impact. By contrast, the experience of PIA in other European countries has been very different. In Spain and Portugal, for example, PIA is a central pillar of the regulators' strategies for the fixed market in those countries. Effective access to duct, poles and verticals has enabled us and other operators to make significant investments into FTTH networks and has stimulated new levels of competition in those markets.

If PIA were made effective in the UK, it would help address all four of the strategic challenges identified by Ofcom in the DCR.

[3] Ofcom, Strategic Review of Digital Communications – Discussion document", page 6

Table 1: Ofcom's strategic challenges and how PIA potential contribution

Strategic challenge	How PIA could help address it
Investment and innovation, delivering widespread availability of services	PIA would enable investment in new FTTH networks by alternative operators while avoiding inefficient duplication of investment in civil infrastructure. This in turn would enable a level of innovation that is not possible under the current regime. Co-investment in countries like Spain and Portugal has enabled wider FTTH footprints than would have been achieved if reliance has to be made solely on the incumbent. In fact, PIA has stimulated investment even by the incumbent, contrary to the UK where investment in FTTH by has been scaled back compared to original plans.
Sustainable competition, delivering choice, quality and affordable prices	Greater infrastructure-based competition enabled by PIA will lead to more sustainable competition with less reliance on regulated access, greater choice and competition focussed on price and quality through full control at the network layer.
Empowered consumers and businesses, able to take advantage of competitive markets	While UK consumers at present enjoy choice in relation to service provider, most service providers rely on the same active products provided by BT. Competition deeper into the value chain will enable operators to differentiate themselves more from their competitors, ultimately empowering consumers with more knowledge and ability to leave worse performing operators.
Targeted regulation where necessary, deregulation elsewhere	PIA would represent access at the lowest level of the network. In other countries, this has stimulated investment and the development of commercial agreements between operators. This ultimately reduces the reliance on regulation of active services over time and enables the rolling-back of regulation in competitive geographic areas.

We strongly encourage Ofcom to look into a revised PIA approach in more detail. PIA is necessary in the UK if Ofcom wants to create the right environment for deeper competition and the development of ultrafast broadband services. Only with FTTH can operators provide UK consumers with the same choices, opportunities and prices which are already available to millions of consumers in Europe.

In this report, we provide examples of where PIA has been successfully implemented in other countries. We describe the impact that it has had on the market and on customers in these countries. We go on to explain the features of the PIA system that have made it successful and our recommendations for how this experience could be applied in the UK. We focus on Spain and Portugal where Vodafone has direct experience of FTTH roll-out through PIA and complement these with examples from other leading EU markets.

3 Impact of PIA

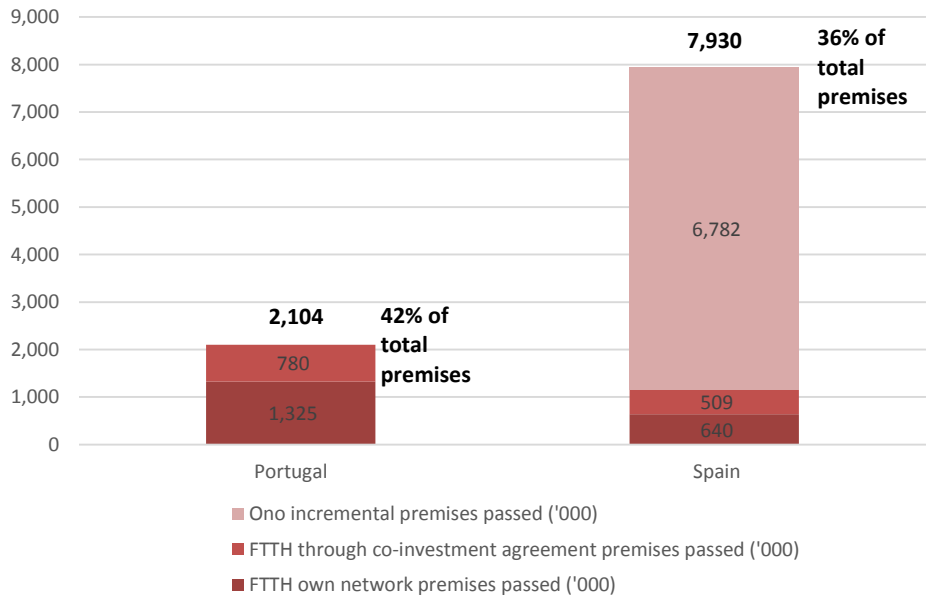
PIA has had a significant positive impact on the broadband market and for consumers.

PIA has had a major impact on the entire telecommunications market in the countries where it has been implemented effectively. In Spain and Portugal, for example, PIA has encouraged investment into competing FTTH networks in both urban and rural areas.[4] This has resulted in more innovation, better network performance and improvements in the quality of service provided to customers.

3.1 The impact on investment into fibre-optic networks

Effective PIA has been a fundamental part of the FTTH network investment in Spain and Portugal. It has reduced capex requirements and accelerated network deployment. This has resulted in faster network deployment and more competition while at the same time avoiding unnecessary duplication of networks. Figure 1 below shows current Vodafone NGA deployment in the two countries.

Figure 1: Vodafone NGA deployment in Spain and Portugal – Premises (HH) passed



Source: Vodafone
Note: Data for Portugal is as of August 2015, data for Spain is as of June 2015

Faster network deployment

[4] Vodafone accepts that PIA will not be suitable everywhere. Access to a suitable active product like VULA will be required in geo-types that cannot support alternative fibre investment via passive access.

PIA significantly reduces the capex required for rolling-out FTTH networks. In Spain, for example, PIA has reduced Vodafone's capex per home passed in its FTTH network rollout by at least 40% compared to building it on a greenfield basis. This has allowed us to roll out FTTH networks faster and further than would have otherwise been possible.

There has been strong demand from competing operators for access to Telefonica's ducts since the introduction of the new regulatory system (known as MARCo[5]) in November 2009. The length of Telefonica's ducts being accessed through this system has increased ten-fold over the past five years and now stands at over 10,000km.

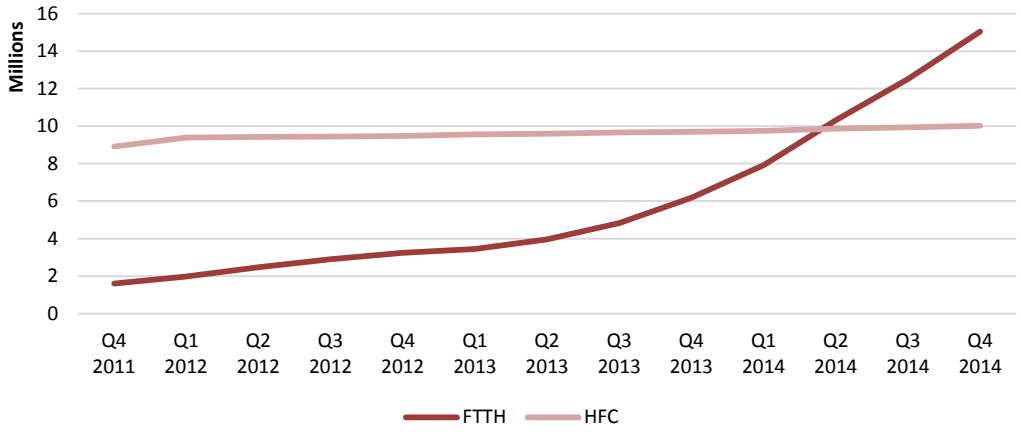
There is no sign that demand for PIA in Spain is slowing down. In fact, the use of Telefonica's ducts has accelerated over the last two years (Figure 2).

Figure 2: km of Telefónica sub-ducts occupied - monthly cumulative, all operators

This rapid take up of PIA has been driven by the Spanish operators' FTTH network rollout programmes. Fewer than 2m homes in Spain had FTTH networks passing them in 2011. By the end of last year this number had increased to 15m – an increase of 842% over three years. FTTH network coverage overtook that of the cable TV networks at the beginning of 2014 and now reaches many more homes, despite having started from a very low base only 4 years ago (Figure 3).

[5] Access to ducts in Spain is regulated by the Mayorista de Acceso a Registros y Conductos (MARCo)

Figure 3: NGA access by technology type (HH passed), all operators



Source: *Comisión Nacional de los Mercados y la Competencia (CNMC)*

The rapid expansion of the FTTH networks has been the result of large scale investment by both Telefónica and the competing operators. Telefónica spent €6.7 billion in network investment between 2010 and 2014, covering both fibre and mobile networks.[6] This investment has been driven by competitive pressure from other operators such as Vodafone and Orange which have been rapidly developing their networks using PIA. Vodafone, for example, announced over €600 million of investment in Spain[7], much of which was for fibre networks. More recently, Orange announced that it will invest €70 million this year alongside Vodafone in fibre-optic networks in the Basque region connecting half a million homes.[8]

This experience stands in contrast to BT's fibre-optic network investment in the UK. Rather than accelerating its FTTH network rollout, as Telefonica has done, BT has cut back on its FTTH deployment. It initially announced its intention to roll out FTTH to 25% of British households and currently offers FTTH to less than 10% of households and only on an 'on demand' basis.[9]

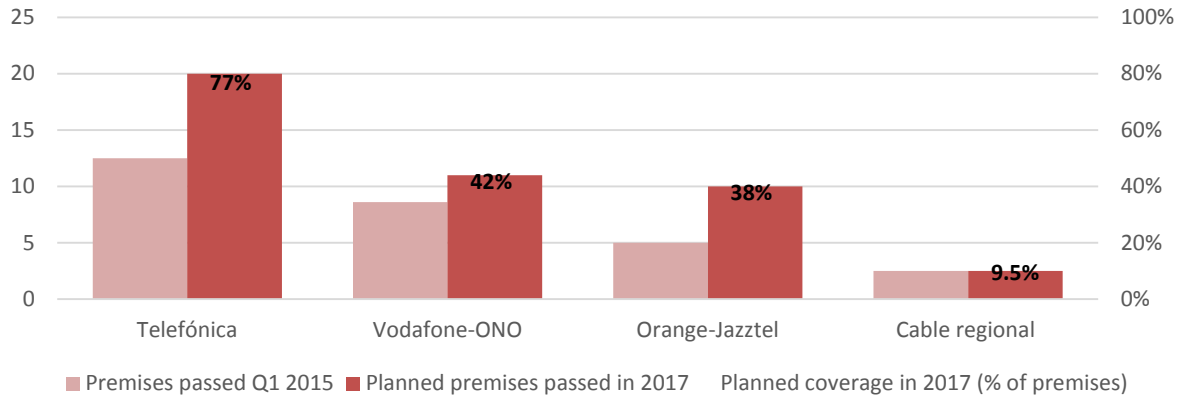
In Spain Telefónica has faced direct fixed network competition from Vodafone and from Orange and this has given it an incentive to roll out its own FTTH network as quickly and as extensively as possible. In the UK Virgin Media has been the only significant network competitor so the competitive pressure on BT to invest has been much less.

[6] http://www.efeempresas.com/noticia/telefonica-se-propone-acabar-con-la-brecha-digital-en-2020-llevando-la-fibra-al-97-de-los-hogares/
[7] http://www.vodafone.es/conocenos/es/vodafone-espana/sala-de-prensa/notas-de-prensa/
[8] http://ccaa.elpais.com/ccaa/2015/03/23/paisvasco/1427115750_423167.html
[9] http://www.alphr.com/news/broadband/391612/bt-aimed-to-get-true-fibre-to-25-of-uk-the-actual-figure-0-7

Increased competition for network provision in rural areas

The impact of an effective PIA regulatory framework is not limited to urban areas. By reducing the cost of FTTH network deployment, it has allowed operators to expand their networks outside core urban areas. In Spain, for example, Telefónica's FTTH network is expected to cover 77% of Spanish premises by 2017 while Vodafone/ONO and Orange/Jazztel are expected to reach 42% and 38% of premises, respectively (Figure 4).

Figure 4 : Actual and planned FTTH coverage by operator – Million premises



Source: CNMC
Note: Vodafone/Ono coverage includes Ono's own cable network

Even in areas of the country where it has not been commercially viable to deploy fibre-optic networks, PIA has had a positive impact. By creating a competitive market between FTTH players, it has enabled operators other than the incumbent to successfully bid for public subsidies for rural broadband rollout.

In Portugal access to PT's ducts has enabled DST, a construction company, to win a tender for the roll-out of FTTH in various rural areas under a government-subsidised scheme. The company was able to deploy a 9,000 km long fibre network, covering 44 rural Portuguese municipalities in the Norte Region, Alentejo and Algarve, which are some of the areas with the lowest GDP capita in the country.[10] This represents a geographic coverage of 20% and a population coverage of 7%, mainly in rural and economically marginal areas of the country.[11]

The impact of PIA on this tender was very significant.

"The cost of passing each household [in these rural areas], to meet the established coverage criteria, is estimated at between 651 euros and 1,630 euros, with this difference mainly resulting from whether or not use is made of existing ducts, masts and buildings of the incumbent operator or other

[10] http://www.norte.dstelecom.pt/rede/ambito/
[11] http://www.prysmiangroup.com/staticres/Nexst-2015-2/bringing-future-proof-quality-networks-to-rural-portugal.html

entities, since, according to various estimates, civil works account for about 70% of a (NGA) network's development cost"[12].

This contrasts with the situation in the UK where only BT has, so far, been able to win contracts under the BDUK framework to deploy FTTC.

Limited network duplication

PIA has facilitated investment into FTTH networks while at the same time allowing the market to develop efficient models of co-investment and network-sharing which have avoided unnecessary duplication of investments. These models have also necessitated little or no involvement by the regulator.

In fact, rather than duplication of networks, the co-investment models have allowed operators to expand their network coverage beyond the areas that they would have been able to reach on a standalone basis, without impacting co-investors' incentives to compete with one another. In Spain, the agreements between Vodafone and Orange specify divisions of responsibilities for developing and managing the infrastructure, as well as penalties to ensure compliance of all parties. These arrangements have allowed the operators to reach twice as many households as they would otherwise have and therefore expand the geographical scope of FTTH competition.

Another advantage of co-investment agreements is that, because they require negotiations and discussion between the parties involved, they generally result in symmetric and better defined operational processes, compared to those established with the incumbent through regulation. This has helped with issue resolution and reduced recourse to the regulator, ultimately facilitating network deployment.

In Portugal network-sharing agreements led to the establishment of monthly meetings between the operators that function as alternative issue resolution mechanisms and reduce the need to involve the regulator. These mechanisms have had a marked effect on the operation of the PIA system. The proportion of approvals for access to PT poles has risen from 30% to 80% and a new joint system has been established for more accurate storing of customer addresses. It is used by operators, reducing their dependence on regulation.

More details on the form of these co-investment and network sharing agreements are provided in Appendix A.

3.2 The impact on customers and competition

Ultimately, the most important impact of PIA is on the improved customer experience and quality of service that has been experienced by allowing operators to develop and maintain their own FTTH networks. By developing their own FTTH networks, operators are able to drive product and service innovation and to control the customer's end-to-end experience.

[12] ANACOM, http://www.anacom.pt/render.jsp?categoryId=340689#.VhPP--xVhHw -

Product and service innovation

PIA allows competing operators to develop their own FTTH networks which give them complete control over how products and services are developed and brought to market. This allows competition over a broad range of product characteristics which operators can use to meet the needs of their customers.

This is in contrast to the situation in which competing operators are dependent on the incumbent's regulated active wholesale product to provide broadband to their customers. This arrangement limits their ability to innovate in products and services. It is the incumbent's technology choices and service provision parameters that determine many of the key parameters of the broadband products that they consume. For example, an operator cannot launch a new speed broadband product, unless the profile has been designed and implemented by the incumbent, which is a complex and time-consuming process. In the absence of PIA, decisions about the technical specifications of the broadband product are left almost entirely in the hands of the incumbent, which dictates the pace of product innovation in the market.

The restrictive nature of regulated active wholesale services is illustrated in **Error! Reference source ot found.**. This shows that, where Vodafone operates an FTTH network using an effective PIA regime, it is able to offer a broader range of services and at cheaper prices than where it is dependent on a regulated Virtual Unbundling Local Access (VULA) product. [13]

Table 2: Comparison of Vodafone's offers

	UK	Spain	Portugal
Price	£42 (£25 + £17 for line rental)	£41	£41 (£37 + £4 for TV box rental)
Speed	76 Mbps	300 Mbps	200 Mbps
Mobile telephony	**X**	✔ [14]	✔ [15]
Mobile broadband	**X**	1 GB/user	1 GB/user
Fixed telephony	✔ [16]	✔ [17]	✔ [18]
IPTV	**X**	✔	✔

Source: Vodafone UK: Superfast Fibre+, Vodafone Portugal: Pacote Tv + Net + Voz + Móvel , Vodafone Spain: Vodafone One Fibra Ono 200Mb Plan Móvil S
Note: The offers refer to the bundled package for new customers with the highest broadband speed.

As the simple comparison above demonstrates, in Spain and Portugal customers are able to receive a better range of services at similar or lower prices than what we can offer in the UK where we are constrained by the technical specifications and the pricing imposed by BT on its VULA product.

[13] Comparison considers top-line products in the three markets available on 1/10/2015. Listed prices apply to new customers and exclude promotional pricing.
[14] Up to 200 minutes per month
[15] Unlimited to Vodafone + 2.000 minutes and SMS to other operators per month
[16] Off peak only
[17] Unlimited to Vodafone + 3.000 minutes fixed and 60 minutes to mobile to other operators per month
[18] Up to 3000 minutes per month

Control over the entire customer experience and impact on competition

In markets where operators have been able to develop their own FTTH networks, they are able to fully control the customer experience from sale to activation and throughout the customer lifetime, which has driven differentiation and an overall improvement in quality of service experienced by customers.

Where operators are dependent on the incumbent's network, on the other hand, customers of all operators receive a similar quality of service which is mainly dictated by the performance of the incumbent operator providing the wholesale service. There is also limited commercial incentive for the incumbent to perform beyond the standards specified in the regulated Service Level Agreements (SLAs).

In Spain and Portugal, our FTTH rollout has allowed us to compete across new customer service dimensions that are not possible when products are provided via regulated active wholesale services. Examples include:

- Time taken and ease of installation, including customer-specified times for installation;
- Time taken to activate services;
- Fault diagnosis and repair times; and
- Customer complaint handling.

We can see the impact of this on the service that customers receive from our experience in Spain. There, we are able to provide a significantly better Quality of Service (QoS) when we use our own FTTH network than when we are dependent on Telefonica's wholesale services (**Error! Reference ource not found.**). [19]

Table 3: Comparison of QoS via different delivery methods

[✂]

These differences in QoS translate directly into customer satisfaction. Figure 5 illustrates that Vodafone customers in Spain are significantly more satisfied with services that are provided via its own (fibre) network than via Telefonica's network. The differences are especially pronounced in tasks that require significant involvement of the incumbent, such as activation time.

Figure 5: Customer satisfaction

[✂]

Finally, full infrastructure competition in which competitors control the whole network supply chain, avoids a situation in which customers are exposed to problems that might arise with the incumbent's network and operations.

[19] Some of the difference in QoS may be due to inherent differences between copper and fibre networks but much of it is driven by the additional complexity of processes required when dealing with the incumbent's wholesale services and by the inability of Vodafone to control the entire customer experience.

Our experience in Spain this year illustrates this point well. Industrial action by Telefónica's technicians in 2015 caused maintenance problems with the network and increased the backlog of fault repairs on Telefonica's copper network. This affected all customers dependent on Telefónica's network, including those receiving their services from competing operators such as Vodafone. Customers connected to our own network and serviced by our own engineering team, on the other hand, were unaffected by these problems. Figure 6 illustrates how the fault backlog on Telefonica's network built up during the industrial action and compares it with the backlog on our own network. This clearly shows the advantages of full network competition – avoiding a situation in which all customers are dependent on the performance of a single network and operator.

Figure 6: Faults' backlog for Vodafone xDSL customers (on Telefónica's network) and Vodafone's customers on Ono's network (own network)

[✂]

In the UK we have seen a similar problems with QoS arising from BT's performance. Operators have found that it is not possible to provide customers with a guaranteed level of services because of their dependence on BT for some or all of the service provision. For example, in a recent response to Ofcom, Sky stated that:

- *"More than 90% of the new line installations which require a BT engineer take at least 10 calendar days, with one in 10 installations takes longer than 30 days.*
- *BT changes the agreed installation date for Sky customers on average around 36,000 times a month.*
- *BT misses over 500 appointments each month to install new lines for Sky customers and fails to complete a further 4,000 jobs per month.*
- *Fault rates across BT's network increased by 50% between 2009 and 2012, the last year for which reliable data is publicly available.*
- *BT's performance in fixing faults is consistently below the targets set out in agreements with service providers."*[20]

These issues demonstrate the problems that arise when competing operators are dependent on an incumbent for key inputs to the service delivered to their customers. Competition between ultrafast broadband networks, enabled through an effective PIA regime, avoids many of these issues by allowing operators to control the end-to-end customer experience and to adapt to consumer demands more rapidly.

[20] https://corporate.sky.com/media-centre/news-page/2015/response-to-publication-of-ofcom%E2%80%99s-strategic-review-of-digital-communications-discussion-document

4 The situation in the UK today

PIA regulation in the UK is not effective at the moment. The process is excessively cumbersome and too often results in denial of access or unjustifiably high charges.

PIA in the UK has not been effective and has not led to significant FTTH deployment. The current PIA regime was introduced by Ofcom in 2010 and BT published its PIA reference offer in 2012. Since then PIA access has not been used by alternative operators on any significant scale.

This is not due to lack of interest by operators. Evidence suggests the ineffectiveness of the current regulation has acted as a major inhibitor to wider adoption. Table 4 provides a high level summary of some of the key concerns with the current PIA regime in the UK.

Table 4: Selected factors impacting negatively PIA's success in the UK

Selected issues with UK PIA regulation	Examples
Regulation is not comprehensive	- Poles and vertical wirings are not comprehensively regulated - Some key processes (e.g. information request) are not defined - Some processes are too cumbersome (e.g. establishing an operator as "customer"), while other are not comprehensively defined
Access to ducts is uncertain and not guaranteed	- No obligation to repair collapsed or obstructed ducts - No obligation to remove dead cables - No obligation to propose alternative route - No obligation to share its chambers with other operators - No obligation to provide access if there is insufficient space
Information on infrastructure is not readily available	- There is no database accessible to operators to plan their roll-out. There is no information on infrastructure availability. Operators have to rely on surveys - Information requests are inefficient: information requests have to be done at an individual exchange level and BT treats each request separately and processes it manually - The results of surveys are not shared with the industry so every access seeker has to repeat the survey of the same area.
Ancillary services are not cost-based	- BT charges access seekers for services that should be free of charge (e.g. fixing of collapsed ducts) - Ancillary services are overpriced
Confidentiality of roll-out plans is not guaranteed	- Information request has to be done at the exchange level, so plans on roll-out have to be shared with BT
Usage of accessed ducts is restricted	- Duct can only be used for broadband provision to residential customers. This reduces the economies of scope that could be achieved through optimisation of network roll out for other services such as mobile backhaul or enterprise broadband provision. - It also imposes an additional cost to operators as network management systems are not designed to maintain network information at a service-specific level.

Source: Vodafone analysis

The ineffectiveness of the existing regulation can be grouped into three broad categories – pricing, processes and passive infrastructure availability.

Pricing

Pricing represents the first bottleneck in adoption of PIA in the UK. The price of basic duct access in the UK is broadly consistent with many European countries but it is worth noting that it is more expensive than in Portugal. However, importantly, the basic charge for duct access forms only one aspect of the overall cost. Under the current regime in the UK, operators are subjected to a wide range of costs for ancillary services connected with infrastructure access. The current regulation does not cover all of the prices that BT can charge for services or provide rules for determining when it is necessary to purchase these services. This regulatory gap contributes to both inflated prices and cost uncertainty that render PIA-based projects economically unfeasible or too risky.

BT charges both for services connected to accessing the infrastructure and for services related to the ongoing use of the infrastructure, such as repairs. In Spain and Portugal equivalent charges are lower and simpler than in the UK and some ancillary services are provided free of charge. The differences in the charges between Spain and the UK for non-recurrent ancillary services are substantial and have a significant impact on the overall cost of network rollout using PIA (Table 5).

Table 5: List of current Spanish non recurrent ancillary charges and similar UK charges

Feature in Spain	**Charge £ Excluding VAT – Spain**	**Similar charges in the UK (£ Excluding VAT)**
Information request	£ 23.30	£75/h - Route plan Provision - per hour £75/h - Network records administration charge - per hour
Analysis of the application before survey	£ 38.75	£615.00 Operative accreditation - surveyor £615.00 Assessor accreditation - surveyor
Survey	£ 113.65	
Opening joint box	£ 32.47	£600.00 Joint box breakthrough £12.00 Joint box breakthrough administration charge
Opening manhole	£ 11.37	£522.00 Joint Chamber/Manhole 'pull through' – per 100m sub-duct
Pole visit	£ 4.38	

Charge for works that require the supervision of incumbent	See table below	
Registration of the access request	£ 23.25	£263.00 CP accreditation - per licensing site

Source: Vodafone analysis based on Vodafone Spain and BT[21] data

Even in relation to routine operations, operators in the UK are subject to significantly higher prices than in Spain or Portugal. For example, if the access seeker wants access to the incumbent's infrastructure to conduct routine work, it has to pay for the incumbent's staff to be present on site. The rates differ significantly between countries. While charges in Portugal and Spain are about £30/hour, BT in the UK charges £52.70/hour, nearly 75% more. Table 6 compares charges for works that require the supervision of the incumbent in Spain, the UK and Portugal. It is also worth noting that, unlike the UK, not all work inside the incumbent's infrastructure requires the presence of the incumbent's staff in those countries. A system of accreditation has been set up that allows some processes to be undertaken by competing operators' staff without the presence of the incumbent's personnel.

Table 6: Charges for incumbent supervision of works on infrastructure

Spain (£)	UK (£)		Portugal (£)
Charge per work 77.11	260.30	Co-op survey – per survey	Standard charge 29.10/h first hour, 17.30/h following hours up to 88.60 max
Charge per hour of work 30.85/h	80.05/h	Work outside Working Hours (excl. Sunday and bank Holidays) - per hour	Work outside Working Hours 45.30/h first hour 31.80/h following up to 184.50 max
	105.4/h	Work outside Working Hours - Sunday and Bank Holidays - per hour	
	52.70	BT Assist - per visit (for sensitive areas)	
	52.70 /h	BT Assist - per hour (for sensitive areas)	

Source: Charges were sourced from BT website, Vodafone Spain and Vodafone Portugal
Note: exchange rate £/euro 1.355.

There are many other examples of how details of the PIA regime in the UK increase the cost of competitors' network rollout. Access to BT's chambers is an example of this. Under the current arrangement, BT is not required to share its chambers with other operators. Competing operators are therefore required to duplicate existing infrastructure and build their own chambers, which are then connected to the original chamber owned by BT. BT charges a fee of up to £600 for drilling a hole to connect the two chambers, which is significantly above the cost of such a service. This is in addition to the cost of building a separate chamber, which can be £1,000 - £1,200. The lack of obligation on BT to share its chambers leads to unnecessary disruption and duplication of the costs and negatively affects network investment through PIA.

21

https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=%2BDv%2Bc9B8jITi5t3ObgmQQkgPp7N1FyAmTcwlXCnmJclZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D

Operational rules and procedures around PIA

The experience of PIA across Europe shows clearly that the details of the operational procedures around the PIA system are key to its effectiveness. Where these procedures are well designed, PIA is a highly effective regulatory measure. Where they are slow or difficult to follow, PIA does not have the same impact on the market.

Access to PIA in the UK is governed by BT-centric manual processes that increase the approval times and slow down network deployment. As a result, processes for network deployment through PIA in the UK are more difficult to follow and lack transparency, all of which create a drag on network deployment. Process bottlenecks that currently affect PIA in the UK can be grouped into four stages (Table 7).

Table 7: Process bottleneck stages

Stage	Description	Bottleneck
Pre-access planning	BT does not share with operators its data on existing infrastructure. While BT has a record of its ducts and poles, these cannot be consulted by access seekers before placing a formal access request, which negatively affects the operator's planning ability and flexibility.	• Unavailability of direct access to database
Infrastructure surveys	Following the access seeker's initial request, BT has estimated the time to respond and send the relevant maps to be 10 working days, but this timeline is not binding. As no information on availability is provided by BT, the access seeker has to entirely rely on surveys to determine where space is available. While the burden is on the access seeker to perform a survey and confirm whether there is availability in the ducts, access seekers are granted only limited access to BT's infrastructure. This effectively makes access seekers' field surveys only preliminary, as they do not enable access seekers to firmly conclude on whether space is available throughout the route.	• BT's lengthy manual response process • Reliance on surveys for duct availability, no upfront information • Limited range of access to infrastructure • BT's time-based charging for this activity means they have no incentive to improve
Survey evaluation	Once the access seeker performs a field survey, it needs to communicate the information gathered to BT, for their records to be updated. However, the information is not shared with other operators so that another operator who might want to deploy in the same area would not be given the information gathered during the field survey and would need to survey the area again, instead of BT updating its records. If during the survey it is found that ducts are not viable due to blockages (e.g. part of the duct may be collapsed), BT requires the access seeker to pay for repair work, which can only be performed by BT or its contractors, thus limiting the ability of the access seeker to control costs.	• BT's lengthy manual response process • Lack of sharing of survey findings with other operators • Resolving collapsed / unavailable duct, no upfront information
Formal application procedure	Following the initial survey, a formal access application needs to be submitted to BT with a request for each area the operator seeks to access. Due to no timeline for processing, it usually takes BT 20-25	• BT's lengthy manual response process • Separate applications for each area of interests

	days to respond to each the application. The long and uncertain timeline, together with the requirement of submitting individual requests for each area, are cumbersome and inhibit uptake.

Source: Vodafone analysis

The pricing and process issues highlighted in this section help explain the low uptake of PIA in the UK so far. The regulatory regime is insufficiently comprehensive, uncertain, slow, and cumbersome. In order to improve the regime, Ofcom should redesign the existing regulation to mitigate the problems that have been identified and develop a system that will lead to broad PIA uptake by competing operators.

Passive infrastructure availability

The availability of passive infrastructure is a key factor in the success of any PIA regime. Historically, data on the availability of BT's passive infrastructure has been limited and there have been some concerns about its quality. According to the 2010 sample survey prepared by Analysys Mason for Ofcom, 63% of the 90mm duct ends surveyed and 97% of the 50mm duct ends surveyed had at least 42% of unoccupied space. However, unoccupied duct-end space does not directly translate into useable duct space because of faults, collapses, and cable arrangement within the duct. [22]

Clearly, this is potentially an issue that has to be addressed if an effective PIA regime is going to be introduced in the UK. However, several significant developments have taken place since 2010. Firstly, Openreach has undertaken significant development of its FTTC network, investing £2.5 billion in fibre broadband roll-out up to Spring 2014.[23] The amount of data available to Openreach on its network infrastructure has therefore increased very significantly since the 2010 Analysys Mason survey. Secondly, we expect this situation to improve further with the incorporation of the 2014 Directive on measures to reduce the cost of deploying high-speed electronic communications networks[24] into UK law which will require the mapping of existing network infrastructure.

It is important to note that other countries have faced similar challenges in the design and implementation of PIA regimes but have dealt with these through a combination of regulatory rules, commercial incentives and investment by the whole industry. The situation in the UK should be no different – the lack of past investment in both network infrastructure and the associated data resources cannot be considered as a valid reason to limit future investments. The sooner effective action is taken to address these challenges, the sooner a sustainable market outcome can be reached.

[22] Analysys, Mason, "Final report for Ofcom - sample survey of ducts and poles in the UK access network", January 2010

[23] http://www.bt-ngb.com/about

[24] Directive 2014/61/EU of the European Parliament and of the Council of 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks. Text with EEA relevance/ http://eur-lex.europa.eu/legal-content/EN/NOT/?uri=uriserv:OJ.L_.2014.155.01.0001.01.ENG

5 Determinants of PIA's success in Spain and Portugal

A review of the uptake of PIA in Spain and Portugal suggests that the key factors of success of PIA are common to the two countries.

The experience of countries that have successfully introduced PIA provides useful practical insights that can serve as guidelines for the UK. We chose Spain and Portugal to showcase the success of the PIA regimes there and to illustrate the positive impact on Vodafone as an access seeker. In these countries, PIA has allowed Vodafone and other operators to emerge as a significant investor in fixed network infrastructure competing with both the incumbent and other operators. Our experience indicates that the determinants of success are common across the two countries. However, Spain and Portugal are not the only countries where effective PIA regulation has given rise to significant benefits. France, Lithuania and others have implemented PIA and lessons can be learnt also from the experience of these countries. Appendix C provides more details.

At a high level, successful PIA implementations require regulation that is comprehensive, covering all aspects from operational processes to pricing, across the whole range of required infrastructure. At the same time, regulation should be sufficiently flexible to adapt to new circumstances and changes in the market.

5.1 Regulation of processes

An effective PIA regulation needs well-defined processes in order to facilitate access to passive infrastructure. In Spain and Portugal, detailed process descriptions define the handling of access requests, availability of information, timelines, SLAs etc. with clear timeframes and penalties. Well-designed processes allow operators to plan their roll-outs efficiently, reduce uncertainty about both costs and timelines, and shorten the deployment process.

The effect has been to ensure that the incumbents do not delay providing access to their infrastructure. **[✂]**

Figure 7 shows the number of access requests (SUC) made in Spain, which can be interpreted as a proxy for the speed of deployment. **[✂]**

Figure 7: Submitted and approved SUCs

[✂]

5.2 Regulation of access to information

Availability of up-to-date information about existing infrastructure is paramount to successful PIA implementations. In Spain and Portugal information is stored in databases that are continuously updated to reflect the location, status, and availability of ducts and other infrastructure. The databases, maintained by Telefónica and PT[25] in Spain and Portugal respectively, are accessible to all operators and approved contractors, thus avoiding unnecessary delays which would be caused if exchange of information between operators was needed.

Table 8 summarises the databases available to operators in Spain and Portugal. Coverage and functionality of the databases has been constantly evolving as new information becomes available.

Table 8: Summary of processes for access to information in Spain and Portugal

	Spain	Portugal
Database name	• Escapex (introduced in 2012) • Carpe (older, still in use)	• Extranet (older) • SIC (in pipeline)
Manager / maintainer	• Telefónica	• PT • SIC will be managed by ANACOM[26]
Coverage	• Ducts, sub-ducts, cables, poles, and registers (granularity of information depends on the type of infrastructure)	• Extranet: all PT infrastructure except poles • SIC: Currently under development. Will cover all infrastructure from all utilities, e.g. electricity
Information on duct availability	• Yes	• Yes
Continuous updating	• Yes, following accesses to infrastructure by Telefónica for own purposes or requests by other operators	• Yes, using survey information submitted by operators

Source: Vodafone Spain, Vodafone Portugal

5.3 Regulation of obligations on incumbent on duct availability

Following a successful information request, the access seeker should be guaranteed access to the infrastructure in all but exceptional circumstances. Successful PIA regulation limits the infrastructure owners' ability to use faults in the infrastructure or lack of availability as an excuse to refuse access.

In Portugal the infrastructure owner is mandated to reserve space on all its ducts for access seekers, while in Spain Telefónica must satisfy access requests and provide access to a portion of its subducts depending on the total number of subducts deployed. Incentives exist to "nudge" the incumbent towards compliance if necessary. For example, in both Spain and Portugal the infrastructure owner has to propose an alternative route if the requested one is not viable or provide dark fibre over the requested route.

[25] PT maintains a database of its ducts (Extranet). Other utilities are responsible for sharing information on their infrastructure. As PT infrastructure is the most extensively used by access seekers, details on the Extranet are provided in Table 15 above.

[26] Autoridade Nacional de Comunicações, Portuguese communications regulator

Table 9: Duct space reservation and remedies

	Spain	Portugal

Space in incumbent's duct reserved for other operators	• Depends on number of subducts:
	  • 2 : 1/3 of a subduct
	  • 3 to 7 : 2/3 of a subduct
	  • 8 or more : a subduct
		• 20% of the usable space in the ducts

Remedy if space not available	• Alternative route • Provision mini-ducts and flexible ducts • Removal of dead cables to make space or lump of all available fibres • Dark fibre at Telefónica's expense (temporary remedy: to be provided until alternative route is built or ducts are repaired)	• Removal of dead cables to make space (at infrastructure owner's expense) • Alternative route

Source: Vodafone Spain and Vodafone Portugal

Further, unlike in the UK, there are no restrictions placed on what services ducts are used to provide in both Spain and Portugal. This enables operators to exploit economies of scope in network deployment and plan their network in an optimised manner across all services and customers, including enterprise and mobile.

5.4 Regulation that governs the access and use of poles

A comprehensive and effective poles regulation is key to the deployment of FTTH in areas characterised by single family homes. Because of predominance of multi-unit dwellings which are accessed through duct and in-building wiring in Spain and Portugal, the uptake of access to poles in Spain and Portugal has been limited.

Effective PIA regulation has to ensure that poles deployment costs are clear and uncertainty over investments is minimised. Existing regulation in Spain and Portugal is not comprehensive and contains gaps that lead to inefficiencies in the deployment process and therefore leaves room for improvement. For example, the lack of guidelines for replacement of poles has led to more than a 90% replacement rate in response to access requests by Vodafone in Spain. No appeal process or other recourse is available for operators to contest these decisions and associated charges.

Table 10: Summary of pole regulation

	Spain	Portugal
Top-line regulation and process	• Regulation similar to ducts • Special permissions from municipalities required	• Regulation similar to ducts • Special permissions from municipalities required
Information in a database	• Location but no availability	• None, but access seeker can consult paper maps
Access	• Only by Telefónica's technicians	• Only with PT's technicians
Key gaps in reference offer	• No requirements for alternative route specification • Many "time-stop" points in the timeline	• No requirements for alternative route specification • Many "time-stop" points in the timeline

	• No obligation to make space available for other operators • Deficient process for determining pole replacement needs	• No obligation to make space available for other operators • Deficient process for determining pole replacement needs
Ancillary Pricing	• Regulation incomplete[27] • Telefónica can only charge incurred costs plus a fee for project development. Commercial mark-up not allowed • Telefónica charges up to €1,800 per pole for replacement if no space is available or supportable	• Poles reference offer does not regulate poles' replacement nor ancillary services strictly connected to poles • PT generally does not allow replacement for poles

Source: Vodafone Spain and Vodafone Portugal

5.5 Regulation that governs the access and use of vertical and in-building wiring

Vertical wiring regulation is essential to ensure roll-out in new development areas with tall buildings or multi-unit dwelling units. Regulation of vertical and in-building wiring is necessary to ensure that the first operator to establish a network in the building does not then create a bottleneck that prevents competitors from accessing customers. It has also helped reducing disruption within buildings that might arise from multiple deployments within the inside the building (through verticals) or outside on the façade.

While telecoms NRAs (National Regulatory Authorities) have the remit to regulate the infrastructure of the operators, cooperation with agencies supervising the housing stock is necessary to ensure appropriate access, ownership, and billing of vertical wiring.

Table 11: Summary of vertical wiring regulation

	Spain	**Portugal**
Vertical wiring types	• Common telecommunication infrastructure (CTI) (built in some newer buildings) • In-building through vertical (newer buildings with no CTI) • Façade (older buildings)	• In-building through a vertical (preferred) • Façade (in case in-building not viable)
Infrastructure owner	• First operator to install wiring in the building or an entity as a result of a commercial transaction	• Owner of the building;
Last drop access	• Operators can use existing wiring or deploy their own (required for façade-based access)	• No regulation as a result of the building ownership of the in-building wiring
Operating costs	• Shared equally by the operators that use the vertical wiring	• Shared equally by the operators that use the vertical wiring

[27] MARCo includes technical specifications by type of poles, e.g. rules to calculate the space that has to be left available for access seekers.

Source: Vodafone Spain and Vodafone Portugal

5.6 Regulation granting access seekers' physical access to infrastructure

Regulating how access seekers can physically access passive infrastructure shortens the time required to perform many of the actions of the PIA process, such as repair of faults, surveying, and installation. There are two ways to allow access seekers to physically access infrastructure:

- Granting access seekers (and their contractors) the right to directly carry out works on the incumbent's infrastructure; and
- Regulating the process used by the incumbent to access the ducts in response to another operator's request and allowing the access seeker to participate in surveys of the infrastructure or assist with repairs.

The first option gives operators the ability to control the process and provides a way to compete in dimensions such as time of installation or repair time that go beyond those required from the incumbent.

Table 12: Ability of operators to access physical infrastructure via PIA

	Spain	Portugal
Field surveys	• With Telefónica	• With Portugal Telecom
Installation / maintenance / repair	• Alone	• With Portugal Telecom but operators can perform work independently

Source: Vodafone Spain and Vodafone Portugal

5.7 Dynamic regulation

A dynamic approach to regulation ensures that regulatory requirements can be quickly adapted to market conditions. Allowing regulation to be flexible and dynamic helps avoid overregulation and ultimately guarantees an efficient system. Regulation should be responsive to changes in business environment as well as to any shortcomings that operators identify in the process of deployment.

Table 13: Key changes to regulation since initial passage of PIA rules

Change	Country	Reason	Impact
Clear definition of non-urban and urban areas	Spain	Unclear definitions of non-urban area constituted a barrier to expansion for access seekers because of differential rules for urban and non-urban areas[28]	Clear definition made it easier for access seekers to plan roll-out, allowing them to know with certainty how they could have connected certain non-urban areas
Introduction of flexible duct and dark fibre obligations	Spain	Deployment by access seekers was inhibited in cases of low-quality Telefónica's ducts, unavailability of	Mandated availability of dark fibre enabled access in previously unavailable spaces

[28] For example, in non-urban areas there is no requirement to provide access to contiguous areas. This was problematic in cases where within a city there were areas that could have been classified as non-urban. Indeed, Telefónica used to benefit from the vague distinction between urban and non-urban and consider these areas as urban.

		space, or refusal of access	and created disincentive for unreasonable refusals of access to duct
Establishment of clear and short timeframe for SLA maintenance interventions	Spain	Initial timeframe for Telefónica's maintenance interventions of 15 days produced undesirable experience for consumers	Reduction of timeline to fix faults from 15 days to 8 hours improved QoS
Making available access to non-telecoms utilities infrastructure for connectivity deployment	Portugal	Initial Portuguese PIA regulation restricted access to infrastructure of PT only	2009 Law of Electronic Communication[29] extended access to infrastructure of non-telecom utilities and municipalities, and prompted updates to the access information database
Implementation of Extranet in March 2008	Portugal	Facilitate interactions with the incumbent (e.g. information requests, requests for viability analysis and installation requests)	Access process was facilitated

Source: Vodafone Spain and Vodafone Portugal

[29] 2009 Decree Law n.º 123/2009, of 21st of May establishing the legal regime governing the construction, access to and set up of electronic communications networks and infrastructures.

6 Conclusion: implementing an effective PIA regime in the UK

PIA is an essential factor for bringing investment into FTTH networks to the UK. We have presented evidence that has showed that merely having a PIA regulatory regime "on paper" is not enough - the regulation has to be implemented correctly or else it will have very limited impact.

Current PIA regulation in the UK is not fit for purpose and, as a result, the deployment of FTTH is lagging behind other European countries. But other European countries have implemented effective PIA regimes and these examples provide valuable insights for getting PIA right in the UK.

In this final section we summarise six key findings from our international experience and what Ofcom should learn from them. Getting the regulation right takes time but this should not deter Ofcom from pursuing changes with a clear goal in mind. An effective PIA regime will support investment into FTTH networks - an essential basis for the long-term improvement in the provision of ultrafast broadband in the UK.

6.1 Key recommendations

The key recommendations to achieve a well-functioning PIA regime are:

- The process for access to infrastructure should be streamlined with comprehensive SLAs and SLGs[30]. Penalties should be set for each stage of the SLAs.
- Prices for core and ancillary services should be cost-based.
- A database with infrastructure data should be created and made accessible to all operators.
- Space for operators should be reserved on infrastructure, with no restrictions on purpose for which access to the infrastructure is requested.
- Effective use of poles should be enabled.
- Rules for in-building wiring and wayleaves to access MDUs should be codified.

These are discussed below.

6.1.1 Streamline the process for access to infrastructure with comprehensive SLAs and SLGs. Penalties should be set for each stage of the SLAs.

The current process for accessing passive infrastructure in the UK is complicated, uncertain, and expensive. From manual processing of access requests to the requirement that BT's personnel are present during field work, the system contains many areas that could be automated, taken out of BT's control or otherwise made more efficient. An improved process would cut down the uncertainty associated with timings and costs that currently prevent operators from using PIA to deploy FTTH.

[30] Service Level Guarantees

Further, there should be committed SLAs with linked penalties for every stage of the defined processes.

6.1.2 Prices for core and ancillary services should be regulated on a cost-basis.

PIA regulation needs to consider the pricing of both core and ancillary services. Every charge should be cost-based. The current gaps in regulation have led to charges for ancillary services that are substantially higher than comparable services elsewhere in Europe, which access seekers must accept without recourse.

In addition, some services should not be fully charged to access seekers. For example, the cost of removal of obstructions should be borne by the incumbent, as part of routine maintenance of its assets.

6.1.3 Create a database with infrastructure data.

A detailed understanding of where existing infrastructure lies and its availability is critical for fast and efficient deployment of fibre networks. Other countries have implemented extranet map databases that contain information about location, status and availability of different types of infrastructure, including poles. The cost and effort to set up and maintain the database are minimal compared to the benefits they provide to operators who can plan their roll-outs independently and quickly, and these costs have been recovered through database charges in other countries. Guaranteeing fast and easy access to accurate information for all operators is a key feature of these databases. To this end, the management of the database could be the responsibility of an independent party, like Ofcom.

While a real-time business-to-business (B2B) gateway should be the ultimate goal this should not delay quick implementation of interim solutions.

6.1.4 Reserve space for operators, with no restrictions on purpose of use.

Reserving space in ducts and sub-ducts for other operators is key for reducing uncertainty in the time and cost associated with the physical roll-out. In other countries infrastructure owners have to reserve a portion of the duct for others and maintain it in a good working order.

We acknowledge that in some cases it is not immediately possible to provide space in ducts. In those cases the duct owner should repair the duct, clear its dead cables, provide an alternate route, or provide the access seeker dark fibre. The end purpose is the same: to guarantee space for access seekers to deploy their network. Further, no restriction should be placed on the use operators can make of the accessed infrastructure in terms of the services provided over it.

Further, obligations should be placed on BT to communicate any new planned deployment to all operators in advance.

6.1.5 Enable effective use of poles.

The regulation must provide clear and effective guidelines for access and use of poles in the UK. The special characteristic of the UK, where a large proportion of population lives in single-family homes, makes poles access regulation critical. In other countries, poles are often overlooked and treated as less important than ducts. In Spain, gaps in PIA regulation lead to high poles replacement rates and

high charges that inhibit their use. In the UK, poles regulation has to be given the same attention as regulation of ducts. This should include up-to-date databases of poles location and availability.

6.1.6 Codify rules for in-building wiring and wayleaves to access MDUs.

Availability of in-building wiring is crucial for deployment of connectivity to multi-unit dwellings. These rules need to address the existing housing stock and in particular set a good framework for new housing stock coming to the market. A large number of current new buildings contain multiple units and this trend will continue as more people move to increasingly crowded cities.

We understand that cooperation between Ofcom and other agencies will be necessary for setting up effective PIA regulation in buildings. Getting the rules right will enable faster deployment and enable stronger competition between operators.

6.2 Conclusion

The areas discussed above encompass all aspects of roll-out, from the drawing board to the customer. They highlight how important it is for the regulatory regime to be comprehensive. Gaps have significant spillover effects that negatively affect the entire deployment plans.

At the same time, the regulatory regime needs to be flexible to accommodate technological and market changes that current market participants cannot predict. Comprehensiveness and flexibility are not mutually exclusive. An effective PIA regulation enables commercial agreements between operators that deliver superior service for consumers. Evidence from other countries shows that infrastructure-based competition is possible and leads to desirable market outcomes.

We believe that implementing our suggestions will generate benefits to UK consumers, operators, and the regulator and urge Ofcom to implement them in response to this review.

Appendix A: Details on co-investment agreements

An effective PIA regime has enabled operators to enter co-investment agreements and increase the speed and extent of FTTH roll-out in both Spain and Portugal. Further, these co-investment and co-sharing agreements have reduced the risk of inefficient network duplication, and in turn enabled resources to be allocated more efficiently.

We believe that such agreements would be greatly beneficial to the UK market as well, reducing the need to rely solely on regulation to achieve desired market outcomes.

In this context, this section discusses the details of some of these co-investment agreements induced by PIA in Spain and Portugal.

Vodafone Spain and Orange

Table 14: Agreement characteristics

[✂]

Vodafone and Orange started a co-investment agreement in 2013, in which both operators committed to connect via FTTH an equal number of households and to grant each other access to the respective networks. The network sharing agreement is on the basis of an 'active' service.

[✂]

The agreement allowed Vodafone and Orange to double the areas in which they are able to offer FTTH services to customers, thus increasing competition in these areas.

[✂]

Risk bearing. The agreement does not restrict the number of customers each party can connect on the other party's network and therefore does not restrict competition on the retail level. However, the monthly fee per customer paid by both operators ensures operators are compensated for the costs incurred.

Vodafone Portugal and PT

Table 15: Agreement characteristics

[✂]

[✂]

[✂]

The arrangement allows both operators to have absolute autonomy and does not require them to share information on network use, service provision or customers, and it allows Vodafone to develop and provide, on an uninterrupted basis, differentiated and independent services from those provided by PT.

[✂]

Charge. Each party paid an equal lump sum for network deployment. There are no per customer fees or fees of other forms involved apart from the charges paid for the consumption of energy when Vodafone is co-located in PT's Central Office.

[✂]

Vodafone Portugal and NOS (Optimus)

Table 16: Agreement characteristics

[✂]

[✂]

Charges. Each party pays a fee per customer connected.

[✂]

Appendix B: Further details on PIA in Spain and Portugal

In the main part of the report, we focused on the key metrics and aspects of the success of PIA in Spain and Portugal.

In this section, we provide further evidence and discussion on the experience in those countries.

Take up of PIA in Spain and Portugal

Whilst the two graphs below show different metrics, the key message in both cases is the same. Effective PIA regimes have enabled increasingly fast FTTH roll out in both countries, starting from a negligible number of households passed in 2010, to significant coverage being reached by 2015.

Both figures also show that a step change in the rate of deployment has occurred from 2013 and speed of deployment is continuing to increase.

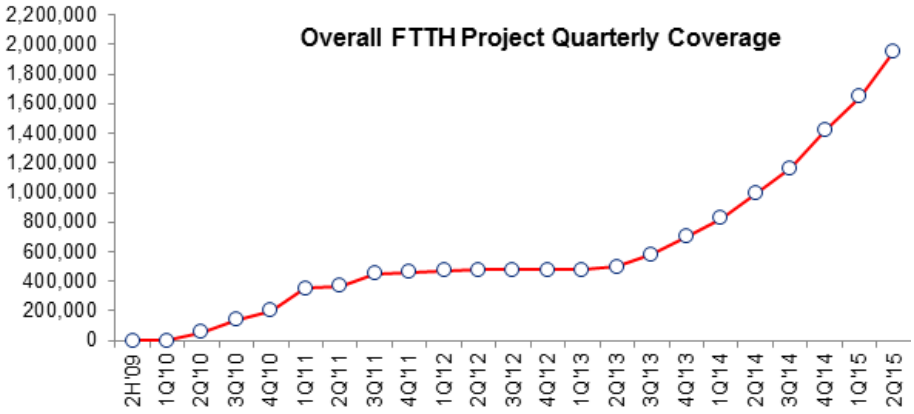
Spain

Figure 8: Total km of subconducts occupied in Spain

Source: CNMC

Portugal

Figure 9: Number of households connected in Portugal



Source: Vodafone Portugal

Operational details of key PIA determinants

This section provides some additional details on the operational aspects that have made PIA successful in both Spain and Portugal.

Regulation of process: Information request and access process

Spain

The MARCo covers most aspects of PIA, and defines specific steps in the process to obtain access to infrastructure. Among the processes that are regulated are:

- The access request (whose protocol is called 'Shared use Request' or 'SUC');

- The updating of the information database; and

- The SLAs process and the installation process.

Processes have defined steps, with attached timeframes and corresponding penalties for when these timeframes are not respected.

The steps required to access infrastructure as defined by the CNMC are in the table below.

Table 17: Defined steps to access ducts and poles – Spain

Action	Action owner	Timeframe	Charge to access seeker
Consultation of duct maps	Access seeker	-	€0
Validation of information request to Telefónica	Telefónica	10 working days to validate request and propose time for survey	€52.5

SUC 1: Joint survey	Access seeker and Telefónica	30 working days following information request validation	€154 + €44*number of vaults + €15*number of main holes +€5.5*Number of poles Recurring cost of €0.7 per year for each metre of 40mm subduct
SUC 2: Joint documentation	Access seeker and Telefónica	10 working days following joint survey	€0
SUC 3: Approval of SUC	Telefónica	5 working days following publishing of joint documentation	€0

Source: Vodafone Spain

According to the MARCo, Telefónica has 10 days to validate access seekers' information requests, after which the SUC can take up to 45 days. In practice, on average the SUC is completed in 36 days. The table below illustrates the time it takes Telefónica on average to complete the process compared to the regulated timelines set by the CNMC for the SUCs, and it shows that in most cases Telefónica completes the actions in less than the maximum regulated time.

Table 18: Regulated time and effective average time of SUC by action - 2015

	SUC validation SLA	**Site survey proposal SLA**	**T1: Site survey result SLA**	**T3: SUC confirmation**	**Total SLA (T0 to SUC Confirmation)**	**Pole assessment SLA**
Standard SLA	T0 +10 wd	T0 +10 wd	T0 +30 wd	T2 + 5 wd	45 wd	30 wd
Average lead time for FTTH:	**[✂]**	**[✂]**	**[✂]**	**[✂]**	**[✂]**	**[✂]**
Average lead time for FTTx:	**[✂]**	**[✂]**	**[✂]**	**[✂]**	**[✂]**	**[✂]**

Source: Vodafone Spain
Note: T0 refers to the validation of information request by Telefónica. "wd" refers to number of working days

The success rate of SUCs, i.e. the number of approved SUCs per 100 SUCs submitted, has been fairly stable over the years, and always above 60%, indicating that a well-structured process helps reduce arbitrary rejections by the infrastructure owner.

Figure 10: SUC's success rate

[✂]

Portugal

Similarly, regulation in Portugal also defines the key procedural steps for access to infrastructure. The steps required to access infrastructure as defined by PT Ducts Reference Offer are set out in the table below.

Table 19: Defined steps to access ducts and poles – Portugal

Step	Action owner	Timeframe	Charge to access seeker	Penalty
Consultation of duct maps	Access seeker	-	€100,000 per year for the entire country	-
Information request	PT	PT has 1 working day to respond	€0	€50/day
Viability analysis request	PT	PT has 10 consecutive days to give viability information to the access seeker	The analysis costs: €63 (without alternative route request) / €72.80 (with alternative route request) + €46.1 per CVPs passed Average price: €550	€50/day
Installation request	PT	If access is feasible PT has 5 working days to process and validate the access seeker request	€18	€50/day
Register request	PT		€0	
Joint survey	Access seeker and PT		Paid by PT if information request outcome validated, otherwise access seeker pays	

Source: Vodafone Portugal

Regulation of access of information: Information database

Access to information on the location and availability by operators is a key determinant of PIA success.

The following table summarises the key features of the existing duct database regulation in both Spain and Portugal.

Table 20: Ducts database regulation in Spain and Portugal

Action	Spain	Portugal
Database name	Carpe and Excapex	Extranet (SIC to be launched in the future) – does not include poles
Owner	Telefónica	PT (Extranet), ANACOM (SIC)
Infrastructure covered	Ducts (including sub-ducts and cables), poles and other registers	Ducts and registers. Poles are in separate database.
Access charges	Free of charge	Around €100,000 a year for the all country
Maximum number of registers per request	40	Ducts: 20 Poles: 50
Update timeline	15 days after each survey	30 days
Display of cable availability	Yes. Displays number of available cables.	Yes. Traffic light system in place
Map view functionality	Yes.	Yes for ducts and registers. Extranet does not cover poles (whose map can be requested via email).
Planned improvements	Telefónica launched Excapex in2012 and is currently migrating all maps from Carpe.	PT is introducing an algorithm to calculate best route given availability. ANACOM plans to launch SIC, which will be managed by ANACOM and will include utilities ducts.

Source: Interviews with Vodafone Spain and Vodafone Portugal

Regulation on obligations on incumbent on availability

In both Spain and Portugal, the incumbent is subject to specific obligations to ensure that availability of infrastructure is achieved as often as possible. This includes obligations on the incumbent to undertake required repair and maintenance activity on its infrastructure to minimise the occurrence of blockages.

Spain

The CNMC requires that all repair costs are shared by all affected duct occupiers according to their usage of the ducts. Telefónica is required to initially bear all costs, which it then divides among all

affected operators according to rules set in the MARCo. All repairs and tasks have well defined SLAs and responsibility is assigned by the CNMC. The following table reports some of the incidence maintenance tasks as defined by the CNMC:

Table 21: Selected SLAs, Spain

Task	Starting status	Final Status	Maximum term (working days)	Task owner
Appearance and access to fix fault by operator	Operator informs of existing fault	Access provision	2 hours (+30% over working time)	Telefónica
Fault or break in duct fixing with impact on service	Operator informs of existing fault	Fault fixing	8 hours (+30% over working time)	Telefónica
Head cable from central node fixing	Operator informs of existing fault	Fault fixing	24 hours (+30% over working time)	Telefónica
Access provision and escort to operator from head cable from central node fixing	Operator informs of existing fault	Access provision	2 hours (+30% over working time)	Telefónica

Source: Vodafone Spain

Telefónica is required to reserve space for access seekers in all ducts. The space to be reserved is defined in the following way:

Table 22: Regulation on duct availability for access seekers in Spain

Number of subducts in the duct section	Space to be reserved for access seekers
Side exits	No obligation
2	1/3 of a subduct
3 – 7	2/3 of a subduct
More than 8	One subduct

Source: Vodafone Spain

Section 3.3.1.of the MARCo, "*Condiciones Técnicas para la compartición*", includes different practical scenarios explaining how the obligation should be interpreted in each case.

Further, when a field survey finds that no space is available in the duct, Telefónica has an obligation to remove all unused cables to make space. If no unused cables are found, Telefónica has an obligation to provide the access seeker with an alternative route. However, the CNMC has set some constraints to the alternative route that Telefónica can provide the access seeker. In particular, the alternative route:

- Can use up to a maximum of three times the number of registers of the original SUC;

Should not result in saturation in sections different to the original SUC; and
- Cannot cost more than a maximum of twice the cost of the original SUC.

If an alternative route satisfying these constraints cannot be found, Telefónica has the obligation to provide dark fibre to the access seeker. The latter point was added following Vodafone's request. While no access seeker has ever requested access to the dark fibre, the mere existence of the regulation appears to have decreased Telefónica's access refusal rate.

Portugal

In Portugal, PT is required to reserve 20% of usable ducts' space to access seekers.

In the case when there is no space is available in the ducts, ANACOM have set out a clear process to ensure the access seeker is not refused access. The process comprises the following steps:

- Access seeker and PT do a joint visit to ascertain that there is no space in the ducts;
- If space is found, PT pays for the joint visit and provides access;
- If no space is found, the access seeker bares the cost of the joint visit and PT must provide alternative access. This can be done by:
    - Removing dead cables in the ducts. The cost of removal is borne by the cable owner and cables shall be removed within 30 days.
    - Repairing faults in the ducts. The cost of repair is borne by PT.
    - Providing alternative route to the access seeker.

PT is not required to fix faults in the infrastructure following an access seeker request to access, but rather has to provide an alternative route if there is no available space as a result of faults. Subsequent to access being granted, PT has to bear the costs of any repairs to its infrastructure. The only case in which PT is allowed to charge the operator for work on the ducts is if an operator files a request for clearance of the ducts.

The table below shows the timelines defined by ANACOM to regulate clearance of duct obstructions and the associated penalty.

Table 23: Rules regulating clearance of ducts' obstructions in Portugal

Step	Action owner	Timeframe	Penalty
Time-limits applicable to the duct clearance service	PT	5 working days between a request from an operator for clearance of an obstruction in a duct segment and a response from PT outlining cost. 5 working days for responding to PT on estimated costs. PT has then 30 working days following authorisation from municipalities to start work	€50/day

Source: Vodafone Portugal

Regulation that governs the access and use of poles

Due to their urban configuration characterised by tall buildings, regulators in both Spain and Portugal have not defined pole regulation in the same level of detail as duct regulation. As a result, in both countries pole regulation suffers from some shortcomings. However, the consequences of this are significantly less pronounced in those countries than they would be in the UK, where a significantly larger proportion of buildings are reached via poles.

Spain

Pole regulation is included in the MARCo and in many respect, particularly on a procedural level, mirrors duct regulation. For example, pole access request follows the steps of the SUC.

However, two main aspects differentiate pole regulation from duct:

- While accessing already existing ducts or poles does not require any licences from the interested municipalities, pole substitution can only be undertaken if permits have been obtained from all interested municipalities.
    - Telefónica is responsible for managing the process of approval of the licences. Since Telefónica has no incentive to put in effort to quickly obtain the licences for the access seekers to access its poles, usually several months pass before the access seeker obtains the required licences.

- The processes regulating pole access are less defined than those regulating duct access. In particular, the CNMC has not designed a clear process to assess the conditions of the poles and the cost of replacement, which instead exists for ducts. This gave Telefónica the freedom to decide which poles required substitution and what the cost of substitution should be.[31] Telefónica has requested the replacement of 90% of the poles to which Vodafone Spain has requested access, charging Vodafone Spain for the substitution €1,800 per pole.

Portugal

Poles are subject to a different Reference Offer (RO) than ducts. While similar to the ducts' RO, the Poles' RO timeframes are not in line with market needs and procedures are more archaic (no Extranet is available for poles, but information can be requested via email). Thus, accessing poles takes longer than accessing ducts. In addition, , contrary to what happens with ducts, PT has no obligation to give an alternative route if pole access is not viable.

Regulation that governs the access and use of vertical and in-building wiring

Spain

[31] MARCo nonetheless establishes that Telefónica should charge the incurred cost plus project fees, no mark-up is allowed.

With respect to in-building wiring, two different regulations are in place:

- The Common Telecommunications Infrastructure (CTI) regulation, passed by the Industry Ministry. According to the law as initially passed, any building constructed after 1995 has to include a CTI for telecom networks. In 2011 the law was updated and specifies that all building built after 2011 have to have a CTI which is able to support NGA networks.[32]; and
- Symmetrical regulation imposed by the CNMC on vertical wiring regulation, which applies to buildings without CTI and buildings built before 1995. [33]

When a building has the adequate CTI, operators have the right and obligation to deploy their networks using the CTI.

In newer buildings without CTI but with built-in vertical, operators are required to use the vertical, while for older buildings the CNMC requires wires to be placed on the façade.

According to in-building regulation, the operator that first develops vertical wiring in a building remains its owner. However, the operators has to develop the wiring as to allow for sharing and the ownership can be transferred to building owners or other operators if commercially agreed.

The first comer has the following obligations:

- To provide access to the vertical wiring to other operators; and
- To provide access to the last drop (i.e. the cables connecting the vertical wiring to a specific flat) to any access seeker. However, access seekers can choose whether to use the incumbent's cables or roll-out their own cables in the last drop.

When the vertical is deployed by façade, which constitute the majority in Spain, the last drop is considered to start from the street cabinet and arrive at the single flat. In this case, each operator is responsible for connecting a customer to the cabinet through rolling cables on the façade of the building. The Ministry is working on a draft regulation detailing the rights and obligation to which operators deploying NGAs in buildings without proper CTI are subject, which will replace the current CNMC regulation.

Portugal

According to Portuguese vertical wiring regulation each building owns its vertical wire. However, operators are liable for all costs associated with the construction of the wires. These costs are shared equally by all operators active in the building.

This implies that the costs are initially borne by the first operator that becomes active in the building. However, as more operators start operating in the building, they reimburse the first operators of part of the costs. Hence, if n operators are active in the building, each pays the cost of vertical wire installation/n.

[32] http://www.minetur.gob.es/telecomunicaciones/Infraestructuras/Normativa/1.-%20Normativa%20de%20aplicación/REAL%20DECRETO%20346_2011.pdf

[33] http://telecos.cnmc.es:8080/c/document_library/get_file?uuid=5c140e07-8830-44a8-ab01-df7317942bce&groupId=10138

Dynamic regulation

Ensuring that PIA regulation can be changed and improved to respond to unexpected issues or changes to market dynamics is fundamental for its success.

Regulation in both Spain and Portugal has been changing to adapt to changes in requirements and address areas where it was not effective. This has contributed significantly to the success of PIA in these countries. Some of the most impactful changes in regulation include:

Spain

- **Provision of a clear definition of non-urban and urban areas**.

  The lack of clarity around non-urban area definition constituted a barrier to expansion for access seekers, as different regulations apply for urban and non-urban areas[34], and thus uncertainty on the classification of certain areas resulted in disputes between the incumbent and the access seekers. By providing a clear definition of non-urban areas, the CNMC made it easier for access seekers to plan roll-out.

- **Introduction of flexible duct and dark fibre obligations.**

  The obligation to provide dark fibre and flexible ducts to access seekers when duct access is unavailable improved PIA's functioning both directly and indirectly. On the one hand, it allowed access seekers to access areas that were previously unavailable due to quality of Telefónica's ducts. On the other, the obligation improved the overall PIA process by creating a disincentive to Telefónica for refusing access.

- **Establishment of clear and short timeframe for SLA maintenance interventions**.

  While SLA maintenance regulation was included in the MARCo from the beginning, it was recently revised by the CNMC. The time given to Telefónica to fix any fault was reduced from 15 days to 8 hours, and a 2 hour intervention time was added. This change significantly improved the quality of customer service that access seekers can guarantee on Telefónica's network, bridging the gap between their quality of service and Telefónica's.

- **Protection of sensitive roll-out information**.

  Telefónica used to require access seekers to communicate the names of the customers as a prerequisite to grant access. This harmed access seekers especially in the business segment. The CNMC introduced a new piece of regulation obligating Telefónica to provide access irrespective of any information on perspective customers.

[34] For example, in non-urban areas there is no requirement to provide access to contiguous areas. This was problematic in cases where within a city there were areas that could have been classified as non-urbn. Indeed, Telefónica used to benefit from the vague distinction between urban and non-urban and consider these areas as non-urban.

Portugal

As in Spain, regulatory changes were aimed at addressing unregulated areas, adjusting incentives, or adjusting regulation following changes to the market.

The regulatory change that accelerated PIA's take-up in Portugal the most is the 2009 Law of Electronic Communications. The law mandated access to infrastructure to be provided on a cost-oriented basis, and envisaged the creation of a database of all appropriate infrastructure (including, but not limited to, utilities and municipalities' infrastructures) to be managed by ANACOM (without prejudice to Extranet, which was developed and is managed by PT and only has PT's infrastructure). Moreover, the law extended duct and pole access obligations to all operators, state-owned bodies, supervised bodies and public utilities that own infrastructure able to support telecommunications services. Currently, about **[✂]** of the ducts accessed by Vodafone are owned by entities other than PT.

Table 24: Kms of ducts accessed by Vodafone Portugal by infrastructure owner

[✂]

The law anticipated the European Union Directive 2014/61/CE[35], which aims at creating a market for physical infrastructure by obliging all utilities operators to offer access to their physical infrastructure for deployment of high-speed broadband networks (30 Mbps and above).

[35] Directive 2014/61/EU of the European Parliament and of the Council of 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks Text with EEA relevance/ http://eur-lex.europa.eu/legal-content/EN/NOT/?uri=uriserv:OJ.L_.2014.155.01.0001.01.ENG

Appendix C: Lessons on PIA from other European countries

A review of other European countries that have implemented PIA in some form reinforces the belief that there are some key factors that facilitate the take-up of PIA. At the same time, the variety of outcomes across the countries suggests that these factors are necessary but not sufficient to ensure a successful PIA regime. Further, it appears that there is no one recipe: there are different ways in which these key factors can be incorporated into the PIA regulation, and different operational rules can be successful as long as they are in line with the general principles of regulation. Overall, it appears that what is important to the success of PIA is that these key factors are incorporated in a comprehensive and flexible regulation.

Some of the key factors common across multiple countries are:

Necessity of an easily accessible and accurate information database

In Spain, Portugal, Lithuania and other countries where PIA has been successful, a database of infrastructure has been made available to access seekers. In Lithuania the online infrastructure database has been fully operative since 2003 in the three main municipalities of Vilnius, Kaunas and Klaipeda, but the NRA plans to expand it to all of the 60 municipalities. The maps are populated using the information held by the municipalities about the existing underground infrastructure and updated with new information as soon as each municipality updates its database with new information. The maintenance of the online system is the responsibility of the regulator and any operator seeking information on underground infrastructure may register on the system and gain access for free.

Obligation to provide an alternative route or access

In France, similarly to Spain and Portugal, regulation requires that infrastructure owners create space in ducts where possible by removing cabling that is not being used. In addition, in France the regulation requires operators to rolling out an FTTH network to create space to collocate at the point of mutualisation to facilitate access for access seekers.

By contrast, in Austria if there is no space in the ducts then the PIA rules do not require the incumbent to create space and it can terminate a contract if the ducts are full and it wishes to roll out its own cables. This is one of the factors that has contributed to the limited uptake of PIA in that market.

As in Spain and Portugal, in many other countries in Europe the infrastructure owner is also required to provide access to dark fibre, often as an alternative solution when ducts are not viable. For example, in Lithuania Teo LT is required to offer access to dark fibre between the distribution point

and the end user.[36] In France, since 2006, Orange has been required to publish an offer for dark fibre access in its backhaul network. Otherwise, dark fibre is mainly offered on a commercial basis only. In Italy, Telecom Italia is required to provide dark fibre at regulated prices and terms and conditions. This includes access to the terminating segment of fibre into the building, in the case of FTTH deployment. In Austria, the incumbent is mandated to provide access to dark fibre when duct access is unavailable or it is uneconomical for an operator to use duct access.

Protection of access seeker confidential information

Confidentiality is perceived as a risk by many operators if information requests result in potentially sensitive information being passed directly to the incumbent. This risk is reduced by management of the database by a third party, such as an NRA. In Lithuania, for example, the regulator, RRT, maintains records in three municipalities. In addition, the dataset needs to be accessible in its entirety, so that access seekers do not need to reveal their plans through the map requests. This is the case in Lithuania, where by registering on the online database, access seekers gain immediate access to information on duct roll-out and availability across the whole areas covered in the database. This enables them to act in private without sharing confidential information with the incumbent.

Flexible regulation

Getting the operational rules around PIA right is typically an iterative process. An alternative approach to dynamically fixing regulation over time is to spend more time getting the regulation correct in the first place. France has not made multiple changes to its PIA regulations but has engaged in multiple rounds of consultation in which the operators have had a significant input. As a result, the PIA framework in France has been largely industry-led and has resulted in a very prescriptive set of SLAs and penalties. Early indications are that this approach may be successful in encouraging the rollout of FTTH networks in France with alternative operators showing a substantial interest in rolling out their own FTTH networks and an increasing amount of coverage with two or more networks and network rollout deals between operators.

Appropriate pricing of services

Pricing has a key impact on the success of PIA. There are significant differences in pricing structures across Europe, both in the structure of pricing and the levels. The two basic approaches to pricing are volume-based pricing and length-based pricing. Volume-based pricing (based on both length and surface area) ensures access seekers are charged according to the amount of space they occupy and can incentivise efficient use of ducts. For the French and Portuguese NRAs, volume-based pricing was the chosen approach. Length-based approaches were chosen by the Austrian, Italian and Lithuanian NRAs. The argument used for length-based charging is that these charges are easier to calculate and provide more transparency to access seekers.

[36]Distribution point: is the last interconnection point in the distribution network before the end customer that provides the last drop.

Prices can also vary by geography. They can be set either to reflect the higher costs of rolling out a metre of duct in urban areas, such as in Portugal, or to encourage rollout in rural areas through lower prices per metre reflecting that more duct needs to be used in more rural areas. For example, in Lithuania discounts are available for large requests that can reduce the rollout costs in rural areas and regulatory setup in France results in operators paying less for duct access in rural areas.

The PIA pricing structure can also have an impact on the design of the access seekers' networks. For example, volume based pricing may discriminate against P2P network operators as they require more space in the duct closer to the exchange. To reduce any competitive disadvantage caused by this, ARCEP set a lower price for access to ducts between the exchange and cabinet compared to the cabinet to the property.

The effect of pricing on the success of PIA as a regulatory measure is illustrated by the case of Austria. The price of access to ducts in Austria is substantially higher than in other countries and does not vary by region despite the price for dark fibre varying. When this is compared to the comparatively low prices of unbundling and retail products, this creates a disincentive for an alternative operator to use duct to roll out its own network compared to using the incumbent's network. This is one of the key reasons why PIA uptake in Austria has been low and it has not had a significant impact on the market.