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Infrastructure investment on the margins of the market: The role of niche infrastructure providers in the UK

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Abstract

Across Europe, policymakers and market forces are striving to deploy next generation access (NGA) networks and ensure ubiquitous access to superfast broadband services. Due to scale economies and sunk costs, the roll-out of NGA is expected to be profitable only for large-scale providers and in densely populated areas. This has resulted in an uneven distribution of NGA networks, which is expected to be complemented by public intervention. Nonetheless, alternative providers, such as utilities and local communities, have significantly contributed to NGA diffusion in many countries. Over the past five years, several small-scale initiatives have emerged in the UK, bringing fibre networks to urban and rural areas previously overlooked by either commercial or subsidised deployments. A multiple case study is here employed to investigate the nature and the drivers of niche providers in the UK NGA market. The comparison emphasised similarities and differences across these initiatives, identifying a number of elements recurring in their strategies. This analysis sheds light on the contribution of niche providers to bridging the digital divide in the UK and is meant to provide a preliminary assessment of their sustainability and potential growth.

Keywords:

Alternative broadband providers; niche strategies; digital divide.

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1.Introduction

The considerable opportunities of digitisation require an infrastructure capable of providing faster and more and reliable connections (Broadband Commission for digital development, 2015). Basic broadband, provided by ADSL, is no longer sufficient to support the rising consumption of data and to satisfy the increasing hunger for bandwidth (Ericsson, 2013). As a consequence, the diffusion of next-generation access (NGA) networks has become a major priority for policy-makers (Broadband Commission for Digital Development & Cisco, 2013; European Commission, 2010; House of Lords, 2012).

Public authorities are increasingly involved in the development of NGA networks, since the market alone is unlikely to provide the optimal level of coverage and speed (Falch & Henten, 2008). This interplay between public and private operators is generally considered as essential to ensuring universal access to superfast broadband (Falch & Henten, 2009; ITU, 2012). Nonetheless, the potential contribution of other organisations, such as utilities and local communities, has been highlighted due to their historic role in supporting broadband development (Analysis Mason, 2011; Mölleryd, 2015; Ragoobar, Whalley, & Harle, 2011). In fact, a one-size-fits-all approach does not exist and any country needs to identify its own optimal mix of public and private initiatives to ensure universal access to superfast broadband (Belloc, Nicita, & Rossi, 2012).

The development of NGA in the United Kingdom exemplifies how the interaction between public and private parties in broadband market has evolved over the past twenty years. For the first decade of this century broadband deployment in the UK has been market-driven, with regulation actively promoting competition (Nardotto, Valletti, & Verboven, 2015). Since 2011, however, the UK government has committed itself to correcting the market failure in NGA development through the provision of subsidies in rural areas (DCMS, 2011).

The combination of private investment and public subsidies is expected to deliver superfast broadband to 95% of UK premises by 2017 (Hirst & Sutherland, 2015). However, in 2015 almost half of rural premises could not access speeds greater than 10 Mbit/s and 2% of UK premises were provided with connections delivering less than 2 Mbit/s (Ofcom, 2015a). In this context, numerous small-scale infrastructure providers have emerged across the UK to build fibre networks in underserved rural and urban areas (PRISM, 2014).

Such initiatives are increasingly drawing the interest of policymakers and practitioners because of their potential contribution to NGA diffusion in the UK (Ofcom, 2015b). Accordingly, this paper explores the nature and the strategies of these new infrastructure providers, to shed light on their

implications for the NGA development in the UK. With this in mind, Section 2 reviews the literature on the drivers of broadband investment and in particular the role of alternative providers. The methodology is outlined in Section 3. Section 4 presents the four case studies, which are compared and discussed in Section 5. Concluding remarks and policy recommendations are suggested in Section 6.

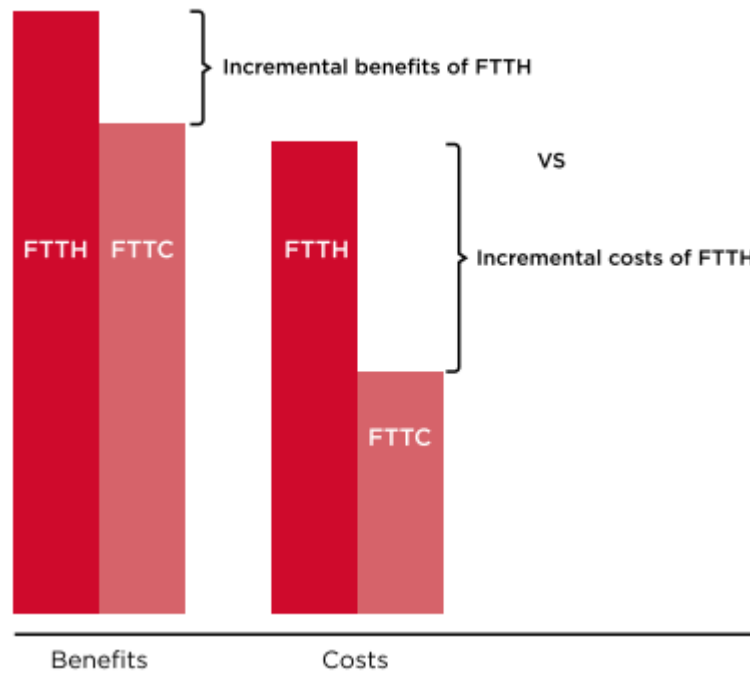
2. Literature review

The development of NGA requires a capital-intensive investment in high fixed costs (Amendola & Pupillo, 2008) to deploy fibre either to the end-user's houses (FTTH) or to the street cabinet (FTTC). The deployment cost is determined by the network architecture (Figure 1) and exogenous factors, such as population density. The economies of scale in network roll-out (Avenali, Matteucci, & Reverberi, 2010) make NGA investment viable only for a limited number of large-scale operators (WIK, 2008).

Consequently the incumbents are more likely to invest in NGA. However, they might have an incentive to delay their investment to preserve and enhance the value of their existing assets (BEREC, 2016). This risk is minimised when the incumbent is exposed to the competitive pressure of other infrastructure providers (Briglauer & Gugler, 2013), such as cable operators. On the contrary, few service-based competitors¹ have actually climbed the highest rungs of the 'ladder of investment' (Cave, 2006) and deployed alternative NGA networks (Cullen International, 2016).

¹ Broadband providers relying on regulated access to the incumbent's infrastructure.

Figure 1: Costs-benefits comparison between FTTC and FTTH



Source: NESTA (2015)

Nevertheless, both incumbents and their competitors have historically focused on the most densely populated areas (Grubestic & Murray, 2004). The economies of scale in broadband provision are a major deterrent to private investment in rural areas (Glass & Stefanova, 2012), which can even experience an internal digital divide due to the excessive costs of connecting geographically dispersed premises (Rendon Schneir & Xiong, 2016). Where the market fails to provide superfast broadband, public intervention is justified to complement private investment (European Commission, 2013), by providing financial support or even developing public networks (Frieden, 2013; Gómez-Barroso & Feijóo, 2009).

Alongside telecommunications companies and public organisations, often crucial has been the contribution of other players external to broadband market but willing to invest in fibre networks (Analysis Mason, 2011). Since the early 2000s, utilities, communities of end-users and private investors, such as property developers, have actively promoted the roll-out of broadband networks often focusing on small-scale projects (Nucciarelli, Sadowski, & Achard, 2010; Ragoobar et al., 2011; Salemink & Bosworth, 2014). The characteristics and strategies of these alternative providers are discussed in the following sub-sections.

2.1 Utilities

Since the telecommunications market was liberalised, utilities have been major providers of both long-distance and access networks (Falch & Henten, 2008; WIK, 2008). The public ownership of local utilities has encouraged their involvement in broadband deployment (Troulos & Maglaris, 2011), but also private companies, such as Dong in Denmark, have invested in NGA (Mölleryd, 2015).

The entry of utilities in broadband market has been mainly driven by the synergies existing in the roll-out and management of networks (Tadayoni & Sigurðsson, 2007). The reuse of existing infrastructures can significantly reduce the deployments costs (Gillett, Lehr, & Osorio, 2006; Troulos & Maglaris, 2011). Furthermore, utility companies generally have a low cost of capital and can cross-subsidise broadband investment with the revenues from other services (Matson & Mitchell, 2006).

Many utilities, like Burlington Electric Department in Vermont (Mitchell, 2011), have opted for a vertically integrated model to achieve also marketing economies of scope. Others have focused on passive infrastructure, either partnering with a telecommunications operator or adopting an open access model (EPEC, 2012). In the former case, a single provider is in charge of retail services: this model was initially adopted by Metroweb, which was founded as a joint venture between Fastweb and AEM, the electric utility in Milan (Table 1). In the latter case, broadband services are retailed by multiple providers: for example, more than 35 ISPs were active on the MälärEnergi's network in Västerås (FTTH Council Europe, 2015).

Overall, the entry of utility companies has been assessed positively as an enabler of investment and competition in broadband market (Ford, 2007; Tahon et al., 2014; Troulos & Maglaris, 2011). However, their actual contribution to NGA diffusion has varied widely across developed countries. In the UK, their role has been negligible and scarcely successful, allegedly because of the limited involvement of public authorities in utility sectors (Analysis Mason, 2008). In general, their influence has diminished over time across Europe, after most of their networks have been acquired by telecommunications companies². Nevertheless, new projects involving utilities have been recently announced³, thereby suggesting that their involvement should be reconsidered in future.

² For example, the Danish incumbent has acquired the FTTH networks deployed by DONG and other power utilities.

³ For example, Enel has started the roll-out of FTTB in 224 Italian cities.

Table 1: A sample of utility investment in NGA

	Burlington Telecom	MälarEnergi Stadsnät	Metroweb	Dong
Utility company	B.E.D.	MälarEnergi	AEM	Dong Energy
Technology	FTTH	FTTH	FTTH	FTTH
Geographic Scope	Burlington	Västerås	Milan	Northern and Eastern Zealand
Investment model	Public company	Public company	Joint Venture	Private company
Business model	Vertically integrated	Passive+active	Passive only	Open access
Coverage	n.a.	60%	> 90%	150,000 HH

Source: Mitchell (2011), EPEC (2012), Felten (2009), FTTH Council Europe (2015)

2.2 Community networks

On occasion projects led by local authorities or utilities have been referred to community networks (Mitchell, 2011; National Economic Council & Council of Economic Advisors, 2015). In this paper we adopt the definition of the European Commission (2014), considering as community networks those infrastructures financed and developed by end-users. Local institutions may be involved in the project, but they do not play a leading role.

The first community projects emerged in the early 2000s (Forlano, 2008; Sandvig, 2004), when groups of end-users across US and Canada opened their private routers to build public Wi-Fi networks (Powell & Shade, 2006). Bottom-up initiatives have been later undertaken also in the fixed broadband market. OnsNet is a cooperative FTTH network established by the citizens of Nuenen (Nucciarelli et al., 2010), while Guifi.net Foundation owns and maintains an open access FTTH, financed and deployed by end-users in rural Catalonia.

The involvement of community members in the network design and roll-out significantly reduce the cost and uncertainty of NGA investment, making FTTH sustainable in scarcely populated areas (Domingo, Van der Wee, Verbrugge, & Oliver, 2014). The infrastructure is generally owned by a non-profit cooperative, which may either self-provide the retail services or partner with independent ISPs (Plunkett Foundation & Carnegie UK Trust, 2012). The network deployment is financed by equity from local stakeholders, as well as by loans and grants (Heery & White, 2013).

The success of these initiatives is deemed to rely on the dedication of volunteers and their capacity to involve other individuals (Middleton & Crow, 2008). Wallace, Vincent, Luguzan, and Talbot (2015) have identified five types of capital crucial for rural community networks: human (the leadership of community champions), technological (technical skills and link to local universities), identify (commitment of the community), social (the relationships internal and external to the community), and financial.

Historically, community-led initiatives have proved to represent a valid alternative to commercial and public-funded broadband networks, especially in rural areas (Domingo et al., 2014; Heery & White, 2013), but their sustainability in the long-term is still unclear. As suggested by Wallace et al. (2015), successful community networks are likely to be acquired by major providers – for example, KPN is now the majority stakeholder of OnsNet (Van Der Wee et al., 2011). On the other hand, initiatives like Guifi.net remain independent.

2.3 Private companies from outside the telecommunications industry

Private companies from other sectors have sporadically invested in broadband, generally in partnership with telecommunications operators. For example, KPN established a joint venture with Reggeborgh and partnered with housing corporations (Nucciarelli et al., 2010). Consistently, real estate and construction companies have been identified as facilitators for NGA deployment (Ragoobar et al., 2011; Troulos & Maglaris, 2011).

The most noteworthy alternative private investor in NGA has been Google, who launched its FTTH project in 2010. As of July 2016, Google Fiber (2016) served six cities (Kansas City, Austin, Provo, Charlotte, Nashville, Atlanta) and planned to cover five more (San Francisco, Salt Lake City, San Antonio, Huntsville, Raleigh). This expansion has been based on both greenfield deployments and the acquisition of existing networks. For example, in 2013 Google took over the municipal fibre network in Provo for \$1, committing to increasing its capacity and coverage (Davidson & Santorelli, 2014).

Initially meant to be a neutral operator (Higginbotham, 2012), Google Fiber is now a vertically integrated triple-play provider. The network deployments are entirely funded by Google, but local authorities often provide indirect financial support. For example, the development agreement in Kansas City included a waiver on right of ways and permit fees (Trogdon, 2013). Also local utilities have collaborated with Google, either providing access to their passive infrastructures (Baumgartner, 2016) or partnering in the commercialisation of fibre services (Community Broadband Networks, 2016).

Table 2: Drivers and strategies of alternative NGA providers

	Utilities	Communities	Other private investors
Drivers	<ul style="list-style-type: none"> • Economies of scope (Gillett et al., 2006; Tadayoni & Sigurðsson, 2007) • Lower cost of capital (Matson & Mitchell, 2006) • Public ownership (Troulos & Maglaris, 2011) 	<ul style="list-style-type: none"> • Commitment of community members (Middleton & Crow, 2008) • Technological, relational, human, financial and identity capital (Wallace et al., 2015) 	<ul style="list-style-type: none"> • Partnership with telco (Analysis Mason, 2011; Nucciarelli et al., 2010) • Reuse of existing infrastructure (Baumgartner, 2016) • Public support (Trogdon, 2013)
Technology	<ul style="list-style-type: none"> • FTTH+wireless 	<ul style="list-style-type: none"> • FTTH+wireless 	<ul style="list-style-type: none"> • FTTH
Geographic scope	<ul style="list-style-type: none"> • Urban and rural 	<ul style="list-style-type: none"> • Rural 	<ul style="list-style-type: none"> • Urban
Investment model	<ul style="list-style-type: none"> • Public company • Private company 	<ul style="list-style-type: none"> • Cooperative 	<ul style="list-style-type: none"> • Private company • Joint venture
Business Model	<ul style="list-style-type: none"> • Vertically integrated • Open access • Partnership with ISP 	<ul style="list-style-type: none"> • Vertically integrated • Open access 	<ul style="list-style-type: none"> • Vertically integrated
Financing Model	<ul style="list-style-type: none"> • Cross-subsidisation 	<ul style="list-style-type: none"> • Equity from community members, loans and grants (Heery & White, 2013) 	<ul style="list-style-type: none"> • Private capitals

Table 2 summarises the characteristics of the alternative broadband providers, as based on the literature. Scholars and practitioners have analysed their drivers and strategies, but more research is needed to clarify how these initiatives are related to general theories of broadband development. Tadayoni and Sigurðsson (2007) explained the emergence of alternative providers in Denmark as a response to the path dependency of traditional operators. The entry of new broadband providers was also facilitated by the relatively low cost of wireless technology and the involvement of public sector.

These findings partially apply in the current context. Path dependency is emphasised by the choice of incumbents to invest in FTTC (Cave & Shortall, 2016), but wireless technologies are unlikely to play a central role in NGA market due to their limited bandwidth (KPMG, 2010). The role of public sector has also changed significantly, since central governments are increasingly leading and coordinating public interventions (Broadband Commission for Digital Development & Cisco, 2013). This is likely to benefit the incumbents since they have the scale and the resources to support nation-wide initiatives (National Audit Office, 2012).

Consequently the entry of niche providers observed in the UK may sound to be inconsistent with the economics of NGA investment and the trend of centralisation in broadband market. The rationales for niche operators have been studied as a competitive strategy based on market segmentation and product differentiation (Dalgic & Leeuw, 1994), but their sustainability has been questioned by Noy (2010) due to the risk that demand reduces or stronger competitors enter in the

niche. Our analysis will help clarify the rationales for small-scale providers in a capital-intensive industry like NGA market.

3. Methodology

The purpose of this study is to explore the strategies of niche infrastructure providers and explain their contribution to NGA development in the UK. For this reason, we employ a multiple case study that enables both exploratory and explanatory research (Yin, 2014). A multiple case study is also expected to highlight within-group similarities and intergroup differences (Eisenhardt, 1989), enhancing the reliability and accuracy of the results.

The analysis focuses on four niche providers in the UK: a community-led project, a private operator building FTTH in rural areas, and two private operators deploying fibre networks in urban areas. These cases have been selected as the most relevant and representative of the UK market after an extensive review of sources addressing NGA development.

As shown in Table 3, the four case studies have been analysed in relation to three dimensions: their drivers, their investment strategies and their outcome. We aim to understand why alternative providers have entered the NGA market, what strategies they adopt and how their investment impacted upon the diffusion of superfast broadband in the UK.

Data have been collected from semi-structured interviews and secondary sources, such as financial statements, company websites, press releases. Documentary analysis has provided an overview of the business models and the strategies of niche providers in the UK, while interviews have focused on their drivers and interactions with other public and private players in NGA market.

Table 3: A framework for the analysis of NGA initiatives

Drivers	Investment Strategy	Outcome
<ul style="list-style-type: none"> • Supply- side • Demand-side • Policy 	<ul style="list-style-type: none"> • Technology • Geographic Scope • Investment model • Business model • Financing model 	<ul style="list-style-type: none"> • Coverage • Take-up • Speed • Price

Source: developed by the authors using WIK (2008) and European Commission (2014)

4. Case studies

Since the NGA roll-out started in 2008 (WIK, 2015), superfast broadband⁴ services have been delivered to 83% of UK premises, with a take-up rate of 27% (Ofcom, 2015a). The coverage of superfast broadband has grown by almost 20% (from 65% to 83%) over the past three years, with an even sharper increase in Wales (from 37% to 79%) and Scotland (from 45% to 73%) (Ofcom, 2013, 2015a).

The diffusion of NGA networks has been mainly driven by British Telecom (BT) and Virgin Media. The former has invested £2.5 billion in FTTC, covering 68% of UK premises. The latter has deployed DOCSIS 3.0⁵ to 44% of UK premises (British Telecom, 2016; Ofcom, 2014). Overall Ofcom (2014) estimated that private investment had delivered NGA to 78% of UK premises, with 35% of them covered by two competing networks.

In order to subsidise and complement private investment, in 2011 the government launched the Superfast Broadband Programme under the supervision of BDUK⁶ (DCMS, 2011). This programme is aimed at expanding superfast broadband coverage to 90% of premises by early 2016 and to 95% of premises by 2017 (Rathbone, 2016). In addition, seven pilot projects have been concluded in March 2016 to test alternative technologies for the delivery of superfast broadband to the hardest-to-reach 5% of premises (DCMS, 2016). A complementary initiative, Superconnected Cities, sought to increase demand for superfast broadband, by issuing vouchers to SMEs across 50 UK cities (Table 4).

Table 4: BDUK programme

	BDUK funding (£m)	Target	Status
Rural Broadband Programme – Phase 1	530	90% coverage by early 2016	Achieved in April 2016
Superfast Extension Programme – Phase 2	250	95% coverage by 2017	Under way
Competitive Fund	10	Pilot projects to identify alternative solutions for the final 5%	7 pilots completed in March 2016
Superconnected Cities	150	Vouchers of up to £ 3,000 to help SMEs in 50 cities	55,000 vouchers issued between December 2013 and October 2015

Source: Ofcom (2014, p. 23), DCMS (2016), Rathbone (2016)

⁴ Superfast broadband provides at least 30 Mbit/s (Ofcom definition) or 24 Mbit/s (BDUK definition) in downlink. This paper adopts Ofcom's definition, which is consistent with the target set by the European Commission (2010).

⁵ The standard enabling cable to provide up to 152 Mbit/s in downlink.

⁶ Broadband Delivery to UK is an agency within the Department of Culture, Media and Sports

BDUK's funds have been awarded through competitive tenders, managed by the county councils and the devolved administrations. All the 44 contracts in Phase 1 have been won by BT (Table 6): other competitors like Geo and Fujitsu had withdrawn from the bidding, being unable to meet BDUK requirements (Telegeography, 2013). This lack of competition has raised concerns on the suitability of BDUK framework to maximise the value-for-money of public investment (Public Accounts Committee, 2014). Within the Phase 2, BT has won 38 out of 47 contracts, with the remaining 5 awarded to alternative infrastructure providers (Table 6).

Despite the progress in NGA diffusion across the country, the latest data from Ofcom (2015a) confirmed the persistence of a significant digital divide between rural and urban areas (Table 5). Only 37% of rural premises have access to a speed greater than 30 Mbit/s, while 48% of rural households cannot access a speed greater than 10 Mbit/s. As a result, the government launched a reform of the Universal Service Obligation in order to give everyone a broadband connection with a minimum download speed of 10Mbit/s (Ofcom, 2016). This is expected to also benefit those 4% of urban premises that could not access 10 Mbit/s in 2015 (Ofcom, 2015a).

Table 5: Availability and diffusion of broadband and superfast broadband in the UK

	2011	2012	2013	2014	2015
Coverage < 2 Mbit/s – national	14%	10%	8%	4%	2%
Coverage NGA – national	58%	65%	73%	75%	n.a.
Coverage SFBB – national	n.a.	n.a.	n.a.	75%	83%
Coverage NGA – rural	n.a.	19%	25%	33%	n.a.
Coverage SFBB – rural	n.a.	n.a.	n.a.	22%	37%
Take-up SFBB – national	n.a.	7.3%	16%	21%	27%

Source: Ofcom (2011a, 2012, 2013, 2014, 2015a)

Table 6: BDUK funds allocation

Authority	BDUK funds - Phase 1	BDUK funds - Phase 2	BDUK Total funds	Phase 1 - awarded to	Phase 2 - awarded to	Take-up (%)
Rutland	£820,000	£180,000	£1,000,000	BT	BT	52%
Wiltshire, South Gloucestershire [c]	£5,370,000	£3,470,000	£8,840,000	BT	BT	38%
Northamptonshire	£4,626,530	£5,500,000	£10,126,530	BT	BT	37%
Cambridgeshire, Peterborough	£6,750,000	£1,500,000	£8,250,000	BT	BT	35%
Cheshire East, Cheshire West & Chester, Warrington, Halton	£ 4,000,000	£2,118,000	£6,118,000	BT	BT	33%
Coventry, Solihull, Warwickshire	£4,445,000	£9,680,000	£14,125,000	BT	BT	32%
North Yorkshire	£17,840,000	£10,320,000	£28,160,000	BT	BT	32%
Berkshire Councils	£2,579,767	£3,560,000	£6,139,767	BT	Gigaclear, Call Flow	32%
Suffolk	£11,680,000	£15,000,000	£26,680,000	BT	BT	32%
Lancashire, Blackpool, Blackburn with Darwen	£10,830,000	£3,840,000	£14,670,000	BT	BT	31%
North Lincolnshire, North East Lincolnshire	£3,140,000	£1,180,000	£4,320,000	BT	BT	31%
Buckinghamshire and Hertfordshire	£4,732,000	£6,630,000	£11,362,000	BT	BT	30%
Central Beds, Bedford Borough, Milton Keynes	£2,600,000	£3,780,000	£6,380,000	BT	BT	29%
Hampshire	£6,062,307	£9,200,000	£15,262,307	BT	BT	28%
Norfolk	£15,440,000	£9,590,000	£25,030,000	BT	BT	28%
Northumberland	£7,687,887	£2,000,000	£9,687,887	BT	BT	28%
West Yorkshire	£4,615,000	£8,000,000	£12,615,000	BT	BT	28%
East Sussex, Brighton and Hove	£10,640,000	£3,000,000	£13,640,000	BT	BT	28%
East Riding of Yorkshire	£5,570,000	£5,000,000	£10,570,000	BT	BT	27%
Leicestershire	£3,418,895	£5,100,000	£8,518,895	BT	BT	27%
Lincolnshire	£14,310,000	£2,350,000	£16,660,000	BT	BT	27%
Shropshire	£9,294,257	£11,380,000	£20,674,257	BT	BT	27%
Nottinghamshire	£4,500,000	£3,350,000	£7,850,000	BT	BT	27%
Kent and Medway	£11,463,509	£5,600,000	£17,063,509	BT	BT	27%
Oxfordshire	£4,060,000	£4,124,500	£8,184,500	BT	BT	26%
Newcastle upon Tyne	£970,000	£430,000	£1,400,000	BT	not proceeding	26%
Worcestershire	£4,497,032	£2,390,000	£6,887,032	BT	BT	26%
Cumbria	£17,130,000	£2,860,000	£19,990,000	BT	BT	25%
Greater Manchester	£2,990,000	£450,000	£3,440,000	BT	BT	25%
Merseyside	£5,460,000	£700,000	£6,160,000	BT	not proceeding	24%
Staffordshire and Stoke-on-Trent	£7,440,000	£1,680,000	£9,120,000	BT	BT	24%
Essex, Southend-On-Sea, Thurrock	£6,460,000	£10,720,000	£17,180,000	BT	Gigaclear	24%
West Sussex	£6,761,243	£1,250,000	£8,011,243	BT	BT	23%
Herefordshire and Gloucestershire	£18,170,000	£10,980,000	£29,150,000	BT	Gigaclear	23%
Devon & Somerset (including, Plymouth, Torbay, North Somerset, Bath & NE Somerset)	£32,639,945	£22,750,000	£55,389,945	BT	in procurement [a]	23%
Wales	£56,930,000	£12,110,000	£69,040,000	BT	BT	22%
Dorset, Bournemouth and Poole	£10,441,020	£1,540,000	£11,981,020	BT	BT	22%
Durham, Gateshead, Tees Valley and Sunderland	£10,103,267	£6,080,000	£16,183,267	BT	BT	21%
Rest of Scotland [b]	£50,000,000	£20,990,000	£70,990,000	BT	in procurement	21%
Derbyshire	£7,390,000	£2,190,000	£9,580,000	BT	BT	20%
Isle of Wight	£2,490,000		£2,490,000	BT	-	20%
Northern Ireland	£4,400,000	£7,240,000	£11,640,000	BT	BT	19%
Black Country		£4,990,000	£4,990,000		BT	6%
Telford & Wrekin		£2,000,000	£2,000,000	n.a.	BT	6%
South Yorkshire		£10,400,000	£10,400,000	n.a.	BT	4%
Cornwall		£2,960,000	£2,960,000		BT	0%
Highlands and Islands	£50,830,000		£50,830,000	BT	-	0%
Surrey	£1,310,000	£100,000	£1,410,000	BT	not proceeding	0%
Swindon		£1,500,000	£1,500,000	n.a.	UKB networks	0%
The Cotswolds		£1,600,000	£1,600,000	n.a.	Gigaclear	0%
	£ 472,887,659	£263,362,500	£736,250,159	44	38	

[a] Airband Community Internet Ltd contracted for the most rural region

[b] Funds in phase 2 include also Highlands and Islands

[c] In phase 2, two separate contracts have been awarded to BT - here treated as a single contract, for the sake of simplicity

Source: compiled by the authors from data provided by BDUK and Openreach

Alongside the major private and public initiatives, a number of alternative operators have been actively investing in NGA across the UK (Ofcom, 2012): their number has almost doubled (from 34 to 65) between 2010 and 2014. These initiatives are primarily focused in rural areas and employ a mix of technologies, with FTTP preferred to FTTC (PRISM, 2014). The most noteworthy alternative providers have been local communities and developers (Analysis Mason, 2011), while utilities have historically played a marginal role in the UK broadband market (BIS, 2010; Ragoobar et al., 2011).

Community-led initiatives have arguably been flourishing in rural areas since the early 2000s. For example, some villages in Lancashire and Cumbria established community Wi-Fi before deploying their own FTTH networks (Plunkett Foundation & Carnegie UK Trust, 2012). While initiatives such as B4RN have proved to be successful (DCMS, 2016), other community-led networks have recently been either acquired by private operators (for example, Vtesse Networks by Interroute in 2014) or abandoned (such as NextGenUS in Yorkshire and Cumbria) due to financial and organisational difficulties (Jackson, 2012).

In urban areas alternative NGA providers have focused on new-build developments and multi-dwelling units (MDUs) such as student accommodations (Analysis Mason, 2011; Berendt, 2014). Many of these initiatives have been led by companies in the building sectors – such as Quintain and Brookfield Utilities, which started Velocity1 and IFNL respectively (Berendt, 2014).

4.1 Broadband for the Rural North (B4RN)

B4RN is a community benefit society based in rural Lancashire, an area historically underserved by commercial operators. Only 60% of local exchanges in Lancashire are unbundled (SamKnows, 2016) and 14.8% of premises were unable to access basic broadband in 2011 (Ofcom, 2011b). Various communities, such as Wray-with-Botton and Wennington, had established their own Wi-Fi networks in the early 2000s. These projects, backed by Lancaster University, succeeded in providing broadband to remote areas but were constrained by the lack of reliable backhaul.

The poor quality of existing telecom infrastructures encouraged local residents to build their own fibre network. B4RN was started up in 2011 by a group of local citizens, championed by Barry Forde (previously manager of local telecommunications providers like LUNS Ltd). Since then B4RN has built 800 km of core network and connected 1,500 customers to FTTH. Originally focused on eight parishes, by June 2016 the project covered forty-three parishes.

The deployment is based on parishes rather than postcodes. The roll-out is started once the residents have collected sufficient funds to cover all the premises in their parish. The network roll-out mainly relies upon volunteers, who are trained by B4RN in partnership with the equipment suppliers. The participation of local residents allows B4RN to lay its infrastructure across farmland, significantly reducing the deployment costs.

Originally the project was expected to break-even at 1,000 connected customers and pay back the investment within 10 years (B4RN, 2013). A £3.5 million investment was estimated to connect 3,200 premises across 10 parishes. However, the take-up has exceeded the expectations: on average, 65% of homes passed have an active connection.

Connected customers are charged a non-recurring connection fee of £150 and a monthly subscription for 1 Gbit/s services. B4RN does not offer bundles with BT landline for voice services, but has a commercial partnership with Vonage, a voice over IP (VOIP) provider. Despite being vertically integrated, it also provides wireless ISPs with wholesale access to its backhaul network.

As a community benefit society, B4RN relies mainly on private funds from local investors. By January 2016 £1.5 million had been collected from shareholders, who are required to invest at least £100 (for 100 shares), with the maximum investment of £100,000. Regardless of the number of held shares, any shareholder has a single vote. The shares must be held for a minimum of three years and can only be sold back to B4RN.

Another £1 million has been collected from local lenders, with a £300,000 loan provided by an independent grant-making foundation. Private and public sponsors, like The Forest of Bowland AONB and the Land Rover Countryside Bursary, have supported B4RN through financial contributions and donations in kind. Crowd-funding initiatives have also been launched

To date, no public funds have been awarded to B4RN. Initially the communities explored the opportunity of applying to the Rural Community Broadband Fund⁷ (RCBF) and BDUK funds, but the requirements were considered unsuitable for their projects. BT won both the BDUK bids for a total amount of £36.3 million (Superfast Lancashire, 2013). The BDUK-funded roll-out has included also some of the parishes targeted by B4RN, which were initially excluded from BT's commercial and subsidised plans (Jackson, 2014).

⁷ A scheme of £ 20 million, jointly financed by DEFRA and BDUK, initially intended to provide superfast broadband to the hardest-to-reach premises.

4.2 Cityfibre

Cityfibre was founded in March 2010 by Greg Mersch and Mark Collins, who had previously been involved in the start-up and management of various telecommunications companies. One of these, i3 Group, built FTTH networks in Bournemouth and Dundee that were bought by Cityfibre in April 2011 for £4.7 million (Cityfibre, 2011).

The company builds and operates pure fibre metropolitan area networks, which are meant to be “a backbone for a future deployment of a gigabit-capable fibre to the home access” (Cityfibre, 2015, p. 5). These networks do not serve end-users but enable retail providers to deliver broadband services and interconnect with the Internet. Cityfibre has opted for an open access business model: by June 2016 it partnered with 49 local and national ISPs.

The main source of revenues is the provision of dark fibre, but the turnover from Ethernet-based active services is progressively increasing. Furthermore, Cityfibre is a major supplier of fibre links to the towers of mobile network operators like Vodafone and EE. The networks are usually designed according to the demand and needs of potential customers in the served cities, which are required to register their interest to be included in the network route. Anchor contracts with ISPs and the public sector enable Cityfibre to almost completely cover the initial investment, maximising the gross margins of network deployments.

Being a wholesale-only operator Cityfibre is not directly involved in the retail market. However, Cityfibre’s parent company also owns Gigler, a retail FTTH provider based in Bournemouth. Moreover, it holds a 33% stake in Bolt Pro Tem Ltd, a joint venture with Sky and TalkTalk for the roll-out of FTTH in York. The ISPs have each invested £5 million in the joint venture, while Cityfibre has contributed its existing fibre assets (Garside, 2014). The first phase of the project was completed in March 2016, connecting 11,000 premises (Jackson, 2016).

Table 7: Cityfibre’s projects before KCOM’s metro networks acquisition

City	Launch Partner	Network length/coverage
York	Pinacl Solutions Sky+ TalkTalk	125 km, 110 public sites 11,000 premises (FTTH)
Edinburgh	Commsworld	150 km, 500 premises
Peterborough	Serco	90 km, 107 public sites
Kirklees	Easynet	80 km
Hull	MBNL	56 km, 37 small cells
Southend on Sea	City council	50 km, 120 public sites
Dundee	City council	200 public sites
Bournemouth	Gigler	21,000 premises (FTTH)
Coventry	City council	140km
Aberdeen	Internet For Business	n.a.
Newport	Logicalis	50 public sites
Glasgow	HighNet	n.a.
Bristol	Triangle Networks	82 km
Newcastle	NHS	11 km
Bath	University	12 km
Bradford and Leeds	Exa Network, Diva Telecom	200 km
Milton Keynes, Northampton	DBfB, Exa Network	160 km
Sheffield	Ask4	15 km

Source: compiled by the authors from data provided by Cityfibre

Cityfibre is entirely financed by private capital and has been listed on the London Stock Exchange since January 2014. On admission to AIM it raised £16.5 million, and the company is now capitalised at more than £160 million. The company has also available £165 million of debt facilities and has been qualified for a debt guarantees from HM Treasury’s Infrastructure UK scheme.

Investing in urban areas, Cityfibre is not eligible for public subsidies. Nevertheless, it has a strong interaction with the public sector, since local authorities and other public agencies are often anchor tenants in Cityfibre’s projects. In several cities, such as York and Peterborough, the local councils have been actively promoting and endorsing Cityfibre’s deployment as a key component of their digital strategies and Smart City projects.

Over the past six years the company has invested almost £50 million in 37 town and cities, by deploying both greenfield fibre networks and taking over existing assets from local authorities and other infrastructure providers. In January 2016 it completed the acquisition of KCOM’s metro networks in 24 cities and 1,100 km of long distance network for £ 90 million. This represented a

significant extension of Cityfibre's geographic scope and is consistent with the company's medium-term goal of serving 50 cities.

4.3 Gigaclear plc

Founded in 2010 by Matthew Hare, the former owner of Community Internet Group, Gigaclear plc builds FTTP networks in rural areas unserved by major providers and excluded by public interventions. Some of the served villages had previously established their own community networks, which have been later taken over by Gigaclear. Rutland Telecom's FTTC network was bought in May 2011 for £200,000, while Cotswolds Broadband C.I.C, a FTTP and fixed-wireless community provider, was acquired in December 2015 for £106,000.

Unlike these community-led projects, Gigaclear is a private company and does not involve local residents in the funding and roll-out of the network. However, the company works in partnership with local campaigners and businesses to raise broadband awareness and aggregate demand. In fact, Gigaclear invests only in 'qualified communities', with a minimum level of customer pre-orders ensuring a first-year project return of over 10%. On average, the percentage of pre-registered customers is 28% and the return on each project is expected to be over 20%, with a payback period of 5 years.

Gigaclear serves both residential and business users with superfast broadband, while voice services are provided in partnership with Vonage. Despite being vertically integrated, Gigaclear's networks are open to other ISPs. Currently the company has commercial relationships with an ISP aggregator, a wireless ISP, and three ISPs focused on the business segment.

The company is entirely owned by private shareholders. The main shareholders are Woodford Investment Fund and Prudential Infracapital, with an equity investment of £24 million and £20 million respectively. A £18 million loan has been secured from the European Investment Bank (EIB) in January 2016.

Furthermore, Gigaclear has been awarded funds from four local authorities. In March 2014 it won the bid for fibre roll-out in Northmoor, who had obtained a £186,000 grant from RCBF. The project was completed in two months, covering 542 premises at an average cost of £800 per home passed (Jackson, 2015). In 2015, Gigaclear was awarded BDUK funds in Essex, Berkshire, Gloucestershire and Herefordshire, for a total of £8.7 million (see Table 8).

Table 8: BDUK contracts awarded to Gigaclear

Local authority	Public funds	Gigaclear investment	Premises to cover
Essex	£ 2 million	£ 5.5 million	4,500
Berkshire	£ 3.7 million	£ 16 million	11,700
Gloucestershire and Herefordshire	£ 3 million	£ 7 million	6,495

Source: compiled by the authors from data provided by BDUK and Gigaclear

As of December 2015, the company owned and operated 56 FTTP networks in 11 counties (Buckinghamshire, Cambridgeshire, Essex, Gloucester, Hertfordshire, Kent, Lincolnshire, Northamptonshire, Oxfordshire, Rutland, West Berkshire), with 35 more networks under construction. In December 2015 the homes passed by Gigaclear totalled 15,000 with a take-up of 36%. Generally, the deployments include all the premises in a village, but the hardest-to-reach premises may be required to subsidise the roll-out (Palmer, 2016).

Gigaclear’s projects have focused on rural areas previously excluded by either private or public NGA investment. Nevertheless, as experienced by B4RN, the entry of Gigaclear led BT to amend its FTTC investment plan: the company has estimated that 45% of its networks have been partly overbuilt by the incumbent (Gigaclear, 2016).

4.4 Hyperoptic

Hyperoptic was founded in 2010 by Dana Tobak and Boris Ivanovic, entrepreneurs with a long-term experience of broadband markets. In 2005 they started BE Un Limited, the first ADSL2+ provider in the UK, later acquired by Telefonica and now part of BskyB group (BBC News, 2013). Boris Ivanovic had previously launched BoStream, a FTTP provider in Sweden (O’Dwyer, 2004).

Hyperoptic rolls out FTTP networks to urban multi-dwelling buildings (including 50 or more units⁸). It works in partnership with developers, property managers and housing associations to install fibre in either existing or new properties. Unlike other niche providers, Hyperoptic does not deploy its own passive infrastructure but focuses instead on the roll-out of point-to-point fibre wiring into end-users premises.

The installation of fibre into the target building starts once 10% of residents have registered their interest. However, this does not imply either an upfront payment or an exclusivity requirement. Residential and business users can choose between 20Mbps, 100Mbps and 1Gbps offers. Further

⁸ Until October 2015, this threshold was set at 80 units.

tailored services for businesses have been launched since March 2015 and a ‘no contract’ option for new customers has been made available.

Hyperoptic is entirely financed privately. In May 2013 Quantum Strategic Partners Ltd became a major shareholder after investing £50 million in the company. A £21 million loan was secured from the EIB in July 2016. Being focused on urban areas, Hyperoptic has not benefitted from public funds for fibre deployment but has partnered with the Connection Vouchers Scheme.

Since 2011 Hyperoptic has deployed FTTP networks across 13 cities: London, Cardiff, Bristol, Reading, Manchester, Leeds, Liverpool, Sheffield, Birmingham, Glasgow, Newcastle, Nottingham and Brighton. New deployments are expected in Portsmouth, Watford, Leicester, Southampton, Slough, Edinburgh and Woking. Being focused on single buildings rather than widespread deployments, the overall coverage of Hyperoptic is still limited but the company is aimed at delivering FTTP to 500,000 premises by 2018. The take-up rate has varied across the served buildings, depending on the availability of other superfast broadband services with an average of 30% one year after the network installation.

Table 9: Summary and comparison of the four case studies

	B4RN	Cityfibre	Gigaclear	Hyperoptic
Incorporation	December 2011	March 2011	December 2010	April 2011
Geographic focus	Rural	Urban	Rural	Urban
Technology	FTTH	Fibre-only metro network	FTTH	FTTB/H
Investment model	Community-led initiative	Private company	Private company	Private company
Business model	Retail+wholesale	Wholesale only	Retail+wholesale	Retail only
Financial mix	Local shareholders+debt	Listed on AIM+debt	Financial investors +EIB loan+BDUK	Financial investors + EIB loan
Customer target	Residential users and SMEs	Public sector, ISPs, Mobile operators	Residential and business users	Residential and business users
Turnover (£000) ⁹	144	6,408	1,369	4,140
Profit (£000) ⁹	- 47	- 6,362	- 5,996	- 12,210
Network assets (£000) ⁹	1,779	48,712	6,729	8,839
Geographic scope ⁹	30 parishes	37 cities	56 communities	13 cities
N. of employees ⁹	10	83	63	211

Source: compiled by the authors from data provided by Bureau Van Dijk (2016)

5. Findings and discussion

Table 9 illustrates the heterogeneous nature and target of alternative NGA providers in the UK. Each provider has developed a unique strategy to address a specific niche in the market, defined by

⁹ As of 31st December 2015.

the gap between the demand and the supply of connectivity. Such a gap can be measured in terms of either broadband coverage or network performance. In the former case, the niche providers target those geographic areas unserved by subsidised and commercial deployments. In the latter case, the niche providers complement the existing supply of NGA by delivering pure fibre networks where a demand for faster broadband exists.

The differences between and within the niches have required these providers to implement variable strategies. Cityfibre has adopted an open access model for the provision of dark fibre, but provides FTTH through either its retail subsidiary or a joint venture with two major ISPs. Hyperoptic, B4RN and Gigaclear are vertically integrated with both rural providers also offering wholesale services. Consequently, the case studies suggest that niche providers are likely to adapt their business model to the product they offer and the area they serve.

Similarly, the investment model and the financial mix are affected by the geographic focus of the initiative. The urban niches are targeted by private ventures funded by financial investors. Gigaclear suggests that even in rural areas there may be a case for private investment, while B4RN's experience has shown that community-led initiatives in remote areas are feasible without public subsidies. The four case studies emphasise the ability of alternative providers to attract a mix of financial resources fitting the investment needs and conditions of their targeted niche.

The different nature and scope of these providers are reflected also in their marketing. Hyperoptic and Gigaclear differentiate their services in terms of bandwidth and price, while B4RN offers only a single product that requires a smaller expenditure for network management and billing. Perhaps due to its non-profit nature, B4RN's product was the most affordable among 1Gbit/s offers. Gigaclear's services, in contrast, are the most expensive, reflecting the higher deployment costs and reduced competition of rural areas. In any case, these niche providers offer higher speed than the major service providers – see Table 10.

Table 10: Comparison of retail offers¹⁰

	Broadband only	Phone+broadband	Phone+broadband+TV
20 Mbit/s	Hyperoptic: £19.33	TalkTalk: £18.26 Hyperoptic: £20.50 Sky: £22.98 BT: £25.64 Vodafone: £27.38	TalkTalk: £28.63 Sky: £43.81
38 Mbit/s		Sky: £26.23 TalkTalk: £26.96 Vodafone: £37.38	TalkTalk: £38.63
50 Mbit/s	Virgin Media: £33.08 Gigaclear: £48.23	Virgin Media: £29.77 BT: £34.73	Virgin Media: £32.32 BT: £44.73
76 Mbit/s		Vodafone: £42.83	BT: £59.65
100 Mbit/s	Hyperoptic: £29.33 Virgin Media: £38.08 Gigaclear: £53.58	Hyperoptic: £29.50 Virgin Media: £34.77 BT: £49.65 Gigaclear: £61.58	Virgin Media: £42.32
200 Mbit/s	Virgin Media: £46.08 Gigaclear: £60.78	Virgin Media: £45.57 Gigaclear: £68.78	
1,000 Mbit/s	B4RN: £42.50 Hyperoptic: £47.83 Gigaclear: £82.33	Hyperoptic: £47 Gigaclear: £90.33	

Source: compiled by the authors from data provided by www.uswitch.com

To date, retail triple play is not offered. Access to media content was highlighted by Tadayoni and Sigurðsson (2007) as a barrier for alternative providers, lacking the scale and the resources to acquire content themselves. However, the increasing supply of online content from OTTs and broadcasters is likely to reduce the competitive disadvantage of niche providers unable to replicate triple-play offers.

With regard to the relationship with public sector, the experience of niche providers varies significantly across the case studies. Gigaclear is the only to have benefitted from public funds, but local councils have actively supported Cityfibre being either anchor tenants or promoter of its projects. In contrast, Hyperoptic and B4RN have had a less straightforward interaction with respect to the release of permits and wayleaves. This suggests that public support can facilitate the development of niche providers, but it has not been a major driver for their entry into the UK NGA market.

The influence of regulation has been negligible for all these initiatives due to their limited reliance on regulated services. Initially their interaction with Ofcom was aimed mostly at obtaining

¹⁰ Average monthly price based on a 12 month contract with unlimited data usage.

‘Code Powers’¹¹, to streamline fibre roll-out. However, the relationship with the regulator has changed over time for those providers directly competing with the incumbent. The recent appeal of Cityfibre against Ofcom’s decision to impose a price cap on BT’s dark fibre (Competition Appeal Tribunal, 2016) highlights the potential impact of ex-ante regulation on the sustainability of niche infrastructure providers.

In summary: the four case studies exemplify the diversity and complexity of niche infrastructure projects across the UK. However, the analysis has also outlined a number of recurring elements across their strategies:

- the leverage of past experiences in broadband market;
- the implementation of demand aggregation mechanisms;
- the reliance on strategic partnerships; and,
- the adoption of a modular approach to NGA deployment.

These factors can be identified as key features of alternative NGA providers and are expected to influence the sustainability of their investment in niche markets.

All these case studies are related, in different ways, to past initiatives in broadband market. Gigaclear, Cityfibre and Hyperoptic have been founded by entrepreneurs with a long experience as initiators and managers of telecommunications companies. Likewise, some of the communities involved in B4RN project had previously established cooperative Wi-Fi networks. These past experiences have endowed the new providers with detailed knowledge of broadband markets and the technical know-how needed to manage the risks and complexity of network investments.

This expertise has been vital to building trust around the projects, gaining support from financial investors and local stakeholders (public authorities, prospective customers, potential suppliers). Similarly, the skills within the local communities have been crucial to both the planning and the execution of B4RN, which periodically organises free training sessions for its members to share and develop the technical know-how in fibre roll-out. Cityfibre and Gigaclear have also sought to leverage past investment in NGA markets by taking over extant assets from other providers. The existence of underutilised or underperforming assets is likely to affect the growth strategy of these niche providers, in terms of the localisation of their investment.

In general, the location of alternative NGA deployments is demand-driven. The case studies have adopted a variety of mechanisms to measure the actual demand of superfast broadband within a

¹¹ The Electronic Communications Code empowers network providers to build their infrastructure on public land and to take rights over private land. Providers with Code Powers can benefit from exemptions under planning legislation and carry out street works without applying for a specific licence.

specific area. Gigaclear, Cityfibre and Hyperoptic require their potential customer to pre-register and trigger roll-out once a threshold is met. Similarly, B4RN covers a parish only when a sufficient number of households have joined and contributed to the project. Cityfibre relies also upon anchor tenant contracts with ISPs and major customers. As a result, these providers focus their investment where sizeable demand for fibre networks already exists.

The level of demand aggregation required to commence the investment varies across the four initiatives, but the pre-registration is never binding and does not imply an upfront payment. Furthermore, once a certain threshold is met the fibre is usually deployed to any premise, including those who did not register. Consequently, this mechanism is primarily aimed at estimating the potential of each project rather than minimising its financial risks. In contrast, anchor contracts ensure a steady source of revenues that are expected to fully cover the initial capital expenditure over the medium term.

Consistently with their emphasis on demand aggregation, niche providers usually exhibit a high take-up rate – on average, greater than 30% for commercial deployments and 65% for the community-led initiative. On the other hand, their demand-driven approach implies that these initiatives are unlikely to include those areas where the demand of broadband is suboptimal, generally due to socio-demographic factors such as income and the level of education.

Furthermore, niche providers tend to engage in partnerships to access key inputs for their NGA projects. The nature and objective of these strategic relationships vary across the four case studies – see Table 11. The community-led initiative relies on the involvement of local residents to reduce the deployment costs. The relationships with suppliers and anchor tenants enable the providers to specialise in a subset of activities along the value chain. As a result, Cityfibre has focused on the provision of passive infrastructure with the local ISPs in charge of retail services, while the partnership with Vonage has enabled Gigaclear and B4RN to become fully independent from BT’s infrastructure.

Table 11: Key partners for the four case studies

Provider	Partners	Input
B4RN	Local communities Vonage	Voluntary work, in-depth knowledge of the area, free wayleaves Voice services
Cityfibre	Local ISPs Local authorities	In-depth knowledge of the local market Promotion within their communities
Gigaclear	Broadband campaigners Subcontractors, equipment suppliers Vonage	Promotion within their communities Technical expertise Voice services
Hyperoptic	Developers, property managers	Wayleaves and innovative bundles

These strategic relationships activate synergies that create value for both parties. The ISPs partnering with Cityfibre can reduce their reliance on BT, which is also their main competitor. The local councils can leverage Cityfibre's infrastructure to implement their digital strategies and enrich public services. Even the owners of MDUs can leverage their relationship with Hyperoptic to enhance their value proposition, by providing innovative bundles and advanced services to their customers.

To leverage the existing demand and the strategic relationships in a specific context, all of the case studies have adopted a modular approach. This implies that each deployment is based on a single geographical unit: a parish for B4RN, a village for Gigaclear, a MDU building for Hyperoptic, and a city for Cityfibre. Any incremental project is developed autonomously in order to leverage the opportunities and maximise the return on the investment in that specific unit. This approach has enabled the four providers to successfully expand their footprint, by replicating and adapting their model to new niches in the NGA market.

This modular approach also ensures a high level of flexibility as each project is designed and implemented according to the demand and the resources existing within the targeted area. As a result, the routing of Cityfibre's networks is based on the location of pre-registered and prospective customers, while B4RN deploys its ducts taking into account the geography of each parish. Moreover, this flexibility enables the alternative providers to responsively adapt to the special requests of their customers, whether it is a service provider requiring lit rather than dark fibre or a landlord offering broadband bundled with the monthly rent.

Since each project focuses on a single area, the niche providers tend to build their infrastructure in order to connect all the customers within that unit. Gigaclear's and B4RN's deployments usually include all the premises in a village or parish to achieve economies in the construction phase. This implies that both providers are aiming at covering 100% of the premises in their targeted communities, thereby reducing the scope for further public interventions to bridge the digital divide in these areas.

On the other hand, the coverage of niche providers in the cities has so far been limited by their scope and focus. Cityfibre is currently delivering FTTH in just York and Bournemouth, though its metro networks are meant to be the starting point for the roll-out of fibre in the last mile. The commercial success and financial return of the ongoing projects in York and Bournemouth are likely to affect the likelihood and intensity of further FTTH investment within and beyond these cities.

Despite their overall coverage being limited by their niche strategy, the contribution of alternative providers to the development of NGA in the UK has been significant. By investing in pure fibre networks, they are leading the provision of ultrafast broadband (delivering a minimum download speed of 300 Mbit/s). Furthermore, their entry in the market has often pushed the incumbent to revise its investment plans. This has raised concerns on the fairness and efficiency of BT's behaviour (PRISM, 2014), especially in those areas where its deployments are subsidised. Nevertheless, these reactions have proved how competitive pressure exerted by niche providers can induce major providers to expand the coverage and the capacity of their NGA networks.

6. Conclusions

The four case studies have provided an overview of niche providers' role and contribution to NGA development in the UK. Their deployments contradict the general view that private investment is profitable only in densely populated areas and for large-scale providers, since they bring fibre networks where major public and private initiatives have failed to fulfil the demand for fast and reliable broadband.

They have developed a variety of strategies to address the gap between the demand and the supply of superfast broadband in the UK. Their unique business models have leveraged the opportunities and resources within each niche to compensate the diseconomies of their small-scale. On the other hand, their modular and demand-driven approach has enabled niche providers to outperform major public and private deployments, in terms of coverage and take-up.

In fact, these providers arguably represent a new paradigm in broadband markets. They do not rely on BT's infrastructure and have leapfrogged the ladder of investment by deploying their own fibre networks. Moreover, they generally adopt flexible business models – delivering both retail and wholesale services – and partner with OTTs usually perceived as competitors by 'traditional' telecom operators.

The success of such disruptive initiatives is likely to depend on the competitive responses of major broadband providers and the ability of public institutions to leverage their potential. A level playing field between mass-market and small-scale projects need to be ensured, in order to prevent anticompetitive behaviour and an inefficient allocation of resources in NGA development. This is likely to require a different approach to public intervention in broadband markets, which is still centred on the simplistic juxtaposition between competition in urban areas and market failure in rural areas.

At this stage, the sustainability of niche providers in the long-term remains unclear. None of the four case studies are profitable, but this is consistent with the cost structure and the long payback period of NGA investment. Whether niche providers will grow or will be acquired by major players, their overall impact upon NGA need to be further assessed and clarified, considering both the direct benefits for the targeted areas and the indirect repercussions for the market, in terms of competitive pressure and diffusion of innovative business models.

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