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Published in:
Telecommunications Policy

DOI:
[10.1016/j.telpol.2021.102201](https://doi.org/10.1016/j.telpol.2021.102201)

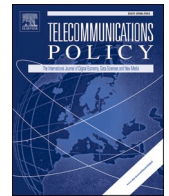
Published: 01/11/2021

Document Version
Publisher's PDF, also known as Version of record

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Please cite the original version:
Lähteenmäki, J. (2021). The evolution paths of neutral host businesses: antecedents, strategies, and business models. *Telecommunications Policy*, 45(10), Article 102201. <https://doi.org/10.1016/j.telpol.2021.102201>

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The evolution paths of neutral host businesses: Antecedents, strategies, and business models

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ARTICLE INFO

Keywords:

Neutral host
Strategy
Antecedents
Regulation
Business model
Ownership
Path dependence

ABSTRACT

A neutral host company provides wholesale infrastructure sharing services through digital platforms to the downstream-markets enabling customers to take advantage of economies of scale and to access knowledge assets. Through a qualitative study of more than 50 businesses, the analysis of neutral host business antecedents, emergent company strategies, and ecosystem business models reveal that the markets of data and communications are highly fragmented, different, and diversified, but the categorization of business traits suggests the attribution of typical underlying business and investment decisions. The policy implication is that to enable asset sharing, the markets should not be constrained through a local-monopoly prohibiting regulation, but additional innovation fostering practices shall be implemented to provide further social benefits and business consolidation opportunities before dominant designs emerge. On the global level, increased collaboration among policy makers is needed to ensure the parallel evolution of local digital platform regulatory frameworks.

1. Introduction

Throughout the history of industries, the strategic decisions of market participants have played a crucial role in shaping how industry assets are utilized. In telecommunications markets, for more than 100 years, providers have made decisions to share their infrastructure with others to enable end-to-end network coverage instead of building their own global networks (Dunnewijk & Hultén, 2007). And in the data markets, analysis firms have decided to buy and sell datasets with each other to expand data coverage (Koutroumpis et al., 2020). These strategic decisions have in turn created local wholesale markets that have opened a wide range of business opportunities. When these markets have matured, however, they have required regulatory frameworks to prevent, e.g., anti-competitive behaviour, violation of personal privacy, and discriminatory pricing. Moreover, the initiatives of authorities have steered market evolution, e.g., in means of telecommunications privatization to enhance competition (Ros & Banerjee, 2000) or the act of general data protection regulation to enhance the market power of individuals (Krämer & Wohlfarth, 2018).

Demand for digital services in modern societies has increased dramatically in recent years, which in turn has increased the need to expand infrastructure sharing practices on the telecommunications and data markets. Infrastructure sharing capabilities have evolved through technological evolution, but this development has also created a need for a dedicated business entity called a neutral host provider. The extant literature acknowledges three major domains where a neutral host business, and the corresponding infrastructure sharing, can take place; wide area infrastructure requiring sharing due to scale (e.g., Kibilda & DaSilva, 2013); urban area infrastructure requiring data collection for better decision making (e.g., Anttiroiko et al., 2014); and local micro environments with special

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<https://doi.org/10.1016/j.telpol.2021.102201>

Received 4 December 2020; Received in revised form 16 June 2021; Accepted 16 June 2021

Available online 25 June 2021

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circumstances (e.g., Kibria et al., 2017). Although the literature agrees that the role of a neutral host is to aggregate downstream needs and to build corresponding technology platforms for sharing (Paglierani et al., 2020; Yrjola, 2020), these studies also tend to focus on modern urban areas utilizing 5G technologies as a contextual factor. The literature dismisses, however, the other structural and environmental factors of these neutral host companies.

Although infrastructure sharing has a long history, the term *neutral host* is a relatively new concept in the area of data and communications businesses as it emerged in the mid 2000s. The original need was stemming from passive infrastructure sharing operations, where distributed antenna systems (DAS) required an operator independent company to run the infrastructure (Muir et al., 2006). First the concept diffused to the science literature (Ramachandran, 2008) and then later to the business literature (e.g.; Rayal, 2013) resulting in a fragmented use of the term. There have been some recent studies related to the concept unification, but it seems that the paradigm has not settled yet due to the fact that there are still several alternative definitions for the neutral host concept (e.g.; Benseny, Walia, Finley, & Hämmäinen, 2019; Paglierani et al., 2020; Paolino, 2019). Hence, the existing literature is inconclusive of what 'neutral host' actually means.

Policy makers may find it hard to set effective rules and incentives on novel neutral host markets if it is unknown what these markets and its stakeholders actually are. As some scholars have pointed out, the regulation of neutral host ecosystems is a multi-dimensional endeavour resulting in a complex interplay of policies (Korpisaari et al., 2020, p.90-91), for example on the areas of personal data protection and privacy, network and spectrum regulation, competition law, and public procurement legislation. This raises two major topics to be addressed. First, as the term is used differently by several stakeholders, including scholars, policy makers, and industry players, that allows mixed interpretations of market structures and market powers, and it may even lead to misaligned policies, the study finds it important to clarify the terminology in the neutral host literature. Second, as some business evolution scholars have pointed out (David, 1994; Reynolds, 1981), it is crucially important to understand the history of a business due to the fact that the path-dependent nature of business decisions steer individual company strategies, but it also shapes the whole market evolution. The historical insights, in terms of company evolution, may provide paramount views to the organization level factors of neutral host markets. Addressing these topics together allow this study to elaborate further the antecedents and future directions of neutral host markets and implications for policy makers.

This study formulates a dense form of the neutral host definition and defines that *a neutral host is a service provider that builds and operates an integrated technology platform that is solely for sharing purposes*. This generic definition allows the broader use of a neutral host model in various context as it strives to minimize the role of technological factor, and this perspective allows this study to research existing markets and interpret the future directives on the higher levels of ecosystems rather than focusing on platform assets which are subject to technological evolution and rapid obsolescence.

In this line, the context of this study is the strategic factors of neutral host market companies. In this context, technology platforms are seen as enablers for businesses and regulatory landscape of telecommunications, spectrum allocation, and data privacy policies as a framer. The technological context and scope of this study span across all major standards in use, including mobile and fixed technologies such as 3 GPP 4G/5G and IEEE 802.11 in the fields of communications, and including different kinds of data platforms such as IoT sensor networks and big data platforms. The reason why this research is needed is because of the need for better structural understanding of markets. As the neutral host models diffuse into various markets, various stakeholders should identify the decision-making criteria and the background factors that affect them. Moreover, it has become clear that neutral host markets are subject to consolidation as the activity on mergers and acquisitions has gained momentum. How the most important assets of modern digital societies become distributed and who holds the controlling power of it are not superfluous questions, but these require increasing attention to ensure the socially optimal development of the policy landscape. This study sets the research question as: *On what paths neutral host companies have emerged and what strategies those companies have taken?*

Through an empirical study of more than 50 existing organizations utilizing the neutral host model, this paper categorises and analyses strategies and business models seen in the market. Moreover, the study categorises typical ownership structures and investment strategies to gain an understanding of company antecedents on the markets. This paper concludes that data and communications business models are significantly different, implying that these are two separate markets, and there are very few neutral host companies that operate on both of these markets. Moreover, it turns out that the original line of a business and company ownership structures impact first to company level strategies and then to corresponding ecosystem level business models.

This paper contributes to the literature on neutral host market structures, neutral host strategies, and neutral host models. First, this paper contributes to the neutral host market structure literature by igniting the research on the categorization and elaboration of distinctive emergence paths. While existing research explains extant roles and relationships through abstract and static value network configuration models (Benseny, Walia, Finley, & Hämmäinen, 2019), this paper deepens this understanding empirically by showing how organizations actually have evolved. Moreover, the contribution of this study includes a clarification of the neutral host concept terminology. Second, this study advances the research on neutral host strategies. While existing research has been limited to explaining the choices made by a neutral host company through characteristic business logic (Ahokangas et al., 2019), this paper broadens this research stream by categorizing strategic choices and ownership structures. Third, this research contributes to the understanding of firm level behaviour differences in the market through linking the investment strategies of shareholders to company strategies, and by doing so this study strives to explain neutral host business antecedents better. While existing research identifies only a few alternative typical ownership categories for neutral host companies (Kibria et al., 2017), this research identifies ten categories for owners with their characteristic investment strategies.

2. The concept of neutral host

Several business scholars have studied the asset sharing practices on data and communications markets, and they have observed the need for a strategic business entity to enhance the efficient use of infrastructure assets. However, as the focus has been in details, the bigger picture has remained ambiguous.

2.1. Review of the neutral host literature

This section reviews the most important part of the literature related to the business models and sharing economies and strategies of a neutral host company. These streams build the bigger picture of a neutral host landscape. First in the stream of neutral host business models, review reveals that although being highly fragmented and inconclusive of several aspects, the extant body of literature builds on the idea that through infrastructure sharing, local communication ecosystems can improve efficiencies and, thus, reduce costs. Second in the stream of neutral host strategies, it is well known that when neutral host models are applied, it also has strategic consequences for others, but only a few of those other areas have been actually studied. Third, the sharing economics literature of digital platforms acknowledges that sharing is not just dividing costs between multiple stakeholders, but it is also dividing knowledge, created value, and risks among platform stakeholders.

The term *neutral host* is a relatively new concept in the area of data and communications businesses. The term emerged in the mid 2000s from passive infrastructure sharing operations, where distributed antenna systems (DAS) required an operator independent company to run the infrastructure (Muir et al., 2006). First the concept diffused to the science literature (Ramachandran, 2008) and then later to the business literature (e.g.; Rayal, 2013) resulting in a fragmented use of the term. There have been some studies related to the concept recently, but it seems that the paradigm has not settled yet due to the fact that there are still several alternative definitions for the neutral host concept (e.g.; Benseny, Walia, Finley, & Hämmäinen, 2019; Paglierani et al., 2020; Paolino, 2019). However, there are some patterns within the literature that is reviewed next.

First, the business model literature is highly segregated through spatial factors, meaning that urban area, rural area, and special venue differences have been the main contextual factor in several studies. Most of the studies focus on urban areas, where the population density is the highest. Paglierani et al. (2020) propose a neutral host model where a small cell operator with cloud capabilities provides full featured connectivity services in urban areas. Their extensive analysis of neutral host enabled connectivity services suggests that neutral host business models are most applicable in specific venues, such as stadiums. Neokosmidis et al. (2018) proposes a model where a local municipality acts as a neutral host by sharing the local infrastructure for MNOs in a local wholesale market. Their model supports active network sharing, but it is limited to the eNodeB level as it assumes that the ownership of spectrum assets is held by MNOs. Benseny, Walia, Hämmäinen, and Salmelin (2019) also propose a municipality driven approach to the neutral host ownership. Their work builds on the scenario where a local neutral host company operates a local small cell-based network. However, their techno-economic analysis shows almost ten years break-even time when comparing a traditional MNO model and the neutral host model, which suggests an unfeasible scenario. Later, Neokosmidis et al. (2020) presented a techno-economic analysis of their business model for a 5G small based network operator. In their results, the payback time of the scenario is also rather slow for investments, which may indicate the lack of scale in these scenarios.

There are also studies which focus on rural areas. Kumar et al. (2020), for example, analyse a scenario where the neutral host model is seen as an industry configuration rather than a role of some individual business entity. In their model, a separate infrastructure provider holds ownership of wide-area network assets and shares it among industry stakeholders to motivate ecosystem members to provide services to areas which were unattractive other vice. Although these rural area studies are rare, these show high potential as monetary incentives have not always been able to motivate incumbents to build services (Kontio, 2020).

Special regions and venues have also been studied through the neutral host perspective. Walia et al. (2017), for example, study campus network options and conclude that small-cell based micro-operator approach can both decrease a number of required base stations in an area, and in turn it can increase network efficiency. However, they also acknowledge that these micro-operator-based approaches are subject to regulation uncertainty as it is still unresolved if these private network operators are subject to public network regulation or not. Moreover, Kibria et al. (2017), proposes the use of a neutral host model in the context of tailored services for different venues. Their model is based on a micro-operator approach and it utilizes a shared spectrum model. In addition, Ahokangas et al. (2019) propose two distinctive dominant business models for a neutral host operating in a micro-operator role; the vertical business model provides tailored services for specific cases; the horizontal business model provides local hosted connectivity for extant MNOs in a feasible and cost-efficient way. This body of literature shows the third important context where the neutral host business model has been applied.

The second stream of literature, neutral host strategies, is very short. Those few papers that handle strategy topics in the context of a neutral host model tend to examine strategic impact for stakeholders in the environment of a neutral host company, but not the strategy of the neutral host company itself. Benseny, Walia, Hämmäinen, and Salmelin (2019) provide two characteristic strategies for cities to deploy a small-cell network using a neutral host model. The study assumes that MNOs rely on cost-efficiency strategies, which implies that the neutral host strategies have to support that path. Neokosmidis et al. (2019) argues that incumbent MNOs have to change their strategy to utilize neutral host infrastructure where present. It remains a question why incumbents have to do it. If this would be the case in the presence of a high regulatory regime, a neutral host company could then just build a natural monopoly infrastructure and let customers come. But this is hardly the case in modern competitive markets. There seems to be a major lacking in the literature in terms of neutral host strategies.

Third, the sharing economy literature covers a significant number of studies related to digital platforms in general, but it mostly

lacks the neutral host perspective in detail. The study of Muñoz and Cohen (2017) includes both telecommunications and data cases, and their analysis reveals that instead of having just one type of a sharing business or economic impact, it turns out that there are at least five distinctive configurations of how a sharing economy may be realized. Configurational factors, such as collaboration governance, mission, resource efficiency, access to funding, ecosystem peer-collaboration, and leverage on technology, influence how the business logic functions within that configuration. Hence, these turn out to be strategic factors which are influenced by both historical aspects of a company and environment (e.g., ownership). The authors also discuss the policy implications of these factors, and conclude that typically sharing economy businesses lead to inclusion and more socially optimal situations. Yrjölä (2019) proposes utilization related economy factors in terms of infrastructure sharing. Moreover, he proposes sharing of knowledge and sharing of created value in ecosystems. While the former factor explains decreasing transaction costs through larger scale and increasing efficiency, the latter factors stem from knowledge exploration initiatives within alliance partnerships (Stettner & Lavie, 2014), and seek for complementarity (Gulati & Gargiulo, 1999, p. 1460). However, in some cases also competition, organizational structures and market configuration create or prevent synergies related to the sharing economy to happen. Moreover, Lehr and Sicker (2019) discuss the implications of forcing infrastructure sharing by policies, and propose a framework to address sharing issues in public utility services. The authors notice that technological flexibility and adaptability have diversified business opportunities which in turn have increased the range of substitutions for consumers.

The neutral host term has also been referenced by several other studies beyond these three areas. These other studies are not specifically addressing the aspects of infrastructure sharing, but they illustrate the contexts where the term has been applied. Scholars on techno-economics have studied, for example, value network configurations (Walia et al., 2017) giving alternative industry structure guidelines for local micro-operators, and small-cell provisioning practices (Paglierani et al., 2020) providing guidelines for local neutral host operators introducing innovative 5G services. Moreover, scholars on neutral host technologies have studied emerging aspects, such as block-chains (Di Pascale et al., 2020), architectures (Colman-Meixner et al., 2019; Foukas et al., 2019), radio-access network slicing features (Ferrús et al., 2019), cloud computing at the mobile edge (Giannoulakis et al., 2016), and network function virtualization implementations (Baldoni et al., 2018; Paolino et al., 2019). Furthermore, scholars on legal and regulatory considerations have studied, for example, micro licensing policies focusing on 5G technologies (Matinmikko et al., 2018), spectrum ownership options (Neokosmidis et al., 2019), spectrum management practices (Massaro & Beltrán, 2020), and licensed shared access practices (Yrjölä & Kokkinen, 2017). All these studies focus on the communications services and also to the 5G related aspects of the neutral host concept.

Some scholars have found it useful to study different use-cases to reveal the impact of contextual factors, such as, deployments in ports (Ahokangas et al., 2020), expanding neutral host networks to rural areas (Cowie et al., 2020), or the use of in vehicle applications (C-V2X) (Basaure & Benseny, 2020). In addition to the interest of academia towards the topic, also industry forums have been active. Organizations, such as Small Cell Forum (SCF, 2021), Alliance for Telecommunications Industry Solutions (ATIS, 2019), GSM Association (GSMA, 2018), and International Telecommunications Union (ITU-T, 2018), have published their views regarding neutral host implementations, regulation, and business models. Through these studies the understanding of the concept has gradually improved but novelty and fragmentation of the topic indicates that there are several opportunities for further studies.

Although the extant literature mostly considers the neutral host model technologically neutral, meaning that the model itself does not constraint which technology is utilized, however, it turns out that the most of the research on the field actually posits neutral hosts

Table 1
Definitions of a neutral host have evolved over the years.

Source	Definition
Muir et al. (2006)	One entity operates a network on behalf of multiple cellular carriers.
Ramachandran (2008)	A neutral host is a system that allows multiple wireless carriers to share the same infrastructure.
Royal (2013)	The small cell network can be operated by a neutral host service provider which leases capacity to multiple mobile network operators
SCF (2021)	A neutral host is a firm that provides services for a number of operators wishing to deploy infrastructure in a particular location.
Giannoulakis et al. (2016)	A neutral host shares IT and network resources at the edge of the mobile network
Walia et al. (2017)	A neutral host is responsible for deployment, operation and managing of indoor small cell networks in an MNO neutral manner.
ITU-T (2018)	A neutral host is an independent wireless operator on a wholesale basis to mobile operators.
GSMA (2018)	In a neutral host model two or more operators rent a single network infrastructure that is deployed and operated by a non-operator 3rd party (may be affiliated with operator(s)).
ATIS (2019b, p. 10)	A neutral host obtains and manages resources, and provides facilities and/or interconnection allowing hosted clients to make use of the platform(s) to provide continuous services to their end user customers.
Paolino et al. (2019)	A neutral host slices its compute and networking resources according to the needs of verticals providing services for end users.
Benseny, Walia, Finley, and Hämmäinen (2019)	The NHO offers a network resource that MNOs can use to extend 3.5 GHz-based (and potentially 26 GHz-based) outdoor capacity and coverage.
Colman-Meixner et al. (2019)	A neutral host can offer its infrastructure to the third parties, and these can create new instances of virtualized services in the neutral operator's equipment.
Paglierani et al. (2020)	The neutral host is the owner of the radio and IT infrastructure deployed in a venue.
Di Pascale et al. (2020)	A neutral host deploys and maintains a small cell network, and provides a common infrastructure that can be used by multiple MNOs, and by other stakeholders enabled by smart-contracts.

to the 3 GPP mobile service context. Li et al. (2020), for example, study DAS implementations in a neutral host context and they acknowledge 5G opportunities. Although their results could be generalized to any wireless standard, however, this study assumes that the neutral host concept as such is technologically agnostic although all use-cases are anchored into some specific technology context.

To synthesize the literature findings, it can be said that the technological side of neutral host models is dominating the literature. At the same time, business strategy and business model related studies are relatively rare. In these few studies, some propose antecedents of the platform-based ecosystemic business models (Yrjola, 2020), which can be considered a historical perspective of a neutral host, while some provide techno-economic models for analysing business feasibility (Paglierani et al., 2020), which can be considered an emergent strategy perspective. However, none of these studies explores these strategies in depth, nor have focused on comparing neutral host models of data and connectivity. This is a clear gap that needs to be addressed in order to reveal how neutral host companies form and how they evolve in their environment. Moreover, the fragmented landscape of neutral host terminology cries for unification. These are important topics to be addressed because, for scholars, without a proper ontological base, academia is struggling to find a common language for this emerging concept, and, for policy makers, without an understanding of structures and evolution paths of neutral host businesses authorities may find it impossible to set effective incentives or appropriately binding regulatory constraints for local markets. As the extent of installed infrastructure and collected data continues to increase, the challenge to find socially optimal policies is becoming harder.

2.2. The model of neutral host

The literature review results in fragmented definitions of the neutral host concept. The extant literature is also inconclusive in the fact if a neutral host concept is a technology specific concept or if it is technology agnostic. The neutral host literature, however, agrees that a neutral host builds its infrastructure for sharing purposes and it operates on the wholesale part of a value chain. Table 1 gives examples of how different scholars and organizations have defined the neutral host term. These illustrative samples show that there is certain development of the term over the years, but also increasing diversity.

This paper takes a dense form of definition and defines a *neutral host* as *a service provider that builds and operates an integrated technology platform that is solely for sharing purposes*. The theoretical context is defined through this definition for this study.

The definition, this study proposes, contains four key characteristics. First, the *service provider* part proposes that a neutral host offers continuous services for its customers in the area of its operations. Second, the *builds and operates* part defines neutral host value adding activities, implying that the service provider constructs required infrastructure together with its key partners and it maintains and develops the infrastructure to meet varying needs of downstream customers. Third, the *integrated technology platform* part scopes and constraints the area of operations. Last, the *solely for sharing purposes* part steers the way how the built infrastructure is leveraged on the business-vice. To elaborate this further, it could be said that the scope defines that a neutral host strives to consolidate required technological components so that those can be delivered to wholesale customers as a one uniform environment. It is also good to notice that the definition does not limit what kind of technological components or applications are actually used, but the definition allows the use of all data and communications related components as long as those support sharing. Hence, it can be assumed that striving to seek economies of scale, innovation through collaboration, and efficiency in markets push business decisions to seek maximized fair utilization. However, this definition does not limit a company utilizing a neutral host model to pursue other businesses that do not fit into the definition. Consultancy services, and retailing or whole-selling of equipment, for example, are businesses that a company may pursue, but are not considered a part of the neutral host business.

3. Theoretical foundation

This study utilizes several theoretical frameworks, such as the concepts of strategy, business models, path dependency, ecosystems, and digital platforms. This section summarizes the most important of those.

This research focuses on analysing a realized company behaviour on a market. This selection implies that this study examines realized company strategies and then interprets the characteristic general model, which fits the real-world data. Generally, a business model and business strategy are variedly understood concepts (e.g. Ansoff, 1957; Mintzberg & Waters, 1985; Osterwalder, 2013; Porter, 1997). Several scholars have strived to clarify the concepts (e.g. Casadesus-Masanell & Ricart, 2010; Seddon & Lewis, 2003), and typical propositions have been that while strategy defines a business logic of one individual company within its environment in several ways (answering to the questions such as, 'what', 'how', 'when', 'why', and 'where'), a business model defines the business logic of some group in more simple way (answering just to the questions such as, 'what' and 'how'). In recent studies, Lanzolla and Markides (2021) discuss the roles of a business model and business strategy, and they propose that a business model can be seen as an analysis view of strategy extending resource-based view and market positioning perspectives. This approach is also in line with Seddon and Lewis (2003) work, which posits the concept of strategy to the level of 'real-world' and the concept of business model to the level of 'model-world'. Adapting this perspective to social constructivism's ontological stances, this study interprets a business model as an abstract description of typical business-related characteristics, which very seldom realize as such in the real world, but rather are simplifying characteristics of such business. At the same time, this study interprets strategy as 'a pattern in a stream of decisions' (Mintzberg & Waters, 1985), implying that these patterns, either deliberate or emergent, can be directly seen in the real-world company behaviour.

The previously described perspective of a strategy implies that there is an infinite number of different distinctive strategies that a company can utilize. However, it turns out that there are three main paths that most of these strategies lay on, the strategies of differentiation, cost leadership, and market focus (Porter, 1980). By utilizing the path of differentiation, a company selects novel product

areas and novel customer segments where to pursue the business (Ansoff, 1957). However, the utilization of differentiation strategies also causes decreasing operational efficiency due to lower average utilization of assets (Schommer et al., 2019). The profit seeking nature of companies pushes them to improve financial results (Coase, 1991), which motivates them to utilize the second path of a cost leadership strategy – i.e. operational efficiency. A company utilizing an operational efficiency strategy seeks economies of scale and scope (Stigler, 1958; Teece, 1980) and strives to maximize the utilization of assets (Majumdar, 1998). The third optional strategic path is the focusing on certain niche market segments in terms of customer needs and demands by providing superior quality and features (Whiteley, 1991). However, this strategy implies that the company needs to constraint its business to certain customers and it may find it challenging to grow or change amid industry changes (Arasa & Gathinji, 2014).

In the external environment of a company, market dynamics, such as changing social needs and technological evolution, on one hand, influence on later strategic decisions made by the company, and on other hand, decisions the company has made in the past influence on future decisions, hence there is path dependence in an emergent strategy. Kay (2005) defines that if there is a correlation between historical actions and subsequent actions (causality), there is a path dependence in that process. This also implies that the order of activities influences the results of that process. However, as complex as the business world is, there is not just one path of decisions and actions to be followed by a company, but there are several trajectories to be followed (Bergek & Onufrey, 2014). There is also strong temporal embeddedness in path dependency, meaning that the same actions but occurring at different times produce different paths and most likely different outcomes. Moreover, Meyer and Schubert (2007) make a distinction between the dependence of a path and the creation of a path, implying the former as emergent and evolutionary, while the latter as strategic and deliberate. Both of these are subject to become institutionalized, meaning that the company enters a lock-in with that situation (Sydow et al., 2009). The theory of path dependence can be seen as theoretical lenses that explain some of the decisions made by a company, but it can be also seen as an analysis framework that helps scholars to identify patterns in company evolution. Fig. 1 illustrates the relationship between the factors explained through path dependence and the factors realized as emergent strategies in this study.

In the business modelling literature, Osterwalder (2013) proposes categories for explaining an emergent business logic. The model includes factors such as, relationships between (i) industry specific resources, activities, and partner networks, and (ii) customer segments, customer relationship practices, and sales channels. Based on the designed value propositions, also corresponding financials can be modelled, in terms of costs and revenues. As an overall description, a business model canvas defines the logic of how a typical company in an industry may transform customer requirements to value for the company. This study also follows this definition as it allows the interpretation of several characteristic business aspects.

Another key concept in this study is the ecosystem, which is also variedly understood (Tsujimoto et al., 2018). The extant literature has several viewpoints to ecosystems, including; an ecosystem is a governance structure seen from a single company point of view

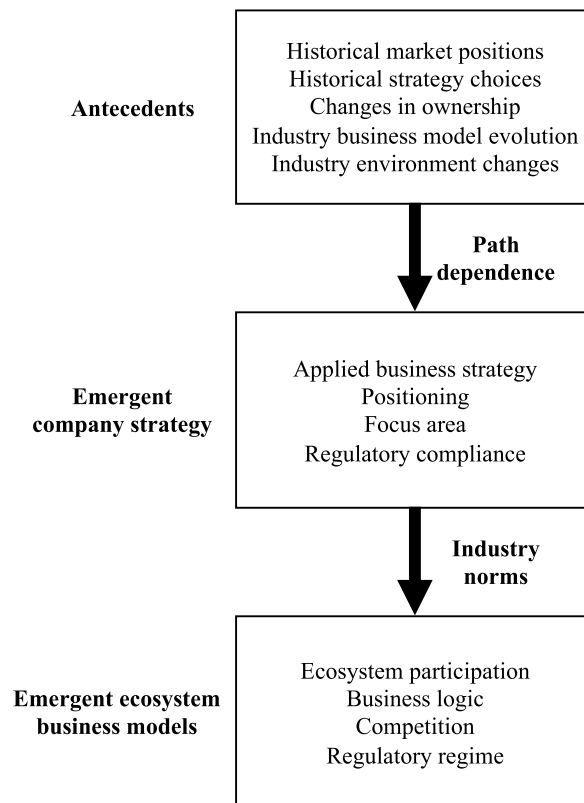


Fig. 1. Historical choices have an influence on the current business strategies, market structures, and business models.

(Adner, 2017); an ecosystem can be a cannon for network-centric innovation, rendering it a network of knowledge sharing (Nambisan & Sawhney, 2011); and in an urban context, an ecosystem can embed a public authority driven governance and sustainability seeking business networks through private sector participation and collaboration (Díaz-Díaz et al., 2017). The common aspects in these are the central coordination by a focal organization, and there are mutual interests among stakeholders. This study utilizes the term ecosystem as a perspective to interpret the external environment of a company. This implies that not all ecosystems are deliberate or even acknowledged by ecosystem stakeholders, but those may be highly emergent and latent for them. This study also applies the population ecology view (Hannan & Freeman, 1977) to interpret ecosystems, as it allows the analysis to consider emerging sub-groups as sub-populations of a wider ecosystem, but it also explains factors such as competition and product selection in these sub-populations. These perspectives allow this study to combine, for interpretation, the strategy as a company level decision making structure and the ecosystem as an external value-creating business network.

When discussing neutral host concepts, one cannot avoid discussing the use of digital platforms. One could say that setting up a digital platform has several similarities to setting up a traditional manufacturing factory, both economically and operationally. These modern information factories have become the norm in several industries, including telecommunications and data. A digital platform allows decreasing transaction costs through increasing scale, and it also allows increasing network effects through more integrated value creation (Kiesling, 2018). A platform typically combines latest digital technological enablers with a suitable and sustainable business logic, that open the sharing of costs and revenues between the focal platform company and its customers (de Reuver et al., 2018; Smedlund, 2012). The digital platform term is a generic concept. It refers to any set of digital technology assets, built and operated by a platform company. In that concept, the focal company leverages high asset specificity in the form of physical assets or knowledge. It may also, under high asset specificity circumstances, gain a natural monopoly position that in turn allows it to price the services and to control access to the platform for its own benefit.

Hence, while a digital platform is a tangible asset that a company holds, it also becomes a subject to obsolescence. To be able to keep up with technological evolution, a company not only needs to be able to renew the platform, but it also needs to be able to renew its market position, ecosystem configurations, and business models to ensure alignment with stakeholders (Agarwal & Helfat, 2009). This strategic renewal capability allows the company to change amid industry evolution.

Epistemologically, it becomes a cross-level interpretation of how strategy, an industry business model, and ecosystems interconnect. At a macro-level, a business model represents how a market is served by market participants. At a meso-level, an ecosystem represents how a network of market participants co-create value. And at a micro-level, strategy represents the path of company level decisions to fulfil the meso and macro-level goals. In this chain of thought, a platform can be seen as a core resource (see resource-based view by Wernerfelt, 1984) that the selected strategy leverages.

The puzzle is, due to the high growth of digital services in demand and the fast pace of technological evolution in recent years, it has become evident that the trend of diffusing digital technologies will remain. At the same time, the underlying market structures change as markets try to seek increasing efficiency. The role of a neutral host company in this change has been ambiguous, and it has become urgent to address two major questions. First, this study strives to answer the question of *what a neutral host actually is?* Second, through the analysis of empirical data, it also seeks to answer the question of *on what paths neutral host companies have emerged and what strategies those companies have taken?*

4. Methods

The general research question that this study seeks to answer is: “*on what paths neutral host companies have emerged and what strategies those companies have taken?*” Since the study puts neutral-host companies to the focal point in trying to identify differentiating characteristics, decision patterns, and their surroundings, qualitative research was preferred above quantitative techniques (Lee & Lee, 1999, pp. 21–22). The reason to do so is that it is not well known what are the lower-level market structures in the neutral host markets and what company level characteristics drive these markets. Specifically, this study utilizes qualitative comparative analysis together with active categorization to reveal underlying aspects. This study assumes that market structures, including business models, are socially constructed, which is in line with the views of Porac et al. (1995). Based on this social constructivism ontological stances, this study also acknowledges that the interpretations made by a scholar actually influence how reality emerges. As discussed in the previous section, this study interprets business strategy and business model as two different concepts. Moreover, it explores environmental factors through the ecosystem view described earlier.

4.1. Sample

This study examines the historical developments and current state of neutral host markets to gain understanding on how markets have formed. To gain an understanding of the neutral host market evolution and company level characteristics, this study reviews a sample of companies on the neutral host markets. In this research, the selection criteria are induced from the theoretical context; hence the study relies on theoretical sampling rather than statistical sampling (Glaser & Strauss, 1967). The context implies that a qualifying

company needs to provide data or communication services for other service companies without striving to compete on end-user markets. In this setting, a neutral host company does not deliver services for end-users, but only for other wholesale type organizations that process services further. For sampling purposes, the author extracted the full list of communication and data service companies from the Orbis database,¹ then any company that provided services for end-users were filtered out. The list was supplemented by collecting public authority driven initiatives that were not present in the commercial database.² As the author wanted to reveal differences between companies, hence to select polar cases, which allows the study to explore the phenomenon of interest, the author selected business entities to the sample one by one from the long-list until he felt that the saturation point has been reached and adding a new firm to the sample would not add significantly new information. Eventually the study reached the list of more than 50 companies and public organizations, and based on the author's interpretation, it represented well the neutral host domain.

4.2. Research data

As the study uses inductive means to interpret generalizable propositions, thus has no predefined hypothesis to be tested, the author strived to collect as diverse a set of data as possible to ensure trustworthiness of the results without going to the actual firms. The author wanted to understand organizational behaviour on the market level and the structures of these entities. Hence, this study collected a diverse set of public data related to the sample companies, such as public relations materials, annual reports, financial reports, marketing materials, press-releases, and public interview records. Company web-pages provided basic information related to business offerings, customer segments, and value propositions. News articles and press-releases provided information related to historical events a company has gone through. Marketing materials revealed the reasons why and how a customer may use the service being offered. Not all material was available for all companies, for example, only publicly listed companies disclosed annual reports, thus this study did not have similar detailed information available for non-publicly listed companies and the author was not able to make any interpretation on those cases. On the other hand, some organizations did not provide a detailed list of provided services, hence such information was interpreted through customer testimonials or white papers, for example. The data collection was done between November 2019 and October 2020. Orton (1997) proposes interleaving data collection and analysis phases to enable iteration between data and interpretation, which turned out to be a good practice also in this study as it allowed the author to find missing information as those occurred. The author downloaded all online material to the local repository for coding. The data collection phase yielded more than 400 documents.

4.3. Analyses

The author started the analysis by familiarizing himself with the context seen through the data, to the historical backgrounds of companies, and the overall development of markets. The first observation was that the communications market is actually much older than initially assumed, as, for example, one of the companies utilizing a neutral host model was established as early as 1989 (SBA, 1998), which is two decades before the 4G-LTE network era that was considered as a starting point of the market. This fact triggered the author to go even further to the history and to seek older events related to the neutral host type operations, but it turned out that the study did not find any older telecommunications related neutral host operations than 1989, which was then decided to be the starting point of the market.

This study used several qualitative analysis methods to interpret the data. For example, this study used qualitative data analysis and categorization methods to identify emergent themes and dimensions among the data (Grodal et al., 2020). Moreover, as the data in this study is mostly a written text, which holds an implicit narrative value, the author also used discourse analysis methods to gain understanding on the actors, their activities, and the relationships between these in the given context (Powers, 2001). These methods allowed the author to extract the needed insights from the data.

The qualitative data analysis method is based on an iterative textual coding procedure (Bazeley, 2013, pp. 125-132). First, the author coded the data using short labels, such as 'provides small-cell services' or 'owned by an investment fund'. The selected criteria were the strategic choices made by the company and different characteristics of the company. The author collected these codes to a table. In the second phase the author searched common dependencies between codes to form second order elements. The author identified that, for example, a company providing services with an end-to-end focus strived to specialise into one specific context (vertical focus), and thus selected a diversification strategy, while a company with a narrow product focus strived to specialise in a limited set of technologies and processes (horizontal focus), thus selected the economics of scale strategy. The author reviewed these categories, the original data, and supporting literature to improve coherence among dimensions. The author selected three key dimensions for further development, (i) business models, which reflect the overall ecosystem level business logics, (ii) the original lines of businesses, which reflect path dependent nature of a company strategies, and (iii) ownership structures, which reflect the

¹ Orbis is a commercial business information database, which contains a wide range of qualitative and quantitative information provided by local authorities and listed companies itself. The accuracy and quality of data in the database cannot be evaluated as the data collection procedures are not disclosed, but we think that the database is a trustworthy source for sampling purposes. <https://www.bvdinfo.com/en-gb/our-products/data/international/orbis>.

² The author collected public authority driven initiatives through extensive search from public websites. The author used search keywords, such as, "smart city; city development program; city data program", to identify potential candidates, and the author reviewed each of those before including them into the sample.

governance of company strategies. On the business models, the author defined two characteristics models using the Osterwalder (2013) framework, one for data and one for communications offerings. On the original line of business dimension, the author defined four categories that emerged from the data. The ownership structure development phase yielded ten categories that emerged from the data. After defining these dimensions, the author compared the emergent categories with the original data and validated if the analysis was able to abduct all relevant aspects of the companies. When data allowed, the author also looked at the temporal dimensions of different events to reveal the causal order of actions. For example, change in company ownership was found to influence the business decisions the company makes. The final review did not result in any major changes, thus the author concluded that the analysis has progressed to the end. Now let us move to elaborate the findings further.

5. Results

This study asks, *on what paths neutral host companies have emerged and what strategies those companies have taken?* To address that question, this study analysed the data, which resulted in three overarching dimensions. First two dimensions, historical market positions and ownership structures, together with direct observations of company strategies, build the view of emergent company strategies and their corresponding evolution paths. The third dimension, the ecosystem level business models illustrate the business logic within the ecosystem, which can be considered as an institutional constraint for a company within that ecosystem. Fig. 1 illustrates the structure of the results. First, this section shows the antecedent factors, such as historical market positions and ownership structures, which act as historical and path dependent factors for emergent strategies. Second, this section elaborates on the emergent neutral host company strategies, which leads to formation of industry norms and rules, and emergent ecosystem level business models. In this ecosystem context, this section elaborates on the implications to the regulatory regime. Together these can enlighten the emergence paths of neutral host companies, and market structures.

5.1. Antecedents of neutral host businesses

The results of the business structure analysis suggest that there is a path dependence in neutral host strategies. The assessed neutral host companies are divided into four separate categories, so that the grouping criterion is the historical business logic. The emerging categories are; (i) infrastructure leasing, (ii) specialization to a certain domain, (iii) incumbent MNOs ally to share costs, (iv) and public stakeholder intervention. Now let us discuss each of these categories and give some typical characteristics for a company in the category.

5.1.1. Infrastructure leasing

Infrastructure leasing is found to be the oldest form of neutral host businesses. Companies, such as China Tower Corporation,³ Crown Castle,⁴ and Helios Towers,⁵ all provide the full range of different infrastructure services from passive cabling to active small-cell services. Part of the infrastructure leasing companies have emerged when mobile network operators (MNO) corporatized their cell tower operations to separate units and divested the unit eventually to free the capital for other investments (Rasay & Shah, 2019). Infrastructure funds have acquired and financed several such new ventures, (e.g. DIF, 2020). Some independent infrastructure leasing companies have been founded by industry specialists together with infrastructure investment funds to challenge incumbents (e.g. WIG, 2020). These cases represent a bottom-up approach, in which the starting point of a company's business is in the simple infrastructure elements and then the business has been expanded to other network elements.

It turns out that these companies are actually competing in two different markets. First, as these companies seek economies of scale, they typically also provide highly standardized services in terms of features and quality, which in turn increases rivalry between these companies on the downstream customer side. Second, as these companies have adopted merger and acquisition tactics as a growth strategy to find new opportunities for business expansion, they also need to compete for the acquisitions. The annual report 2019 of American Tower,⁶ for example, states "We compete, both for new business and for the acquisition of assets.". Hence, these companies require a constant stream of funding to support both the construction of widening infrastructure and acquiring access to new regions. In turn this has resulted in a situation where all infrastructure leasing companies have eventually become publicly listed. Moreover, the process of market consolidation keeps the number of competitors decreasing as the entry barriers constraint new entries heavily.

5.1.2. Specialization to a certain domain

The second category is specialization to a certain domain including companies that leverage special knowledge on some niche. The domains in this category include areas such as railways, metro tunnels, airports, large sport venues, shopping malls, and exhibition centres. Companies typically develop their business gradually over the years by accumulating the domain knowledge that allows them to transform the business to network operator areas while still having their special domain knowledge. Through these explicit domain choices, companies are able to tighten customer relationships, use direct sales channels, and access strong customer references. Such choices provide an opportunity for companies to increase their business growth while introducing new lower-level value propositions.

³ <https://ir.china-tower.com/en/about/profile.php>.

⁴ <https://investor.crowncastle.com/financial-information/sec-filings?c=107530&p=irol-sec>.

⁵ <https://www.heliostowers.com/investors/investor-home/>.

⁶ <https://americantower.gcs-web.com/static-files/abaea648-59f3-4884-a186-4e5c57cccf55>, page 7.

The analysis suggests that due to these diversified paths and lack of competition between the domains, the market has become highly fragmented and it may not be easy to find synergies between the domains. BAI Communications,⁷ for example, operated in the consultancy area by specializing into the public transportation domain before becoming a neutral host, and by utilizing that knowledge, the company developed its business gradually towards active network services. Another example, Iberia Small Cell Networks⁸ was formed as a spin-off from Wireless Infrastructure Group⁹ and Axion when the companies realized that they required deepening knowledge on the domain of airport facilities. As the use of next generation connectivity services and data-based applications increases, it can be assumed that the companies in this category will keep diversifying also in the future.

There are some early signs that also the domain specialization area has started to consolidate. Although the specialized companies have not used merger and acquisition tactics as a primary source for growth, some of them have acquired similar companies to extend their knowledge and to get access to new customer cases. Moreover, this fragmented area has been a good opportunity for pension funds, infrastructure investment funds, and other investors to invest in. This has enabled neutral host companies to scale their innovations and to expand the business beyond the original geographical area.

5.1.3. *Alliances of incumbents for cost sharing*

The third category is strategic alliances including companies that use, e.g., joint-ventures, to seek synergies between ecosystem incumbents. The analysis suggests that the main motivation is to seek economies of scale, thus to decrease production costs. Moreover, it actually turns out that horizontal integration can only take place in the upstream direction as agreeing downstream factors would be considered as a cartel. Allying in the upstream direction allows owner enterprises, for example, to reduce the costs of network operations and be compliant with strict spectrum license terms. Finnish Shared Network¹⁰, for example, was established in 2013 by DNA and Telia in Finland to build and operate mobile networks in the north-east part of the country where the population is sparse. Two examples from the UK, MBNL¹¹ was established in 2007 by EE and Three to ensure nationwide coverage of the services, and CTIL¹² was established in 2012 by O2 and Vodafone to decrease operational costs of the urban network operations. Although a strategic alliance seems to be a common way to improve operational efficiency by sharing the costs of network operations amongst neutral host companies, and some of these have had liberal customer policies, however, some these have been very selective who can become a customer and it can be argued that these are not as neutral as other categories.

5.1.4. *Public stakeholders intervene*

Several public authorities around the globe have identified that there is a need for public authority driven data and communications services. In several cases, cities have carried out development projects that strived to build a collaboration ecosystem that in turn would provide city-wide services utilizing a neutral host model. Some of these projects targeted data related services, e.g. Copenhagen Smart City project,¹³ while others focused more on the communications, e.g. Wireless Philadelphia.¹⁴ Moreover, some projects strived to address both of these, e.g. Singapore Smart City Project¹⁵ and the Sunderland Our Smart City project.¹⁶ These projects can be seen as public stakeholder interventions that steered market evolution by policing how the neutral host ecosystem emerges. The analysis suggests that cities do not pursue their data and communications initiatives primarily for profit, but they want to provide enablers for the well-being of society and to provide business opportunities for companies and to enhance operational efficiency through new technologies. These objectives in turn guide how projects are implemented.

In some cases, the communications services of a municipality area have been combined with other utility services. NextLight¹⁷ in the US, for example, is part of the Longmont utility company, and these units provide combined electricity network services and broadband services. However, this approach implies that the local broadband service provider holds a monopoly position preventing others from enter the market.

As many cities rather choose to act as an orchestrator for ecosystem operations than to be a full featured service provider, ecosystem collaboration models become crucial (Lenkenhoff et al., 2018). In the horizontal collaboration model, a city can choose to establish a dedicated city-owned neutral host company to provide services and to allow infrastructure and knowledge to be shared (the case NextLight). At the same time, using a vertical collaboration model, some cities have outsourced service operations to allow MNOs and other companies to participate as a neutral host, e.g. Dublin in Ireland.¹⁸ In short, collaboration models chosen by cities are highly dependent on regional ecosystem conditions.

To get an access to horizontal resources and knowledge sources, public stakeholder initiated neutral hosts can seek partnering

⁷ <https://www.baicomunications.com/our-services/transit-communications/>.

⁸ <https://www.iberiasmallcellsnetworks.es/en/>.

⁹ <https://www.wirelessinfrastructure.co.uk/about-us/>.

¹⁰ <https://yhteisverkko.fi/suomen-yhteisverkko/>.

¹¹ <https://mbnl.co.uk/about-us/>.

¹² <https://www.cornerstone.network/about/overview>.

¹³ <https://www.copcap.com/set-up-a-business/key-sectors/smart-city>.

¹⁴ <https://technical.ly/philly/2015/03/04/cities-learn-phillys-failed-municipal-broadband-effort/>.

¹⁵ <https://publications.iadb.org/en/international-case-studies-smart-cities-singapore-republic-singapore>.

¹⁶ <https://www.sunderlandoursmartcity.com/about-us/>.

¹⁷ <https://www.longmontcolorado.gov/departments/departments-e-m/longmont-power-communications/about-lpc>.

¹⁸ <https://smardublin.ie/>.

through joint-ventures. However, cities and neutral host companies can also partner vertically to get access to knowledge and resources. For instance, Barcelona City¹⁹ agreed to collaborate with Huawei in late 2019. The city is looking for a partner in the digital transformation industry that can help city businesses leverage 5G and build smart city applications. This collaboration can accelerate the adoption of smart city services in Barcelona, but it may also introduce a vendor lock-in.

In some cases, regulatory decisions have created natural monopolies for certain services. For example, in 2006, Digita²⁰ acquired an exclusive right to operate 450 MHz spectrum for wireless broadband services in Finland. One of the decision criteria was that Digita clearly stated that it uses a neutral host type position in their ecosystem and it provides wholesale services only. Regulatory authority interpreted that this kind of approach enhances ecosystem openness which has more advantages than the monopolistic situation has drawbacks.

All these public authority driven actions have shaped ecosystem structures by influencing company level decisions, i.e. strategies. The list of characteristic strategies is not all-inclusive, but it gives some hints how authority interventions take place. Moreover, it should be noticed that actual regulatory frameworks and explicit industry policies shape market structures further, but those regulate the market as a whole rather than only some specific entity of it.

These four characteristics emergence paths proposed here provide a historical perspective to the emergence of neutral host type companies. This study acknowledges that some companies may actually posit themselves in several of these categories, and there may be companies that actually do not fit any of these. Data markets are especially emerging and characteristic patterns may not have formed yet. Next, let us discuss how the ownership structures are found to influence neutral-host company operations.

5.2. On the ownership structures of neutral host companies

Shareholders of a company can be seen as investors who have varying investment strategies (Slater & Zwirlein, 1992) and they also differ in the level of bearable risk-taking (Hoffmann et al., 2015). Several studies suggest that the ownership structure of a company actually affects its market entry strategies (Amihud & Lev, 1999), which in turn affect its economic performance (Thomsen & Pedersen, 2000). American Tower Corporation,²¹ a publicly listed company in the New York Stock Exchange (NYSE), for example, is mainly owned by institutional investors who expect a relatively stable stream of dividends.²² On the other hand, a neutral host company Kuuskaista,²³ for example, is owned by the members and the users of the services, and while keeping service pricing low it invests excess profits back for the service development and for the society. Hence, in general, it can be assumed that public stock listed companies have the most aggressive ROI expectations, while associations, foundations, and community-based models have the least aggressive ROI expectations.

The analysis phase finds ten categories of ownership structures. Each of these structures has its own characteristic investment strategy of an owner. Table 2 summarizes these categories.

The neutral host companies, that are listed in public stock exchange, are typically majorly owned by institutional investors. These investor brokers typically have the investment strategy of above average profits, and the investors typically require dividends when the company has matured. This in turn increases the need for strict financial targets, which in turn leads to the seek for economies of scale.

The study finds four types of privately owned companies. Joint-ventures formed by incumbent MNOs, early phase challengers, enterprises backed by strong investment funds, and venue owners. First, joint-ventures typically focus on the cost efficiency aspect of the services. As the owners are also the users of the services, they have clear requirements and quality targets for the services. Second, challengers typically seek fast growth through some service niche on a global scale. These companies are led by founder CEOs, and these typically do not have strong financing behind them. DenseAir,²⁴ for example, provides mobile network services in radically different ways than its competitors. Third, already matured companies typically have a strong financing partner or owner who can ensure growth in the previously identified niche. BAI Communications, for example, has expanded its operations through acquisitions to several areas. Fourth, the owners of different venues are typically large real-estate funds. These companies see local venue specific data and communication operations as value-added services, which increase customer retention and brand-value, which in turn increase financial results. Tottenham Hotspur Stadium,²⁵ for example, is owned by the football club Spurs.²⁶ While owners of joint-ventures and venues expect long term investments and stable operations without an exit plan, owners of challengers and already matured companies expect exit opportunities, which implies that the company operations need to show increasing value for owners and market legitimacy.

Rest of the owner categories are non-profits, municipalities or states. First, some of the municipalities have established separate companies for data and communications operations. In these arrangements, the neutral host companies have had relatively small regional scope, but ambitious objectives set by owners. Some of these have been highly successful, Forum Virium²⁷ in Helsinki, for

¹⁹ <https://www.smartcitiesworld.net/news/news/huawei-seals-smart-city-deal-with-barcelona-4804>.

²⁰ <https://yle.fi/uutiset/3-5752451>.

²¹ <https://www.americantower.com/investor-relations/stock-information/>.

²² <https://www.marketwatch.com/story/two-dividend-stock-income-ideas-as-the-fed-works-against-you-2019-07-29>.

²³ <https://www.kuuskaista.com/yrityksesta/kuuskaista-konserni/>.

²⁴ <https://denseair.net/about-us>.

²⁵ <https://footballpredictions.net/blog/who-owns-tottenhams-stadium>.

²⁶ <https://eventmasters.tottenhamhotspurtravelclub.tickets/who-owns-tottenham/>.

²⁷ <https://forumvirium.fi/en/ceo-review-2020/>.

Table 2

Different owner groups have individual characteristics and investment strategies.

Company ownership structure	Owner characteristics	Owner's investment strategy	Company examples	Implications to company strategies
Public	For-profit. Institutional investor. Medium to long term investment with relatively low-risk ROI.	Minor shareholder. Strategic investment. Annual dividend.	<ul style="list-style-type: none"> American Tower Crown Castle Helios Towers INWIT SBA Communications Vantage Towers CTIL (Vodafone, O2) 	<ul style="list-style-type: none"> Seek expansion through M&A Tight financial discipline to meet market expectations
Private company – Joint venture	For-profit. Company extends its core assets to enable a wider offering or geographical operating area.	Joint venture. Strategic alliance. No dividend expected.	<ul style="list-style-type: none"> Finnish Shared Network Ltd. (Telia, DNA) Iberia Small Cell Networks (Axion, WIG) MBNL (EE, Three) Alpha Wireless 	<ul style="list-style-type: none"> Focus on quality, services, and cost efficiency
Private company – start-ups	Entrepreneurial individuals establish a company to fulfil certain identified customer needs.	Fast growth of the company. MBI or divestment of major shares.	<ul style="list-style-type: none"> EveryNet Ontix Ltd DenseAir BAI Communications 	<ul style="list-style-type: none"> Fast growth through experimenting and entrepreneurial activities
Private company - Investment funds	For-profit. Funds seek diversified infrastructure investment targets which provide modest ROI with low risks.	Major shareholder. Long-term investment.	<ul style="list-style-type: none"> Digita FreshWave NextLight (US) 	<ul style="list-style-type: none"> Expansions through M&A activities where strategic fit is high
Municipality	For-profit. Local city ownership.	Major shareholder. Long-term investment to protect local infrastructures.	<ul style="list-style-type: none"> Wireless Philadelphia (US) Sunderland (UK) Verkkosuuskunta Kuuskaista (owned by members) Critical Communications Finland (Erillisverkot) 	<ul style="list-style-type: none"> Prone to political disputes in competition situations
Community	Not-for-profit. Local.	Members invest to get access to community services.		<ul style="list-style-type: none"> Need-based development, low business aspirations
State	Not-for-profit. Nationwide.	Major shareholder. Long-term investment to protect national infra-structures.		<ul style="list-style-type: none"> Tight control on who are the customers
Foundation	Not-for-profit. Local.	Long-term investments. Fill the gap that the market fails to fill.	<ul style="list-style-type: none"> EstWin (Estonian Broadband Development Foundation) EWIA (Investment fund) 	<ul style="list-style-type: none"> Low cost sensitivity Purpose driven development, not business driven
Association	Not-for-profit. Global.	Minor or major-shareholder. Long term investment.		<ul style="list-style-type: none"> Low aspiration on expansions
Venue owner	For-profit. Local.	Major. Add value to the venue.	<ul style="list-style-type: none"> Tottenham Hotspur Stadium (UK) Levi's Stadium (US) 	<ul style="list-style-type: none"> Asset ownership Operations outsourced

example, has managed to attract ecosystem participants and to create significant added value for the society. On the other hand, some of these companies have been prone to political disputes and needed to shut down their operations after some years of operations. Wireless Philadelphia,²⁸ for example, did not get support from the owners, city authorities, and they struggled to provide services using a sub-contracting model. Second, in community-based ownership structures, the members of the services own the infrastructure. This is a highly similar approach than joint-ventures, but typically a number of owners is relatively large. Moreover, due to the needs-based

²⁸ <https://technical.ly/philly/2015/03/04/cities-learn-phillys-failed-municipal-broadband-effort/>.

investments of the company, the service development activity is typically rather low and the company does not have high business aspirations. Verkko-osuuskunta Kuuskaista,²⁹ for example, is owned by the members. It builds and operates passive and active infrastructure in one specific area in Finland, and it has opened the infrastructure for other service companies for service provisioning. Third, in some cases, the state holds the ownership of the company. Typically, there is some critical requirement to directly regulate and control the services and to ensure that the critical infrastructure follows the needs of that state. Critical Communications Finland³⁰, for example, is tightly controlled by different ministries of Finland. Moreover, it is tightly regulated who can become a customer.

As these different categories depict, the objectives of different owner groups are different. The strategic guidance given by owners have direct influence on the strategic choices the company makes, which in turn influence the market level business model evolution.

5.3. Society level influencers to neutral host markets

Governmental actions have allowed new businesses to emerge, but also have forced some incumbents to react; let us take the United Kingdom as an example region. In the late 2010s, the UK government set ambitious targets. The aim is to provide fibre-access to all premises and ubiquitous access to 5G by 2035 (UK, 2018). Achieving this target using the traditional MNO model would increase investment needs to a high level due to multi-operator redundancies. This results in an opportunity for local neutral network operators who may share investment needs and share network assets in certain regions. For example, MBNL and CTIL are two of those neutral host operators in the UK which are going to leverage the opportunity. By setting ambitious objectives, the government signals the market that there are new investment opportunities available, which results in new investment money and emergence of new players. For example, Wireless Infrastructure Group (WIG) (WIG, 2020) was established in 2006 to operate on the cell-tower-leasing market and to introduce competition to the mobile-network-infrastructure market. WIG has changed their strategy to a more co-operational way towards MNOs as WIG's customers are mainly large MNOs. The shift happened after the UK government decided to bet more on the ubiquitous 5G access. The company is privately owned but is nowadays backed by large global infrastructure investment funds.³¹ WIG has expanded the service offering from cell-towers to cover all relevant mobile network infrastructure components. Furthermore, the company seeks new domains for a business. WIG is a major investor in an autonomous vehicle test-bed platform which is the UK's largest. Such a shift to higher tier applications may result in WIG being one of the earliest neutral host operators operating in both the communications and data markets.

Government-led 5G promotions have also taken place in other countries. The Danish Energy Agency has a nationwide plan to promote the use of modern communications technologies and to find ways to create smarter cities (Kokkegård, 2019). Their 5G plan clearly states that the aim is the creation of new markets for independent small-cell operators. The plan contains several actions, such as site-rental, network-sharing, network-slicing, and network-neutrality. Furthermore, the EU funded research project called 5 G-CITY (2017) pilots the neutral host model in three different cities, Barcelona in Spain, Bristol in the UK and Lucca in Italy. Although the consortium of the pilot projects in Lucca and Bristol are entirely on public funding, Cellnex Telecom is participating as a private partner in the Barcelona project. The planned business model is largely based on infrastructure sharing, where street cabinets, lightning poles, and passive and active components of the mobile network all are intended for rental purposes. Although these publicly funded projects aim to create feasible business opportunities, it is open if the projects actually produce them.

There are several initiatives that did not end so well. Some projects, especially in Western countries, faced disputes, MNO objections, and even legal actions when an incumbent operator tried to prevent infrastructure owners and municipalities from becoming a network operator. For example, incumbent lobbying and public debate did prevent Philadelphia City in the US from improving its network operations (Abraham, 2015). On the other hand, some cities previously had active network services for citizens, but have decided to shut down the network due to the emergence of 4G and 5G networks; for example, San Francisco,³² Dublin,³³ and Sydney.³⁴

Several municipality managed ecosystems have opted for the open ecosystem model and have also opted for free-pricing. For instance, Helsinki is classified as one of the most functional smart cities in Europe (Helsinki, 2018). The merit comes from the availability of open data sets. At the time of this study, more than 1000 open data sets are available (FV, 2019). Any company can continue to use them in their applications at no extra charge. Data is collected from applications related to urban use, such as tram location information. Using the data as a platform for new innovations, Helsinki aims to create new data-based markets. Typical goals for cities are to improve operational efficiency, improve the well-being of citizens, improve the visitors experience and enable business growth. The challenge for the data operator is to acquire relevant data and attract new ecosystem members to the platform.

As these examples illustrate, the emergence of neutral host opportunities is highly influenced by political and society level factors. Moreover, regional economic conditions and technology diffusion may influence the business decisions that emerging neutral host companies take.

²⁹ <https://www.kuuskaista.com/yrityksesta/kuuskaista-konserni/>.

³⁰ <https://www.erillisverkot.fi/>.

³¹ <https://www.wirelessinfrastructure.co.uk/wig-raises-220m-to-accelerate-investment-into-new-neutral-host-wireless-infrastructure/>.

³² <https://www.marketwatch.com/story/san-francisco-formally-ends-citywide-wi-fi-effort>.

³³ <https://www.dublin.ie.gov/1912/Downtown-Dublin-Wi-Fi>.

³⁴ <https://www.smh.com.au/national/nsw-govt-dumps-plans-for-free-city-wifi-20080502-2a5t.html>.

5.4. Business models

This section exhibits, by utilizing the Osterwalder (2013) approach, two characteristic business models that are typical in the neutral host markets of data and communications.

5.4.1. On the customer demand and customer segments

The analysis reveals that there are two major customer segments being served and two major demands that are fulfilled in neutral host markets. Some customer organizations strive to solve end-to-end sustainability and innovation related issues by focusing into specific verticals, while some customers require digital platforms for their increasing capacity needs in a horizontal manner.

Data services are utilized in a vertical manner to gain better insights for decision making to a specific problem. Local governments are struggling, for example, with public safety and sustainability issues. Hence, they require the analysis of environment data to extract, for instance, pedestrian counts in public places, vehicle level CO₂-emissions, or the utilization of trash bins. To address these issues, the data operator extracts data from sensors installed into the context, then it aggregates data to a central database through some transport network, and then it processes data and provides processed data as a product or as a service for other service providers. Helsinki based data provider Forum Virium (FV, 2021) states, “We are developing future urban solutions for ... Smart City projects. They support the data and technology competences ... and help the City achieve its carbon neutrality goals”. Hence, in this case the customer problem is environmental sustainability and the customer segments are the municipality and ecosystem members in the Helsinki region. In another case, the city of Singapore (Lee et al., 2016, p15) has taken an even more totalitarian approach. It provides data services for all public and private sectors to solve a variety of problems which transform the whole nation, and as the city authorities say, “to become more smart, sustainable, and efficient”. Table 3 summarizes all major findings related to the use-cases for data services, and Table 4 shows customer segments accordingly.

Communications services are utilized in a more horizontal manner compared to data services. As Table 3 depicts, the customer problems are more related to technologies and business operations. A customer may struggle with long implementation time of new sites, and to address these issues, neutral host communications services are utilized as a flexible and fast deployable infrastructure. For example, the borough of Westminster, a customer of the neutral host operator Ontix (2018), stated: “With an exponential increase in the demand for mobile data, pressure on the borough’s legacy network infrastructure has been growing, with operators struggling to access enough suitable rooftop sites to deploy the macro cells they have been using to date. The Council has therefore been actively seeking to harness its borough-managed assets to improve mobile coverage and capacity and boost the UK’s ambitions to become a world leader in 5G.”. At the same time, some other neutral host communications providers fulfil the other capacity needs of incumbent mobile network operators by providing infrastructure services such as distributed antenna systems, masts, cabling, and other passive site equipment (ATC, 2019). Moreover, in some cases the special circumstances have motivated customers to seek external knowledge to enable digital services in that domain, for example in metro tunnels, trains, or stadiums (BAI, 2020). Table 3 summarizes typical neutral host customer problems, and why customers use data and communications services.

Table 4 summarizes the typical customer segments of data and communications related offerings. Typical customer segments for data operators are other data operators and organizations that provide services on top of the data. Similarly, typical customer segments of communications companies are other mobile network operators and organizations that require infrastructure services in a specific area. These segments imply that customers are not end-users for the actual service but are other service providers; however, the customer segments of these two business areas are distinct.

5.4.2. On the value propositions and offerings

As customer segments and customer demand vary between these two domains, it can be argued that also value propositions, in terms of a business model, are different. The analysis reveals that the typical value proposition of neutral host communications offerings includes the quality of service and cost-efficiency. The reason is mainly due to the fact that the communications market is commodity-product-based and typically competitive advantage is realized through operational efficiency among customers, hence these customers assume that upstream providers offer similar values. Communications-related offerings are typically categorized into three main groups: mobile network services; fixed network services; and, co-location or device placement services. Fig. 2 depicts some alternatives of how modularity can be implemented in the communications service product catalogue of a neutral host provider. These options apply also for 5G based offerings (GSMA, 2019). The figure contains data offerings as an illustrative representation, although the analysis does not identify any company that provides the combined data and connectivity services, but all studies companies have selected only one of those.

As Fig. 2 depicts, the provision of mobile network services is typically provided in a modular environment. This modularity means that an MNO as a customer can select those components from the neutral host offering that the MNO considers useful. Customers typically choose between five classes. In the passive class, the lowest level is site sharing, where customers share physical equipment rooms and masts. This category is part of co-location services. In the passive shared-backhaul category, the customer of a neutral host also uses a passive fibre infrastructure to connect sites to the regional data centres. Active offerings contain three typical offering models. Customers can choose to leverage their own spectrum and core networks, and lease other components from the regional neutral host. In this case, radio controllers, backhaul networks, base stations and site infrastructure are shared. However, this option is mostly feasible for incumbent MNO customers and for those who are eligible for acquiring a spectrum license. In the second active option a neutral host has acquired a frequency license for local use, and that spectrum can be provided for customers as a service, which also allows non-MNO customers to be served. In the third option, the core network is shared, hence a neutral host operator can also provide end-customer services as a full-blown MNO. In this scenario the inter-connection to an MNO network can be implemented

Table 3

The customer demand of services varies between data and communications offerings.

Data services are used for solving	Communications services are used for solving
<ul style="list-style-type: none"> • Inefficient city infrastructure operations • Collected infrastructure data not utilized because it is not available • Safety issues in a city • Privacy issues • Inflexible public transportation in a city • Air quality problems • Sustainability problems 	<ul style="list-style-type: none"> • Expanding capacity needs due to new applications • Redundant investments in several parallel networks • Lack of computing capacity proximity • Lack of places where to put sensors, cameras, etc.

Table 4

Customer segments of the data and communications areas are different.

Customers of data companies	Customers of communications companies
<ul style="list-style-type: none"> • Data brokers • Municipalities (e.g. transportation, environment, healthcare units) • Commercial transportation companies • Private service companies • Data poolers 	<ul style="list-style-type: none"> • Mobile network operators • Data and IoT operators • Infrastructure units of municipalities • Other infrastructure companies

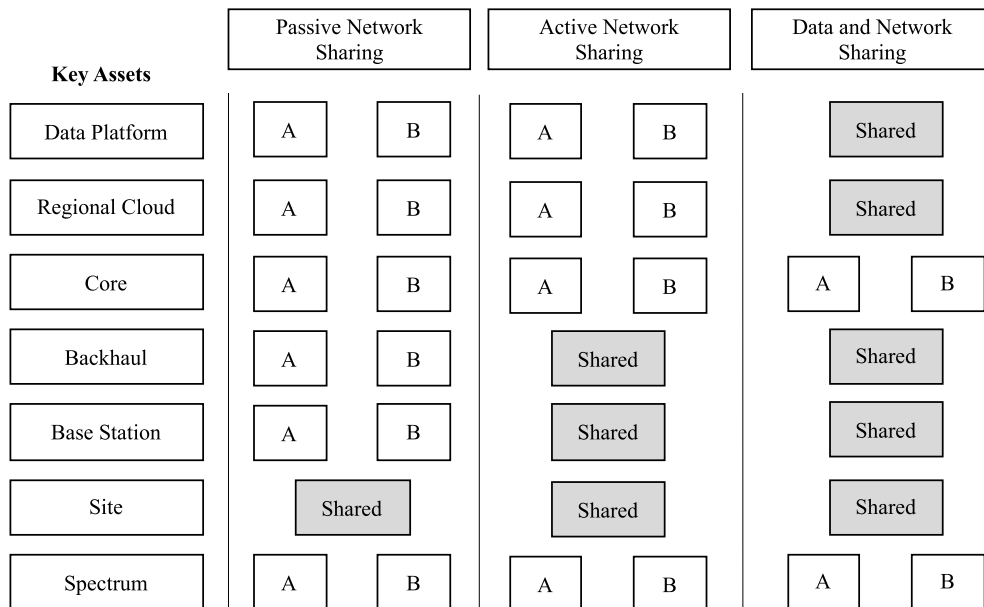


Fig. 2. Infrastructure sharing enables alternative product offerings.
(Adapted from: [GSMA, 2019](#)).

using, for example, national roaming. However, this latter case implies that the neutral host provider dismisses its neutral role as a service provider and enters another market to compete with others.

Recently, due to the emergence of 5G technologies, incumbent MNOs have started to adapt their offerings according to technological possibilities. These changes create demand for 5G related neutral host offerings. A number of new 5G related technological concepts are still waiting to gain momentum, as those terms have appeared in marketing materials of companies, but no company can provide customer references for those. Technologies, such as (i) ultra-reliable-low-latency-communication (URLLC) based services for high-end critical applications; (ii) massive-machine-to-machine type communications (mMTC) based services for wide-scale IoT deployments; (iii) 5G new-radio-light applications for narrow-band-low-power-IoT applications; (iv) 5G network-slicing on general for quality-of-service over mobile-networks; these all takes time to diffuse into the markets.

The fact that communications related neutral hosts are by the definition positioned in the wholesale role in their ecosystem suggest that their products would be relatively simple and commodity-based. However, it turns out that neutral hosts also offer complex products (end-to-end integrated and dynamic products in terms of contracts and capacities) in addition to the typical simple and low-

end products. A neutral host company DenseAir,³⁵ for example, provides mobile network densification services for MNOs. In this service, existing MNO networks and the network of DenseAir co-exist to enhance overall MNO coverage and capacity in a certain region. However, DenseAir's network has its own constraining spectrum license, but at the same time a demand from multiple concurrent customers. This dualism of simple and complex products shows that the market is in the era of fermentation, as neutral host operations continue to emerge and there is still room for new innovations. So is the case in data offerings.

The typical value proposition for the data offering of a neutral host is the creation of new valuable services through urban data ecosystems. The main reason is that the data itself is not seen to have value, but the information produced through different applications has value. Most data-oriented neutral host companies are part of ecosystems that build those end-customer applications, and the role of a neutral host company is to provide data. In Denmark, the Copenhagen Capacity³⁶ company, for example, has built an integrated city data exchange that connects different ecosystem partners both to exchange data and knowledge related to data operations. Hence, the focus of value propositions in data services are in the ecosystem level value creation factors rather than on the infrastructure level.

In some cases, the data ecosystem has a common value proposition that guides the supply of data. The Trafiklab ecosystem, for example, has defined that the value of it is in the lower task complexity, higher access to knowledge, increased possibilities to influence, and lower risk of utilizing transportation and traffic related data (Smith et al., 2016). As the example illustrates, the common value proposition links the data to real-world applications. In these cases, a neutral host provider has ready-to-use datasets in its portfolio that can be used easily in corresponding applications. The emergence of such ready-made datasets may not be constrained by technology, but analysis suggests that instead the lack of identified business opportunities prevents the datasets to be formed. In turn, this suggests a need for ecosystem level innovation processes.

5.4.3. On the revenue streams and cost structures

In general, communications wholesale markets have three dominant charging models, namely usage-based pricing, cost-plus pricing, and flat rate (Courcoubetis, 2003). The analysis findings suggest that communications neutral host markets utilize these same pricing models. The dominant model tends to be flat rate pricing based on allocated capacity and the cost-plus pricing model driven by production costs. SBA Communications,³⁷ for example, states "... our site leasing revenues are governed by long-term contracts with pre-determined pricing ...". This implies that revenue streams are relatively static, but at the same time subject to high competition as services become standardized on the market. This market situation also supports the use of cost-plus based pricing models when the market has become mature. This is due to the fact that prices tend to approach production costs due to the strive for maximizing scale and improving operational efficiency and high industry rivalry among dominant companies.

Second, usage-based pricing models pose a risk to the neutral host operator in the form of non-consumption, which suggests that the model is unlikely in non-established markets, but may turn viable when the market matures. Although this pricing model is in use between incumbents, however, is also heavily regulated by authorities in some regions. In Europe, for example, European Commission (EC, 2017) set enforcing directives to regulate roaming charges between mobile operators, and this development will most likely result in the abandoning of usage-based pricing. The analysis did not directly identify any neutral host communications businesses using usage-based pricing, but those who are providing services in a national roaming mode need to support this pricing model. In some extreme cases some neutral host communications companies can utilize a revenue sharing based model, however, the analysis did not identify any.

One more thing related to communications. As a neutral host network functions as a shared capacity platform for relatively homogeneous communications services, it can be argued that the cost structure of it is highly similar to the cost structures of incumbent MNOs. When the customer base of a service and the usage of the platform grow, the marginal cost of a new customer approaches zero, thus, neutral hosts have the economies of scale benefit (Lähdenmäki et al., 2016).

Moving to data markets, the analysis indicates that neutral host-based data markets have not matured yet as those lack a clear dominant design and the number of players is rather low. In general, there are two dominant revenue structures in digital data markets, single-sided and multi-sided (Zhang et al., 2015). In single-sided models, a data provider sells and a customer acquires an access to data using a recurring or one-time fee based on volume or quality (Yu & Zhang, 2017). In turn, this allows the customer to use data for its own benefit. In this study, it was found out that, for example in Finland, Statistics Finland³⁸ provides various ready-made urban datasets with fixed one-time fee and Traficom³⁹ provides vehicle data using transactional pricing. In multi-sided models, a data provider not only sells data to downstream customers, but may also sell transaction-related information to an upstream customer (Schüritz et al., 2017). The downstream-customer is not necessarily aware of the arrangement. On both sides, the revenue model can be, for example, subscription based, usage fee, or gain sharing. On the downstream-customer side, a freemium model is also an option if the value of information on the upstream side exceeds the potential downstream price. Multi-sided models can be dynamic and even complex, which limits how many different models one individual data company can leverage. One of the case companies, Telia Company⁴⁰, for example, provides crowd movement data for downstream customers by collecting mobile device location updates data

³⁵ <https://denseair.net/about-us>.

³⁶ <https://www.copcap.com/set-up-a-business/key-sectors/smart-city>.

³⁷ https://www.annualreports.com/HostedData/AnnualReports/PDF/NASDAQ_SBAC_2019.pdf pages 10 and 41.

³⁸ https://www.stat.fi/tup/hinnat/tutkimuspalvelut_en.html.

³⁹ <https://www.traficom.fi/sites/default/files/media/file/Pricelist.pdf>.

⁴⁰ <https://business.teliacompany.com/crowd-insights/Crowd-Insights-for-Cities>.

from upstream customers. This allows downstream customers to gain, for example, insights of the movement of passage cars in a certain city region. Data marketplaces and data hubs are emerging multi-sided data markets. Helsinki Region Infoshare,⁴¹ for example, provides open access (freemium) datasets for the community with the idea that the subsequent applications provide greater value for the society and, thus, pay back the free service. The model itself does allow monetizing data, but so far, the commercialization has come through value-added services. As these examples depict, neutral host type data markets are diversified and application oriented, but those also benefit through horizontal integration synergies.

There is one more class of data markets that was found to exist, a data pooling model. In this model, a focal company and other ecosystem members agree to aggregate some of their business-related information and share it among stakeholders. The focal company can also purchase some third-party data and merge it to the pool, which increases the value of pooling. Moreover, it is possible that some of this data is produced by the pooling company itself. The pricing is typically based on the costs of aggregation activities, but also subscription-based pricing is viable if the size of a pool has reached some threshold level. The company GS1,⁴² for example, acts as an orchestrator in the data pooling network. In this case, the role of the orchestrator can be seen as a broker.

Although operational functions may be similar among companies providing data services, (Jindal et al., 2020; Lähteenmäki et al., 2016), their corresponding cost structures may vary based on the underlying technological solutions (Laatikainen et al., 2014; Mazhelis et al., 2012). This study supports these views, and it proposes that cost structures related to data offerings can be divided into two categories; data acquisition, and data maintenance. First, acquisition costs include both the collection of data from in-house sources, such as sensors; and purchasing data from external sources. These costs may be variable, such as transaction costs or flexible capacity costs of public cloud services, but there may also be fixed costs, such as the support costs for integration among ecosystem partners or the costs of on-premise platforms. Second, data maintenance costs are items that are related to; data transferring and processing; maintenance personnel costs; and the support costs of customers. However, in some cases, only part of costs is accumulated to the focal company, while some of the costs are distributed to other ecosystem members, which happens to be the case in the operations of Helsinki Region Infoshare,⁴³ which is acting as an orchestrator of the HRI data ecosystem. As these findings suggest, there is not a dominant design of data business cost structures but it is highly context and case dependent how the structures are realized.

5.4.4. On the business logics of neutral hosts

Based on the analysis, and the supporting literature, this section elaborates on the realized business logics of neutral host companies. While the communications business is found to be relatively stable and predictable it is also found to be subject to high rivalry. On the other hand, as the data business is found to be highly context dependent, it is also found to be dependent on the ecosystem structures and linkages.

In the communications businesses, the main business logic is to build a regional mobile network and supporting infrastructure for that. In this business, the infrastructure can be leased to MNOs and other regional stakeholders who require provided services. A neutral host network forms a platform with certain (i) technical features, that are mainly determined by standardization bodies, such as 3 GPP,⁴⁴ IETF,⁴⁵ or ISO,⁴⁶ and (ii) capacity, that is based on the customer demand. Pricing is determined using regulatory guidelines and cost-plus principles. This business per se cannot be described as complex or dynamic, but it is not simple either. The communications business is relatively stable and long-term due to customer's life expectancy and long technological cycles. However, these factors increase rivalry as competitors may face challenges to differentiate. Unless prevented by policies, high asset specificity will lead to formation of regional natural monopolies. Fig. 3 shows typical business characteristics for the communications services of a neutral host provider.

As most of the communications service operation costs are fixed, it is important that a neutral host company can engage more customers than the required threshold limit for profitability. Costs of operations cannot be automatically allocated to service prices because customer-pricing needs to be competitive and pricing should not be higher than any other competing options for the customers. That is why the communications operators typically choose cost-efficiency, economics-of-scale, and service-quality-based strategies. Furthermore, products in the communications market are mainly commodity, and competition is mainly driven through the quality of service and pricing factors.

On the contrary, data operators typically choose differentiation strategies due to the absence of matured markets. Market competition is based on the distinctive factors, such as service features, how new applications can solve some problems more efficiently than others, and how agile the actual data implementation can be. It can be argued that data itself does not hold any implicit value and the actual monetization is carried out through a value creation process utilizing data. In practice, these value creation processes may be the algorithms that a company has created, which allows it to hold a temporary high asset specificity position. This in turn implies that the value of data is first subject to speculation when the markets are unmaturing, but when the market matures and the value creation process becomes well known (i.e., algorithms become public), the price approaches the production costs of data as it becomes a commodity.

In both data and communications businesses, the role of complementary assets turns out to be highly important (Teece, 1998).

⁴¹ https://hri.fi/en_gb/.

⁴² <https://www.gs1.org/services/gdsn/how-gdsn-works>.

⁴³ https://www.hel.fi/hel2/tietokeskus/data/dokumentit/HRI_TTS2021.pdf.

⁴⁴ <https://www.3gpp.org/specifications>.

⁴⁵ <https://tools.ietf.org/html/>.

⁴⁶ <https://www.iso.org/standards.html>.

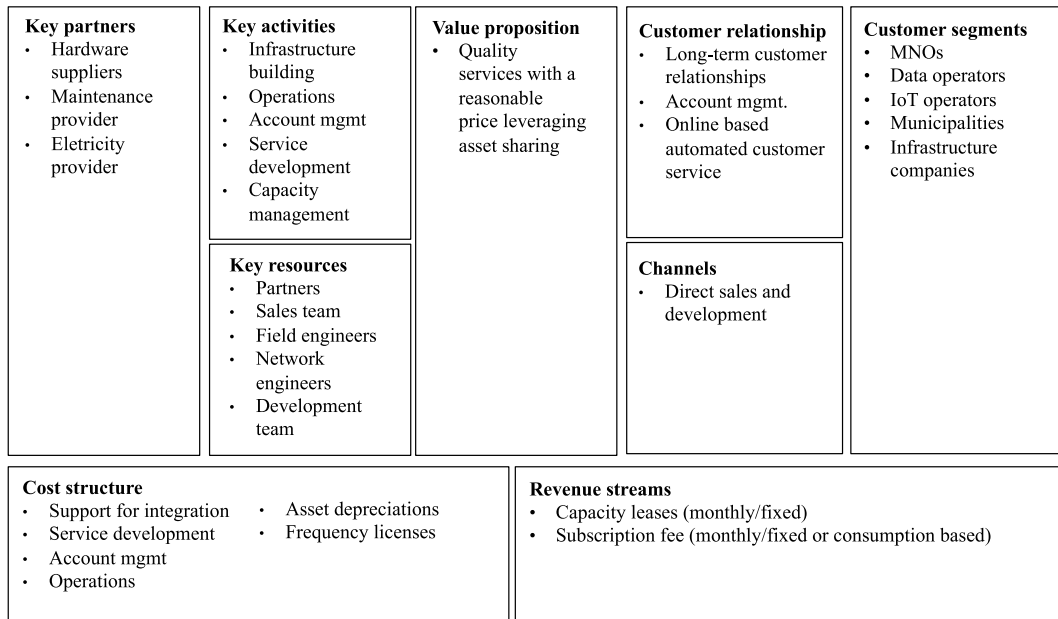


Fig. 3. Typical business characteristics for the communications services.

Although the probable natural monopoly position may be due to an exclusive access to high site asset specificity items (Riordan & Williamson, 1985), the findings suggest that there are substitutions available for customers, which means that these high asset specificity items (Porter, 1997), such as local mobile network or explicit access to data, may build an extensive entry barrier, but those are the base for sustainable competitive advantage. The findings suggest that in these businesses, the most of competitive advantages come through intangible or knowledge assets, and complementary assets may form the distinctive differentiator, in the means of social networks or service design. The role of complementary assets may also explain the lack or emergence of combined data and communications businesses.

Table 5 summarizes the typical business strategies that neutral host companies choose for their businesses. Data businesses rely on differentiation, experimenting and continuous innovation strategies. Communications businesses rely on economies-of-scale, cost-efficiency and service-reliability strategies. Furthermore, the business performance of these two business categories is measured by different metrics. Now, let's move to discuss further implications.

6. Discussion

This research asks two major questions. First, *what a neutral host actually is?* Second, *on what paths neutral host companies have emerged and what strategies those companies have taken?* To answer these questions, this study first reviewed the existing literature and synthesized the term neutral host, as extant literature turned out to be ambiguous. This paper proposes: *a neutral host is a service provider that builds and operates an integrated technology platform that is solely for sharing purposes.* The perspective of this proposition is technology agnostic and it interprets the concept through business and policy-making lenses. Based on this perspective, this study examined companies that fulfil this view by collecting a wide range of public market and non-market data related to extant neutral host companies. The qualitative data analysis resulted in an extensive set of categories and classifications of different business characteristics.

This study interprets business models as an extension of the resource-based view and market positioning perspectives; thus, it follows the path of Lanzolla and Markides (2021). The results of the business model analysis show differences on customer-segments and value-propositions between data and communications businesses. These differences indicate that these two business areas are fundamentally different. The implication is that if such a neutral-host was established which combines these offerings, the company is operating in two different markets. It may be hard to realize synergies between these two segments, but as the results show, some companies try to seek synergies through common complementary assets. Some companies use, for example, 3 GPP based mobile networks for the data acquisition, that in turn is leveraged on another market. In Europe, telecommunication market regulation and privacy related data regulation are both well understood and different stakeholders have managed to comply. If we consider a company combining these two markets and acquiring data through dense sensor networks, however, we face the fact that the unified regulatory frameworks are missing. This gap has allowed the emergence of whole data markets and it has allowed the emergence of new disruptive business models. It remains a question whether we have a market imperfection in these combined neutral host markets that requires policy actions. Meanwhile, policy makers need to be aware of these emerging markets.

As an example, let us discuss one use-case found during the study, the use of location data in the positioning business. To exhibit the

Table 5

Data and infrastructure businesses rely on different strategies.

	Data offerings	Communications offerings
Typical chosen business strategy	<ul style="list-style-type: none"> • Innovation and agility • Differentiation • Learning through experiments • Start-up co-operation • Security • Privacy 	<ul style="list-style-type: none"> • Service stability and quality • Cost efficiency • Telecom regulatory compliance • Tight MNO co-operation • Economics of scale • High degree of standardization • High degree of automation • Service quality • Ability to provide a required capacity
Business metrics	<ul style="list-style-type: none"> • Created ecosystem value through the data • Number of successful and abandoned innovations 	
Activities and processes	<p>Sales</p> <ul style="list-style-type: none"> • entrepreneurial, opportunistic, integrative • Packaged data mostly online based • Solution sales and consultative sales through partners <p>Customer service</p> <ul style="list-style-type: none"> • Skilled data specialists • Application specific knowledge through partners <p>Production</p> <ul style="list-style-type: none"> • Data analysts and specialists that keep wheels spinning 	<p>Sales</p> <ul style="list-style-type: none"> • Catalogue based • Standardized services <p>Customer service</p> <ul style="list-style-type: none"> • 24 × 7 automated incident management through customer portals • Automated service provisioning <p>Production</p> <ul style="list-style-type: none"> • Fixed network, radio network and infrastructure specialists • Automation application development
Core assets	<p>Tangible</p> <ul style="list-style-type: none"> • Sensors • Cameras • Lightning units • Power production <p>Intangible</p> <ul style="list-style-type: none"> • AI & ML algorithms • Application source code • Data sources • Knowledge network • Personnel's superior knowledge of data 	<p>Tangible</p> <ul style="list-style-type: none"> • Poles and distribution • Active and passive infra • Fiber infra • Datacenter infra <p>Intangible</p> <ul style="list-style-type: none"> • Radio frequencies • IP addresses • Service management applications • Automation systems • MNO customers

case, Table 6 summarizes three different approaches. A neutral host company operating a shared network infrastructure can provide network location information with certain constraints using either mobile network location update data (option 1) or local beacons (option 3). The first option allows it to provide, for example, the data for crowd movement analytics, as Telia has done. The third option allows it to provide high accuracy positioning within a specific area, as for example Schiphol Airport has done. However, the ubiquitous positioning capability provided by the global positioning system (GPS) remains beyond the scope of ground based neutral hosts (option 2). The first case is regulated, for example, in Europe through EU level directives, national policies,⁴⁷ regional spectrum regulations,⁴⁸ and general data protection regulation (GDPR) act.⁴⁹ However, it turns out that the third option is regulated only through GDPR, as these local area networks do not constitute an operator network. Nevertheless, these local area solutions can be used to collect much fine-grained data for further applications than mobile network based. Moreover, the second option is regulated only through GDPR, as application ecosystem companies and handset manufacturers are not considered as network operators. However, conglomerates leading these application and handset ecosystems have direct access to fine-grained data with relatively low levels of regulation.

⁴⁷ <https://ec.europa.eu/digital-single-market/en/telecommunications-national-regulatory-authorities>.

⁴⁸ <https://digital-strategy.ec.europa.eu/en/policies/eu-radio-spectrum-policy>.

⁴⁹ https://europa.eu/youreurope/business/dealing-with-customers/data-protection/data-protection-gdpr/index_en.htm.

Table 6

An example use-case of combined data and communications applications (positioning).

An approach to data acquisition	Mobile network	User device	Passive beacon
Data source	Location update messages	UE GPS location	802.11 or Bluetooth beacon
Accuracy in theory	1 m (triangulation, >4 eNBs)	1–5 m (outdoor)	0,1–1 m
Accuracy in practice	1–10 km (cell)	5–10 m	2–8 m
Frequency	15 s (mobile) – 6 h (stationary)	>5sec	>0,2 s
Geographical reach	Outdoor and indoor areas within an MNO network	All outdoor areas (global)	Indoor areas (a specific venue) Outdoor areas (limited scope)
Business for	MNOs, integrators	Application and handset vendors	Venue owner
Use-cases	City and transportation planning, statistical analysis, industry solutions	Asset tracking, spatial awareness for applications, contextualization	Person identification, movement tracking, counting
Ecosystem members	Consultancy agencies, industry specific data brokers	Application ecosystem members, integrators, data brokers	Facility stakeholders
User consent	Subscription T&C	Application T&C	N/A
Legitimate interest	Public interest (?)	Service provisioning	Public safety, service provisioning
Data availability for a third-party	Yes (pre-processed data for ecosystem members)	No (raw data), yes (analysis results and further applications)	No
Society attitude	Turning from resistance to legitimacy	Widely accepted, but yet debated	Mostly ignored
Business examples	<ul style="list-style-type: none"> • Telia Crowd Insights • Vodafone Analytics • Orange 	<ul style="list-style-type: none"> • Google • Apple • Verto Analytics • Quadrant 	<ul style="list-style-type: none"> • Macy's • Schiphol Airport • HUS

6.1. Policy implications

Following the previous example, it is justified to summarize the implications for policy making. Policies related to areas, such as competition, spectrum, and platforms, they all both constraint the business logics within the market, but those also provide incumbent advantage in forms of compliance.

First, competition regulation typically addresses the problems such as predatory pricing and anti-competitive company behaviour (Joskow & Klevorick, 1979). In terms of communications services, in competitive local markets and in the existence of substitutions, it can be assumed that competition ensures fair pricing. However, when a neutral host holds a natural monopoly position, it requires certain safeguards to prevent discriminatory pricing, which may block or favour some ecosystem members. Competition authorities need to be alert to all market entries by scale seeking companies (infrastructure leasing especially) as these entering companies typically tend to acquire other competitors from local markets to increase coverage. In terms of data services, competition authorities shall treat exclusive access to data as a monopoly position, but at the same time they need to consider substitutions. As the location data example depicts (Table 6), distinct ways to acquire data may lead to different ecosystem configurations, which in turn lead to different value capture processes (Lepak et al., 2007). Hence, the policy implication is that instead of constraining the access to data, competition authorities shall examine the ecosystem level configurations in terms of entry barriers. The focal company of an ecosystem may prevent companies that it perceives as a threat entering the ecosystem.

Second, the radio spectrum is a scarce resource, which may become a competitive advantage for its holder. Spectrum licences are typically acquired through auctions (Cramton, 2013), which may inherently favour incumbents. However, policy-makers should be aware that local emerging operators may provide better society level outcomes (through sharing economies), but they lack the assets required to acquire spectrum in scale. Moreover, the use of licence exempt frequencies is not a feasible option due to interference issues (Massaro, 2017). Hence, policy makers should continue providing local use licences, which lowers the entry barrier caused by spectrum regulation. This would allow equal access for neutral hosts to the local markets. Another approach would be to set up a spectrum neutral host whose role is solely to lease frequencies for local markets.

Third, the need for platform regulation has been debated recently. The governments have struggled with the fact that just a few companies are dominating some of the platform markets, but if these markets become regulated, the non-dominating companies may face too strong constraints as those need to comply (Cammaerts & Mansell, 2020). In some regions, the approach has been to extend the use of monopoly classification to these dominant market stakeholders, and hence be able to limit the regulation to only part of the ecosystem members (Romm et al., 2020). In these cases, the dominant company was not a neutral host, but a company providing end-to-end services. However, some of the largest neutral hosts may gradually increase their size, becoming dominant in some areas. Especially data related markets allow fast diffusion and the use of complementary assets, meaning that some market participants may reach a dominant position without audience attention.

Let us consider another policy and regulatory aspect. As the literature review suggested, and Fig. 1 depicted, the policy-making activity is a market level collective action. In this line, the role of a market regulator as a framer is to guide the policy-making process, thus, to steer the market evolution and corresponding institutional frames. In the context of local neutral host markets, a regulatory regime is not only shaped by the authority, but also the market participating neutral host companies influence through a corporate political activity how the institutional settings emerge and evolve. It can be argued that both the path dependency of company decisions and the local political conditions constraint how the institutional work can be pursued. As the example in Table 6 suggests, several markets turn out to be two-sided, meaning that the focal company serves two distinctive markets. In this case, the

applied regulatory regime and the corresponding policy-making process vary based on the linked markets and the context where the service is being applied. Hence, instead of regulating fragmented sub-markets based on the technological borders, policy-makers and market participants shall consider the societal consequences more broadly.

These observations imply that not all neutral hosts are identical nor provide services to the same market. Instead, the both markets, data and communications, are highly fragmented and diversified, and in different regions the ecosystem structure may be highly different. From the policy maker point of view, this implies that also policies need to be local or other-vice allow several alternative ways to serve the market. This means that regulatory authorities shall not set enforcing rules, which somehow put constraints on innovation, but rather set permissive rules which provide further business opportunities for novel ecosystem stakeholders.

6.2. Implications for managers and scholars

Coming back to the analysis results, the business models indicated that both data and communications businesses are platform based. This asset specificity means that there is a high entry barrier for competitors to enter the market, but there is also a threshold level of customers required to cover all costs related to the platform operations. In most cases this indicates that the geographical operating area of a neutral host needs to be large enough to sustain the required customer base. Nevertheless, the study suggests that the region does not need to be especially large, but scale benefits can be exploited through partner networks, ecosystem structures, and joint-ventures if needed.

The analysis of strategy antecedents resulted in the categorization of ownership structures and emergence paths. First, considering the ownership structures, in the two extreme ends we have a neutral host that is; a public stock-listed company which is mainly a dividend machine for owners, and; in the other extreme, a non-profit foundation which strives to ensure that non-monetary objectives are met for the public good. Moreover, there are several other categories between those. The company level strategies diverge between categories while strategies converge inside a category. These observations have a consequence that the ecosystem varies significantly if it is dominated by different owner-base-neutral-hosts, and to have a real understanding of the market also the impact of ownership needs to be understood. Second, the results propose four categories of emergence paths, namely (i) infrastructure leasing, (ii) specialization to a certain domain, (iii) alliances of incumbents for cost sharing, and (iv) public stakeholders intervene. Based on the findings, these antecedents define, up to some extent, whether a neutral host company strives to integrate horizontally and seek scale benefits, or integrate vertically and strive to gain a bigger role in the value chain of that specific context. This path dependence is partly due to institutional behaviour of company owners (Sorensen, 2015; Wustenhagen & Teppo, 2006) and regional 'lock-in' (Martin & Sunley, 2006). Moreover, path dependence can partly also explain the establishment of neutral host joint-ventures (Hennart & Zeng, 2005) and public authority interventions (Pierson, 2000). Hence, the findings support the view that also neutral host companies are constrained by their historical choices.

These emergence path categories can be considered path dependent, due to the fact that underlying factors become institutionalized during the company and market evolution. The interpretation is that companies within a particular category tend to choose similar strategies because of their historical background, and this behaviour partly determines how neutral hosts actually run their business. Understanding this dimension is important because not all neutral host companies are willing to expand their business in the same direction, but there are several paths to business growth, and in turn this has an influence on which incentives are effective for such a company.

6.3. Contributions

This paper contributes to the understanding of the evolutionary nature of business development in the neutral host markets. This paper described the typical traits of data and communications business models, and enterprise-level strategies that current neutral host companies use in their businesses.

This study has two major contributions. First, managers in neutral host companies may consider the antecedent categories as a strategic framework to evaluate market evolution. The diversified nature of neutral host markets may allow companies to exploit novel opportunities through market consolidation and partnering, but it also allows disruptive competitor entries. Hence, this analytical framework can help strategic sensemaking, which in turn allow more deliberate strategies to emerge. Second, as most of the companies pursue some sort of corporate political activity to steer policy making procedures, intentionally or unconsciously, the results of this study can help both policy makers and company managers to speak a common language on the neutral host market evolution. As a local market with embedded policy frameworks becomes institutionalized, the best way to prevent laboursome policy changes is to increase collaboration and experimentation in institutional work.

6.4. Trustworthiness of the results

This study builds on the philosophical stances of critical realism (Easton, 2010), and as the research seeks the latent factors of business organizations, qualitative methods are preferred over quantitative ones (Lee & Lee, 1999, pp. 21-22). Hence, instead of discussing validity and reliability measures, it is more relevant to discuss trustworthiness of the propositions (Golafshani, 2003). The cases that this research studied were selected based on the theoretical context and through critical inspection to find polar cases. Moreover, the sample size was emergent, meaning that as many organizations were included until the saturation point had reached. These practices were supposed to ensure reasonable coverage and diversity among cases. Nevertheless, this study provides a single interpretation of the reality perceived through the data. To ensure that the study was able to capture the most of the essence, the author

used the triangulation practice (Jonsen & Jehn, 2009). Whenever available, the study used multiple sources to collect information and to compare different sources. In the coding phase, only one author carried out all interpretations and categorization tasks to omit any intercoder reliability issues. However, to improve trustworthiness, the data and interpretations were presented to external experts who commented on the findings. The experts did not find any major gaps, suggesting that the results can be considered trustworthy.

6.5. Boundary conditions, limitations, and future research opportunities

One of the boundary conditions in the proposed framework is that it does not include the technology dimensions at all. However, a brief post-study review of utilized technologies revealed that although 3 GPP based technologies (3 GPP, 2021) dominate the mobile communications markets, also other technologies are extensively used, such as low power wide area network (LPWAN) technologies (LORA, 2021), and IEEE/802.11 based technologies (IEEE, 2021). This observation suggests that although the used technology may provide some further opportunities for the utilizing company and the technology also may align the regulatory landscape of that sub-market, the basic business characteristics and business strategies are not impacted significantly by the technology factors. This side-tracking of technology factors, however, opens an opportunity for further studies, as some scholars may find the technological factors of strategies paramount. Moreover, companies were found to be highly innovative acquiring data for data businesses, for example, some companies leveraged mobile handsets acquiring the location data while others used fixed-position sensors. These both cases leverage different technologies, but nevertheless they open similar opportunities for further business creation. It remained a question, what is the role of regulation in these different business creation paths. These factors need to be studied further.

Although the used public data can be considered as a representative, the qualitative and inductive nature of this study limits how the results generalize. Nor can this study exhibit any statistical evidence. This study proposes further company level analysis work to understand evolution processes further. Moreover, further hypothetico-deductive studies are needed to find rigor support for the propositions.

7. Conclusions

This study started from the ambiguous situation of neutral host evolution and with the puzzling question of on what paths neutral host companies have emerged and what strategies those companies have taken. As several high asset specificity markets have turned out to be oligopolistic or even monopolistic, the real-world problem has become evident – decreasing competition and more centralized industry structures drain novel value from the ecosystems. The wide qualitative and longitudinal analysis of real-world companies allowed this study to enlighten the factors driving the neutral host companies already on the markets. This is important because without a proper understanding of structures and evolution paths of neutral host businesses policy makers may find it impossible to find effective incentives or appropriately binding regulatory constraints for local markets. As the extent of installed infrastructure and collected data continues to increase, the challenge to find socially optimal policies is becoming harder.

Funding

This work was funded by; the Neutral Host Pilot project within the LuxTurrim5G ecosystem funded by the participating companies and Business Finland (<https://www.luxturrim5g.com/>); and Aalto University.

Declaration of competing interest

None.

Acknowledgements

The author would like to thank Professor Heikki Hämmäinen, Professor Taina Tukiainen, and PhD Heidi Himmanen for their feedback on the earlier drafts of this paper. The author also thanks Dr Tapio Levä for his valuable insights into the location data business and data markets especially. The author also thanks Editor-in-Chief Professor Erik Bohlin and three anonymous reviewers for their comments in the review process.

APPENDIX A

In the data collection phase, the author searched for various information related to company choices and behaviour on the market. The codification procedure provided an extensive set of emergent elements, which the author reviewed and aggregated to find higher level abstract categories. This also allowed the author to reduce the number of categories. Table A.1 illustrates the final list of elements and categories, and Table A.2 exhibits the sample of collected data and a subset of the studied companies.

Table A.1

Data collection provided several categories of data to be analysed

Collected data elements
Company/Project name
Data source
Home country
Year of incorporation
Operating domain
Ownership (entity name)
Ownership structure (owner type)
Owner characteristics (owner strategy)
Ownership investment strategy (why to invest in the company)
Original line of business of the company
Business strategy (current)
Communication services (yes/no)
Data services (yes/no)
Strategy characteristics (factors driving the strategy)
Key customer segments
Typical customer problems
Business metrics
Sales model
Customer service model
Production form
Key tangible assets
Key intangible assets

Table A.2 contains part of the companies analysed, and as an example, it also contains some collected data.

Table A.2

A sample of collected data and a subset of the studied companies

Company/Project	Data source	Home country	Year of incorporation	Operating domain	Ownership
Acceleran	https://www.acceleran.com/about-us/	Belgium	2012	Global	Private
Acuity Unified Communications Ltd	https://acuityuc.com/aboutus	US		Global	Private
Alpha Wireless	https://alphawireless.com/about-us/	IR	2007	Global	Private
American Tower	https://www.american tower.com/investor-relations/annual-reports-and-proxy-statements/	US	1995	Global	Public stock listed
Antenna Solutions Group - AT&T	https://telecoms.com/interview/senior-manager-antenna-solutions-group-att-small-cells-offer-operators-a-system-that-is-potentially-more-cost-effective-than-other-solutions/	US		Global	AT&T
BAI Communications	https://www.baicommscope.com/about-us/	Australia	1928	Global	CPPIB Canada
Boingo Wireless	https://investors.boingo.com/financials/annual-reports-and-proxies/default.aspx	US		US	Publicly listed company
CellNex	https://www.cellnextelecom.com/en/who-we-are/	Spain	2000	Europe	Public stock listed
China Tower Corporation	https://ir.china-tower.com/en/about/profile.php	China	2014	China	State + Public stock listed
Colony Capital	https://www.digitalcolony.com/	US	2017	Global	Public stock listed
Colt	https://www.colt.net/about/	UK	1992	Global	Private
Comba Telecom	https://comba-telecom.com/en/investors/factsheet	China	1997	Global	Publicly listed company
Commscope	https://www.commscope.com/solutions/5g-mobile/macro-cell-sites/	US		Global	Publicly listed company
Copenhagen Smart City Project	https://www.copcap.com/set-up-a-business/key-sectors/smart-city	DK		Denmark	Municipality
Critical Communications Finland	https://criticalcommunicationsfinland.fi/	Finland		Finland	State
Crown Castle	https://investor.crowncastle.com/financial-information/sec-filings?c=107530&p=irol-sec	US	1995	US	Public stock listed
CTIL	https://www.cornerstone.network/about/overview	UK	2012	UK	Vodafone, Telefonica O2
DenseAir	https://denseair.net/about-us	UK		Europe	Private
EstWin	https://www.elasa.ee/	Estonia		Estonia	Foundation

(continued on next page)

Table A.2 (continued)

Company/Project	Data source	Home country	Year of incorporation	Operating domain	Ownership
Everynet	https://www.everynet.com/company	UK		Global	Private
EWIA	https://ewia.org/	Europe		Europe	Association
ExteNet Systems	https://extenetsystems.com/solutions/small-cells/	US		US	Private
Finnish Shared Network Ltd.	https://yhteisverkko.fi/en/suomen-yhteisverkko/	Finland	2014	Finland	DNA, Telia
Fonda Tech	https://www.fondalighting.com/about-us-1.html	China	2011	Global	Private
Forum Virium/ Helsinki Region Infoshare	https://forumvirium.fi/en/introduction/	Finland		Local data	Municipality
FreshWave	https://freshwavegroup.com/about-us/	UK	2018	UK	Private
Helios Tower	https://www.heliostowers.com/investors/investor-home/	UK	2009	Africa	Public stock listed
Hylan	https://hylandatacom.com/das-and-small-cell/	US	1960	Local	Private
Iberia Small Cell Networks	https://www.iberiasmallcellsnetworks.es/en/	Spain		Local	Axion, WIG
Indus Towers	https://www.industowers.com/investor/	India	2007	India	Public stock listed
Innowireless/Qucell	http://www.qucell.com/sub/company/overview.php	South Korea	2012	Global	Public stock listed
InSite Wireless Group	https://insitewireless.com/about-us/	US	2000	US	Private
INWIT	https://www.inwit.it/en/investors	Italy	2015	Italy	Publicly listed company
Italtel	https://www.italtel.com/about/about-italtel/	Italy	1921	Europe, LatAm	Exprivia-Cisco
JMA Wireless	https://jmawireless.com/about/	US		US	Private
Levi's Stadium	https://info.jmawireless.com/hs-fs/file-2583989386.pdf	US		US	Private
MBNL	https://mbnl.co.uk/about-us/	UK	2007	UK	EE, Three
Mobilitie	https://www.mobilitie.com/	US	2006	US	Private
NextLight	https://www.longmontcolorado.gov/departments/departments-e-m/longmont-power-communications/about-lpc	US	1997	Colorado, US	Municipality
Ontix Ltd.	https://www.ontix.co.uk/	UK		UK	Private
SBA Communication	https://ir.sbasite.com/overview/default.aspx	US	1989	Global	Public stock listed
Singapore Smart City Project	https://publications.iadb.org/en/international-case-studies-smart-cities-singapore-republic-singapore	Indonesia		Indonesia	Municipality
Smart Dublin	https://smartdublin.ie/	IR		IR	Municipality
Sunderland	https://www.sunderlandoursmartcity.com/about-us/	UK		UK	Municipality
Telelink	https://telelink.com/	Bulgaria	2001	Global	Public stock listed
Telia Company	https://www.teliacompany.com	Sweden		Global	Public stock listed
Tottenham Hotspur Stadium	https://www.businesswire.com/news/home/20190418005264/en/Real-Wireless-Tottenham-Hotspur-Stadium-%E2%80%93-the-Best-Connected-in-the-UK	UK		Local stadium area	Private
Vantage Towers	https://www.vantagetowers.com/our-portfolio/das-and-small-cell	UK	2019	Europe	Vodafone
Verkko-osuuskunta Kuuskaista	https://www.kuuskaista.com/yrityksesta/kuuskaista-konserni/	Finland	2002	Finland	Association
Viavi Solutions	https://www.viavisolutions.com/en-us/corporate/about-us	US		Global	Publicly listed company
Wireless Infrastructure Group	https://www.wirelessinfrastructure.co.uk/about-us/	UK	2006	Global	Private
Wireless Philadelphia	https://technical.ly/philly/2015/03/04/cities-learn-phillys-failed-municipal-broadband-effort/ https://technical.ly/project/wireless-philadelphia/	US	2014	Local	Municipality

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