Value Network Configurations in Wireless Local Area Access

Thomas Casey, Timo Smura and Antti Sorri

Abstract—**Rapidly growing demand for ubiquitous wireless access is presenting significant challenges to the scalability of the existing mobile wide area (WA) network infrastructure. This is increasing the importance of wireless local area (LA) access points (AP) and base stations (BS) residing in indoor locations. Uncertainty exists over who will control this, potentially very valuable part of the mobile service delivery infrastructure and there are many interested actors in position of coupling local area access to their existing platform. In this paper we conduct an analysis of possible Value Network Configurations (VNC) that could emerge around wireless local area access. We construct seven alternative Value Network Configurations by identifying important roles related to wireless local area access provisioning, the corresponding drivers and actors in position of taking on these roles. The identification and description of these configurations clarifies the different possible evolution paths for wireless local area access provisioning and acts as a basis for the design of corresponding future technologies and regulatory policies.**

Index Terms— ***Value networks, Wireless local area acces***

I. Introduction

Demand for wireless access is increasing rapidly. Many mobile operators (MO) are witnessing enormous growth in terms of data traffic in their wide area (WA) networks. The growth is fueled especially by an increasing number of laptop users and by the diffusion of flat rate pricing. In the long run this will present significant challenges to the existing mobile network infrastructure and its ability to scale up in order to meet the rising demand cost-efficiently.

In terms of spatial distribution of the demand, it has been observed that most of the traffic originates from indoor locations [1]. People typically spend most of their time at home, work, and certain public places (stores, restaurants and other places with reoccurring visits) meaning that a major part of the demand of a given user is usually distributed into a few indoor(-like) locations.

When it comes to serving indoor locations, wall attenuation presents a major challenge for the WA network to deliver broadband speeds. More efficient utilization of spectrum with more spectral efficient technologies (e.g. HSPA and LTE), spectrum re-farming (e.g. utilizing WCDMA on the 900 MHz band) and spectrum sharing can help to some degree, but off-loading data traffic to wireless local area (LA) access points (AP) and base stations (BS) residing in indoor locations is also a likely option for the MOs [2].

However, increasing the number of sites can result in high operation and maintenance costs for the MOs. As a result various technologies have been developed that enable a venue owner (e.g. home or a small enterprise) to deploy and operate a home base station that extends the coverage and capacity of the WA network. These can be based on existing 3GPP technologies such as HSPA or LTE (e.g. femtocells) or even utilize the unlicensed band (such as UMA). Although the installed base of these home base stations is still relatively low with only small scale deployments and trials under way, their number can be expected to grow significantly especially when capacity becomes the major driver[1].

On the other hand, there is already now a large installed base of wireless local area APs that are utilizing the unlicensed band and are based on Wi-Fi alliance certified IEEE 802.11 technologies. These access points are also in a rather good position to serve the traffic increase[2]. Most of these are operated by private homes and other venue owners providing access to a closed group of subscribers. Enterprises have been especially active in taking advantage of their venue ownership and have deployed their own wireless LA networks which, however, are often coupled to proprietary infrastructure solutions (from e.g. Cisco). Many public deployments also exist such as open LA access networks (e.g. for municipalities) and hotspots.

Fragmented authentication and lack of roaming solutions, however, have led to low interoperability between individual wireless LA deployments which in turn has led to the emergence of different kinds of aggregators such as Wi-Fi communities (e.g. FON) and commercial aggregators (e.g. Boingo) that offer common authentication schemes for all of the APs in their network. User controlled intelligent connectivity clients residing in devices have also started to diffuse in response to fragmented authentication. For these, users can set different policies in terms of what access alternative to use (e.g. based on price).

Furthermore, in the future devices could become intelligent and reconfigurable to the degree of being able to automatically form co-operative ad-hoc type of networks and share their access connection (e.g. through the WA network)

[1] In the early home base station deployments, the main driver has been improved voice coverage.

[2] Mobile operators can see this as a threat but also as an opportunity. As opposed to usage based pricing where an operator wants to attract all possible traffic to its network, if the dominating pricing structure for mobile data is flat rate, the mobile operator wants to dispose of all traffic that it is not getting revenue for and has thus incentives to leverage all possibilities for off-loading this less valuable traffic e.g. to wireless local area access points.

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with other devices in the proximity. In this case the limit to what is an access point and device could become vague.

Business models and industry structure of local area access has been studied to some degree. Lehr and McKnight [3] described a purely open model where the users of Wi-Fi networks are not charged directly for access but service is provided free for a closed user-community, with the costs of providing wireless access subsidized by the hosting entity. Markendahl and Mäkitalo [4] studied existing and emerging public wireless local area solutions and identified various new business models concluding that actors from outside the telecom sector are starting to enter telecom business.

Smura and Sorri [1] constructed four future scenarios describing the macro level industry structure around wireless LA access technologies. The scenarios were based on two important uncertainties about the future: the level of integration in local area access provisioning (i.e. whether or not local area access points are tightly integrated to the WA network) and the degree of vertical integration in the industry (whether or not services such as voice calls or email are coupled to access). The scenarios gave boundaries to how the value network around LA access could configure and gave a rough idea of the power positions of relevant actors.

Uncertainty exists over who (if anybody) will control access to this, potentially very valuable, part of the mobile service delivery infrastructure. Furthermore, as there are many interested actors in position of taking control of local area access and coupling it to their existing platform, the resulting value networks can become complex and diverse. Consequently, there is a need for a structured and thorough analysis of the possible Value Network Configurations (VNC) that could emerge. The purpose of this paper is to answer the following research question:

> What are the possible Value Network Configurations that could emerge around wireless local area access?

Furthermore, we compare the identified VNCs in terms of industry structure and access fragmentation, as described by the scenarios of Smura and Sorri [1]. The results can be used to classify and understand the emergence of current and future value network configurations around wireless local area access. The analysis also clarifies the different possible evolution paths for wireless local area access provisioning and acts as a basis for the design of corresponding future technologies and regulatory policies. It should be noted, however, that the focus of the paper is on identifying possible configurations, whereas evaluating of their probabilities remains outside of the scope.

The rest of the paper is structured as follows. In Section II we will give a background overview of the methodology utilized to describe and analyze the different VNCs. In Section III we will conduct an analysis of the roles related to local area access provisioning and construct seven alternative VNCs. Finally in Section IV we will map the VNCs over the bounding scenarios and draw conclusions.

II. Methodology background

A. Value Network Analysis research

The boundaries and scope of firms are central questions for business executives and corporate executives, and have also been extensively studied by academics. In business strategy literature, Porter [5] introduced the concept of value chain as a framework and tool for representing and examining the set of discrete but interconnected activities. A value chain describes the sequential value creating activities of a single firm, whereas multiple value chains are combined into a larger value system, consisting of several individual firms. Normann and Raminez [6] later argued that strategy is no longer a matter of positioning a fixed set of activities along a value chain and that the focus should be put on how different economic actors work together to co-produce value and on the corresponding (re-)configuration of roles and relationships among the actors. Later, Allee [7] also criticized the traditional value chain thinking indicating that it is rooted in an industrial age production line and defined value network as a web of relationships generating value through complex dynamic exchanges.

Boundaries of firms and division of labor have also been studied in innovation literature. Extending the seminal work of Teece [8], Jacobides et al. [9] introduced the concept of industry architecture, which provides the framework within which actors interact. Industry architectures are usually partly designed (e.g. by regulation or standards), and partly emergent. To benefit from innovation, firms should manage the architecture to become the "bottlenecks" of their industry (Jacobides et al. [9]).

To complement the linear thinking of value chains, Stabell and Fjeldstad [10] defined three distinct generic value configuration models based on long linked, intensive and mediating technologies (originally identified by Thompson [11]). The value creation logic for each of these models is different. For long linked technology, value creation is based on the transformation of inputs into products (e.g. network or terminal equipment) and corresponds to Porter's value chain concept. The value creation logic of intensive technology is based on solving unique customer problems (e.g. site surveys and the installment of wireless LA APs). Finally the value creation logic of a mediating technology is based on linking customers to each other or to other service providers (e.g. operating a wireless access network)[3].

Although the descriptions are given from a single company perspective Stabell and Fjeldstad also define different forms of inter-company value systems. Companies utilizing long linked technology form interlinked chains (e.g. the supply chains of a device vendor), companies applying intensive technologies form referred shops, and companies utilizing mediating technologies form layered and interconnected

[3] It should be noted that the original term for value creation with a mediating technology is also value network.

networks (e.g. the Internet). The identification of these value creation logics is a good starting point when defining the different roles related to mobile services and access provisioning.

Overall the literature related to value networks is very diverse and there is a lack of universal and concise definitions and terminology. In this paper we understand a value network as a set of interlinked (business) actors and technical (or more generically functional) resources that work together to create economic value through services and products.

B. Technology, Roles and Value Network Configurations[4]

Technology is a key issue when defining the possible functional roles that actors can take. For example the traditional cellular technologies have supported the business models and roles of mobile operators whereas the technologies based on the IEEE 802.11 standard have disrupted these and created roles not present in the traditional cellular technologies.

We define a technical component as a collection and realization of technical functionalities, including the technical interfaces to other technical components. Subsequently, we define a role as a set of activities and technical components, the responsibility of which is not divided between separate actors. When it comes to the nature of a role it can be categorized in terms of the applied value creation logic (i.e. whether it is based on a long-linked, intensive or mediating technology).

The strategic importance of roles can also differ and be subject to various external forces such as demand, technology evolution, or regulation. In [13] a methodology was created that enables the identification of strategically important roles by evaluating the corresponding market conditions[5]. It is based on evaluating the interchangeability, related to the openness of the interfaces and the number of possible players, as well as the demand of each role and corresponding technical component(s). A role with low interchangeability and high demand can be seen as an important one. Ballon et al. [14] also found that some (business) roles and some (system) components possess characteristics, related to their position within the business model configuration, that endow them to play a structurally important role. He subsequently introduced the concept of a gatekeeping role to depict such a role.

A technical architecture in turn can be seen as a set of technical components and is analogous to a platform or a set of platforms. Ballon et al. [14] for example define a platform as a collection of crucial information processing and filtering modules that may be used to attract various types of customers and where the corresponding roles may be configured in various ways and may be owned and operated by different business entities. A technical architecture therefore affects the interrelationships of roles, i.e. determines a role configuration.

The platform analogy is especially relevant when it comes to delivering mobile services, where the value creation logic is based on mediating technologies, i.e. a set of layered and interconnected platforms. Some of these mediating platforms can be seen as connecting different sides of a market as is discussed in theories concerning to two- or multi-sided markets [15].

Finally, a Value Network Configuration (VNC) results as actors take on roles and establish business interfaces (contracts and revenue models etc.) among each other.

III. Analysis

A. Role Analysis

We conducted a thorough deconstruction of functionalities and activities around LA access provisioning and identified current and potential roles with high demand and low interchangeability and the corresponding drivers for and against (see Table 1). For most of these roles demand is driven by the rapidly increasing demand for wireless local area access.

Local area access can be provided with both WA and LA networks. The provisioning of equipment for these networks is an important role, especially in terms of development of technology and Intellectual Property Rights (IPR) that only a limited number of actors are able to take. Open technologies such as Wi-Fi certified 802.11 access points are decreasing the importance of this role, although in many cases (e.g. Cisco's enterprise solutions) proprietary extensions are used to increase the lock-in to single vendor solutions.

Spectrum ownership is currently an important role driven by the increasing demand for spectrum and scarcity of feasible spectrum bands. In the long run, this importance might diminish if the allocation and usage of unlicensed spectrum continues to grow, or regulation becomes more liberal and secondary access and leasing of spectrum diffuse, achieving more efficient spectrum utilization than current spectrum licensing.

LA venue ownership is a strategically important role as venue owners have a local monopoly and control access to the venue as well as to fixed broadband and power supplies. Nevertheless, device driven ad-hoc solutions are in a position to bypass this. LA network operation is another relevant role. Although easily operated Wi-Fi APs have led to venue owners being able to operate their own LA networks, centrally managed services where a 3rd party operates the LA network on the venue owner's behalf are becoming more common. There, venue owners may sometimes be responsible of initial

[4] It should be noted that the methodology described here is partly based on the work conducted in [12].

[5] The market condition analysis is conducted for so called control points, which are defined as points at which (technological or business) management can be applied. We see that roles are analogous to control points.

Table 1. Identified important roles related to wireless local area access provisioning[6]. Factors increasing or decreasing the importance of each role are denoted by a plus or minus sign respectively.

Role	Value Logic	Drivers for role importance
Network Equipment Provisioning (including IPR)	Intensive, Long linked	+:Demand for technical improvements, lock-in to proprietary technologies -:Open technologies
Spectrum Ownership	Intensive, Mediating	+: Demand for spectrum increasing, scarcity of spectrum -:More liberal regulation and flexible usage of spectrum, unlicensed spectrum
LA Venue Ownership	Mediating	+:Venue owners have a local monopoly -:Ad-hoc solutions
LA Network Operation	Mediating, Intensive	+:Scale advantages with centrally managed LA APs -:Self-configuring and optimizing features of LA APs
Fixed Internet Access Operation	Mediating	+:Low number of actors with a fixed access network -:Regulation, unbundling of local loop
WA Network Operation	Mediating	+:Low number of actors with a WA network, demand for seamless mobile voice -:Regulation, virtual operators
LA Access Account Operation (including Aggregation)	Mediating	+:Fragmented authentication without interoperability, need for ubiquitous connectivity -:Only temporary access needed, open access availability, reasonable price WA coverage
Service Application Provisioning	Mediating	+:Value increasingly in services, with access only an enabler -:Many service providers
Device Configuration and Usage	Intensive, Mediating	+: New services, new devices -: Device intelligence and self-configuration abilities increase
Device Provisioning	Intensive, Long linked	+: Demand for intelligent connectivity managers -: Open technologies

deployment and basic operation of power supply and fixed access. Such central operation enables scale advantages and cost savings, and increases lock-in. Still, the development and diffusion of self-configuring and optimizing features of access points might counter this.

In some markets fixed internet access operation remains as an important role with only few actors in possession and control of a fixed access network. Regulation and the unbundling of local loop however decrease the importance of this role. The same goes for WA network operation with regulation fuelling the emergence of virtual operators.

LA access account provisioning is currently very fragmented since customer account management is conducted locally. There are no commonly used standardized Authentication, Authorization and Accounting (AAA) solutions that interoperate between LA access networks. As users are getting used to ubiquitous wireless connectivity the importance of LA access aggregators grows. On the other hand local area access in public places is often provided openly to all users (without the need for authentication), or provided on a temporary basis [4]. Furthermore, WA networks are increasingly able to provide coverage and connectivity with a reasonable price (i.e. flat rate pricing).

When it comes to wireless connectivity value is increasingly migrating to the services it enables, such as email, browsing web surfing, or voice calls instead of wireless access itself. Service application provisioning might therefore have an important role also when it comes to wireless local area access.

As the number of new devices and services increase the importance of device configuration (and usage) increases. Many users are not technically advanced enough to configure a device to use many access points. Still the diffusion of simple to use connectivity managers and the general increase in device intelligence and self-configuration abilities could decrease the strategic importance of the role. A demand for these intelligent connectivity managers in turn makes corresponding device provisioning an important role which however could be reduced if open technologies are used.

Based on these identified important roles a generic role configuration[7] can be constructed (see Figure 1). In the final configuration we focus especially on the roles whose logic is based on a mediating technology since the actors in control of strategically important adjacent mediating platforms are in an especially good position of taking control of wireless LA access provisioning[8].

B. Value Network Configurations

In the following we describe seven different Value Network Configurations that could emerge around wireless local area access. The essential differentiating factor between the VNCs is the local area access account operation role, i.e. which actor controls the relationship to the end-user regarding wireless local area access[9]. Each VNC is driven by changes in importance of the corresponding role as depicted in Table 1.

1) Venue Owner Driven VNC

[6] Many of these roles aggregate other roles (for example LA access account provisioning includes Authentication, Authorization and Accounting (AAA), billing, customer acquisition and customer relations related activities).

[7] In [13] a similar concept called Control Point Constellation is utilized.

[8] Although not included in the final configuration technology (and its development) can also be seen as a mediating platform. Actors with an intensive and long linked value creation logic can therefore also have some control of LA provisioning by licensing the corresponding IPR. A spectrum owner can also be seen in a similar manner since it is also providing a critical mediating platform on top of which other platforms operate and can thus exert some control over LA provisioning e.g. by (forward) licensing the spectrum or using it itself. However, in this analysis spectrum ownership is assumed to be part of LA and WA network operation roles.

[9] Here we will not explicitly describe a wholesale business model where a 3rd party actor deploys and operates a wireless LA access network (e.g. on a venue owner's behalf) and possibly sells capacity to other actors, while having no direct relations with end-users. This kind of business model can, however, be present in lower tiers of the value network in many of the described VNCs.

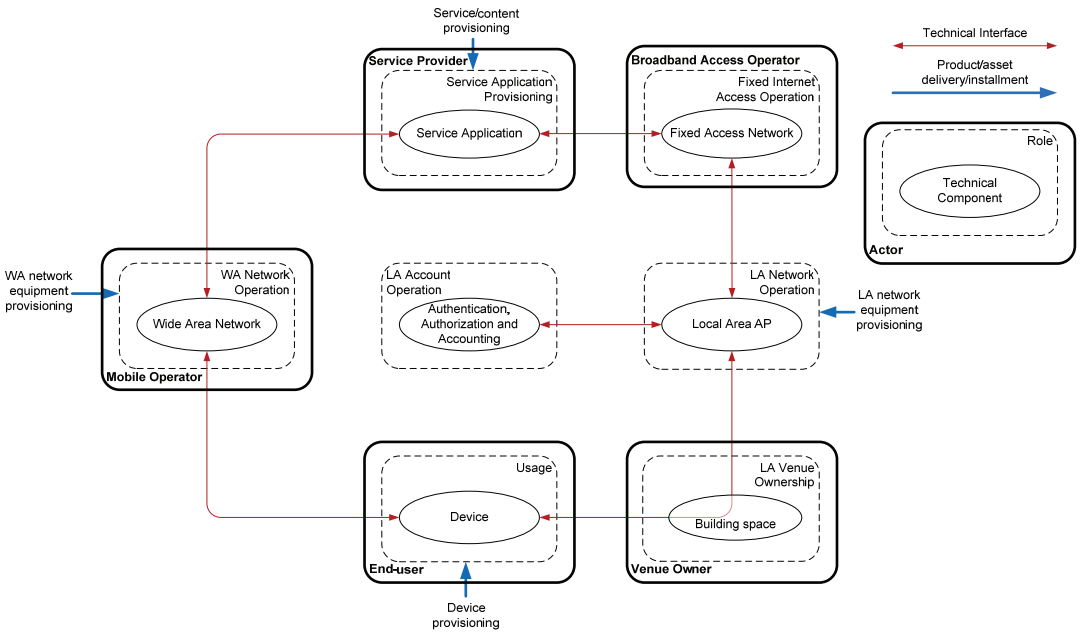

Figure 1. Generic role configuration for wireless local area access provisioning.

In this VNC, a venue owner leverages the strategically important role of LA venue ownership (e.g. due to a local monopoly and control of fixed broadband and power supplies in the venue) and provides LA access to end users. This typically includes a direct contractual relationship with the end-user including the provisioning of authentication keys. In addition to this the venue owner has a contract with a broadband access operator for fixed access. The end-user has separate contracts to service providers services used over the access and possibly contracts with other venue owners and a mobile operator to enable ubiquitous wireless access. If the LA network is large the venue owner can also subcontract its operation to a separate 3rd party (often including site surveys, installation).

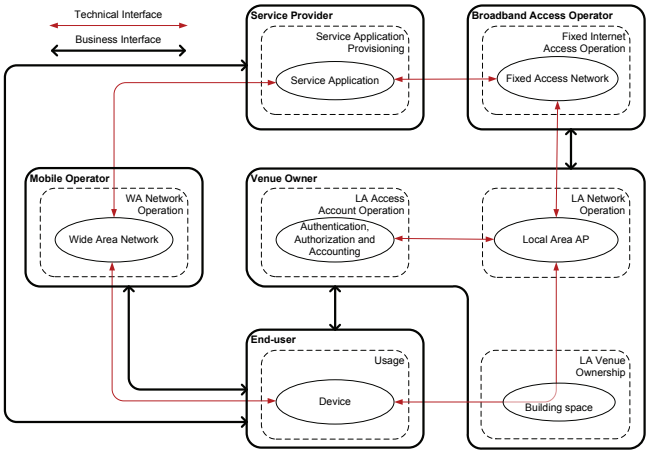

Figure 2. Venue Owner driven VNC.

As discussed earlier several private households and enterprises are configured like this and operate a private local area access network in their facilities. They themselves act also as the main end-user but can also distribute keys to visitors of their facilities. In this case there is usually no revenue logic involved and the cost of providing wireless access is subsidized by the venue owner.

Public LA access provisioning is also common with this model. For example in so called hotspots a venue owner offers local area access either as a separate service or as a value added service to a local service (e.g. restaurant). Open access is another possibility where access is free for all and no key exchanges or authentication is needed.

In terms of technology simple, easy to use access points with open interfaces (such as with Wi-Fi certified 802.11 technologies) enable households and small enterprises with low technical expertise to make small scale deployments. However when it comes to larger deployments, complexity might increase to the degree that the technology becomes very expensive to manage and operate. In addition to this, limited coverage and fragmented authentication, especially in terms of public access, could become an issue since there is direct competition with a possibly omni-present WA network that could be able to provide seamless, reasonable price service everywhere needed.

Intelligent connectivity clients and self-configuring APs could be in a key position to help mitigate these deficiencies and become even more important, if technology heterogeneity increases (i.e. if different technologies are used for LA access provisioning).

Mutually beneficial configurations could also be derived where the MOs WA and venue owner LA networks could complement each other. For example the venue owner could sell local capacity to an MO or even many MOs to off-load their traffic.

2) *Mobile Operator Driven VNC*

In a mobile operator driven VNC, the mobile operator leverages its scarce core asset, the WA network and the corresponding strategically important role, and extends its control to wireless local area access points. The mobile operator has a contractual agreement with the end-user who in the home context acts also as the venue owner. The end-user conducts the initial deployment and basic physical operation of the access point (e.g. supply of power) and has a contract with a broadband access operator for fixed access.

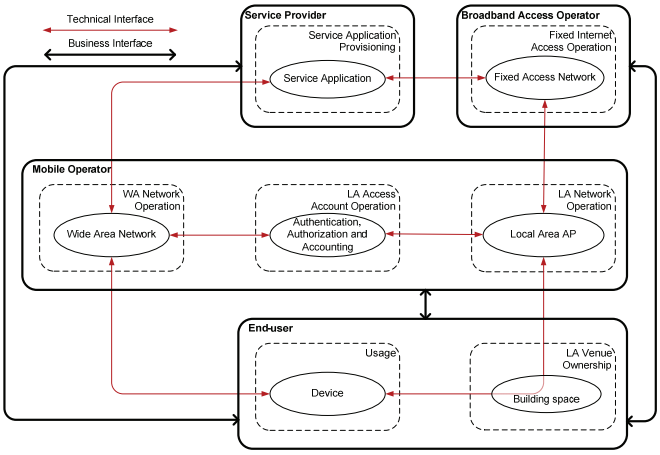

Figure 3. Mobile Operator driven VNC.

Although LA is centrally managed and operated, in a private home or office context the venue owner could have partial control and define a closed subscriber group. When it comes to public access the end-user and venue owners are separate actors that both have contracts with the mobile operator.

The femtocell technology is a current example of an enabler of this configuration. The access points are tightly coupled to the WA network enabling the end-users and venue owners to provide better coverage with seamless mobility and the operator to off-load traffic from WA networks.

There can, however, be technical challenges with femtocells. Contrary to the Wi-Fi access points utilizing unlicensed bands, femtocells must meet strict service requirements and be able to co-exist on the same licensed spectrum bands with the WA network without causing interference. When it comes to user installed access points there is hardly any control over the location of the access point. The central management and operation of possibly millions of these kinds of end-user deployed access points, while having the responsibility of a guaranteed level of service throughout the network, could be very challenging. Still, the increase of intelligence in the access points and the self-configuring and optimizing features could help mitigate this in order to attain scale efficiencies[10].

Yet another issue is that broadband access operators, backhauling the traffic through their networks, could start demanding a share of the revenue gained by the mobile operators. This could be the case especially when wireless LA access would be shared publicly and if traffic volumes would start to increase significantly.

3) *Broadband Access Operator Driven VNC*

If there are only a limited number of actors in possession of a fixed access network, they are also in a rather good position of extending their access platform's coverage with wireless local area access. In the broadband access operator (BAO) driven VNC the BAO has agreements with venue owners hosting their access points and with individual end-users (who can also act as venue owners) utilizing the access points for wireless access. Ultimately, the BAOs can also lease WA capacity from the mobile operators in order to overcome the spotty coverage of a wireless LA network and thus provide a ubiquitous service to their customers.

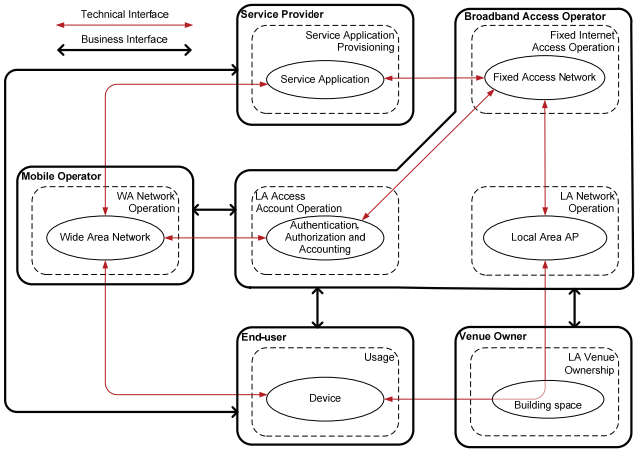

Figure 4. Broadband Access Operator driven VNC.

If the technology enables it, mutually beneficial configurations could be possible where the BAOs could in exchange to WA capacity let the mobile operator's customers roam to their local area access points. The success of the configuration in public access provisioning, however, largely depends on whether the BAO is able to form direct relationship to end-users and venue owners and attract them to utilize the platform. Private home and office deployments with closed subscriber groups might be more natural for the configuration.

4) *Fixed-Mobile Operator Driven VNC*

Fixed-mobile operators own and operate both a WA

[10] Mobile operators are increasingly outsourcing the operation of their WA networks to network equipment vendors. If this trend continues the network equipment vendors might in fact end up operating and managing a large base of femtocells.

network and a fixed access network which are both strategically important roles especially in the absence of competition and regulation. If this is the case, they are in a good position of combining their two access platforms and extending them by offering complete bundles of access and services for example to a household or an enterprise. In a fixed-mobile operator driven VNC the end-user has only a single contract with a fixed-mobile operator who provides complete integrated access and most of the needed services such as voice calls, and video[11].

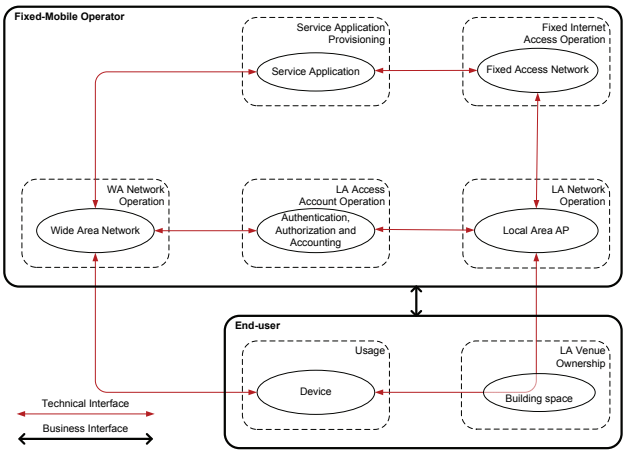

Figure 5. Fixed-Mobile Operator driven VNC.

This VNC does not face possible revenue sharing problems with broadband access operators since the fixed-mobile operator also acts as the broadband access operator itself. The strong position of a fixed-mobile operator can lead to it having tight control of also the functionalities in the devices leading to low interchangeability and closed interfaces. This in turn will possibly leave less freedom for the end user. If this strong position is misused counter balancing regulatory forces could emerge trying break up the closed model and increase competition.

5) Access Aggregator Driven VNC

This VNC is driven by fragmentation in LA access account provisioning and the corresponding need for a central aggregator of end-users and available access points. In the configuration an LA access point aggregator has contractual agreements with end-users and venue owners operating access points. The aggregator can be seen as an operator of a platform mediating the interaction of these two sides, typically enabling public access.

The success of the model depends largely on what kind of access the WA network is able to provide in terms of service quality and prices and the degree of seamlessness when roaming to the individual access points. Even though these kinds of aggregators exist already now for example in the form of Wi-Fi communities (such as FON[12]) and commercial aggregators (such as Boingo[13]), the authentication methods are far from seamless and support mostly nomadic use (i.e. mobility management conducted by the end-user who typically has to enter separate keys to a login page).

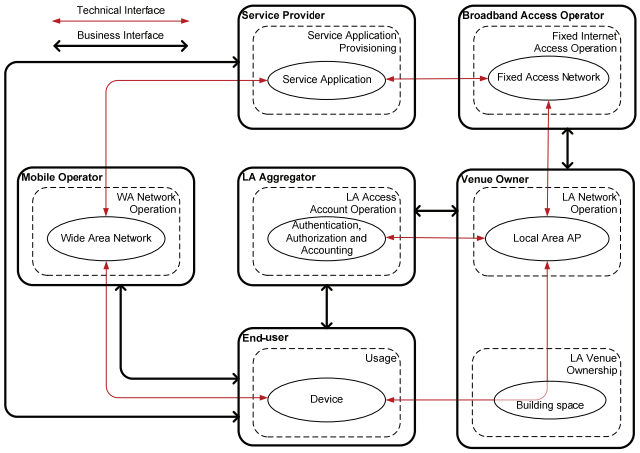

Figure 6. Access Aggregator driven VNC.

The attractiveness and success of the mediating platform is also largely dependent on the size of the end-user base and installed base of APs on both sides of the platform. As the size of such a platform increases new possibilities might emerge, such as selling local capacity to a mobile operator.

6) Service Provider Driven VNC

The increasing shift of value from access to services could lead to a service provider driven VNC where end-users have a single contract with a service provider who offers wireless access in addition to the services.

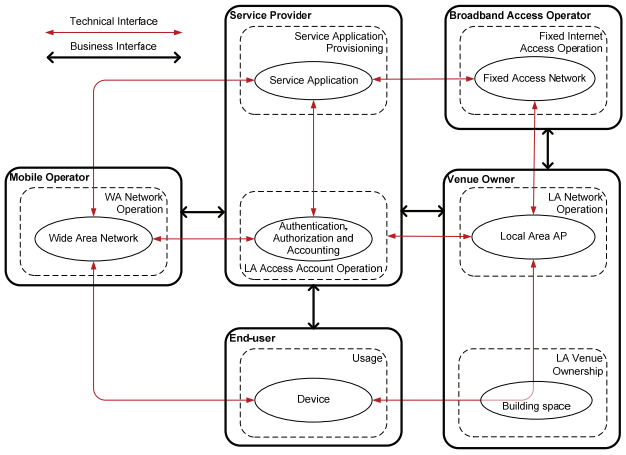

Figure 7. Service Provider driven VNC.

Various internet service giants (such as Google and Amazon) have gradually expanded their position in the value network around wireless access provisioning (e.g. have created their own devices or operating systems and shown

[11] In the home context this is often referred to as quadruple play (i.e. provisioning of fixed-line voice calls, television and video services, broadband access, as well as mobile services).

[12] http://www.fon.com/

interest in spectrum assignments) and could eventually also try control wireless access provisioning themselves. The service providers could create a mediating platform through which their service users could get transparent wireless local area access or even access to a WA network and link it to their service application platform and corresponding user accounts. Their large existing base of users could be very attractive to venue owners operating access points especially if some form of revenue sharing would be in place.

The need for this bundling could emerge e.g. from the rapid increase of video streaming or cloud computing type of applications where thin clients need constant access to central servers. The success of the model is largely dependent on the development and diffusion of interconnecting technologies and interfaces. However if interfaces are proprietary, there is a threat that users are locked into specific service providers.

7) Device Driven VNC

In all of the configurations discussed above the venue owner has been in a strategically important role but with the device driven VNC the LA venue ownership role is bypassed. In this configuration the end users have a contractual agreement with e.g. a mobile operator for access and share their connection with other devices and users in an ad-hoc manner (which decreases the importance of LA venue ownership role).

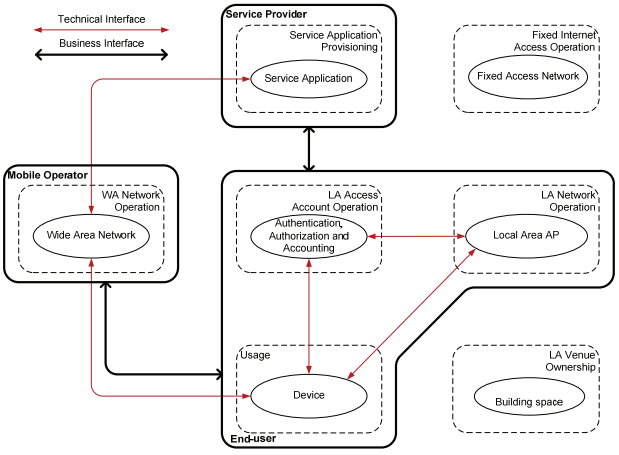

Figure 8. Device driven VNC.

The end-user device has a local area AP and corresponding AAA functionalities integrated into it. There are already now real life examples of such applications (such as Joikuspot[14]) that enable an end-user to turn their device into an access point. Providing access to a closed group or to all devices with open access are the likely forms of operation in the short term. However there are many unexplored possibilities for earning revenue with this configuration. For example FON and Joiku have made a partnership trying to extend the Wi-Fi community which could ultimately enable individual users to gain revenue just by sharing their WA access where ever they are.

Challenges for this configuration arise for example from limited power capabilities of devices, the pricing structure of WA access and general unreliability arising from the mobile nature of the devices. Advances in all forms of device context awareness, e.g. in terms being aware of available radio infrastructure, battery life of the device and user behavior, could help mitigate these challenges.

IV. Conclusions and Discussion

There is a significant amount of potential for value creation related to wireless local area access provisioning and there are many actors in position of creating and capturing that value. In this paper we have identified different possible Value Network Configurations around wireless local area access and described them both in terms of technical and business relationships. The identified configurations are diverse and range from ones where control over wireless local area access is centrally integrated to ones where it is managed locally in the edges. Each configuration is driven by an actor leveraging its control over a strategically important platform. We believe that with small variations almost all possible configurations around wireless local area access can be mapped to one of these. To illustrate the value network configuration space spanned by our VNCs, we mapped them to the four bounding future scenarios constructed by Smura and Sorri [1] as depicted in Figure 9.

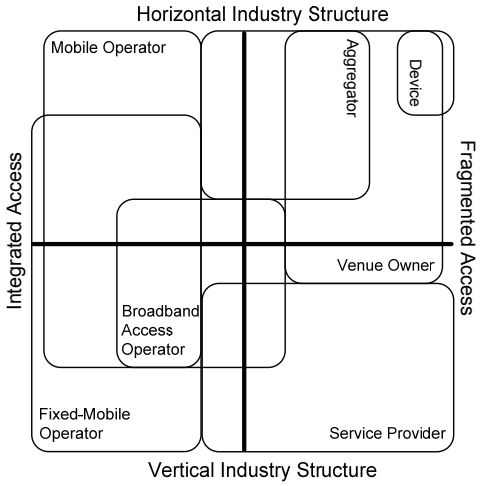

Figure 9. VNCs over four bounding future scenarios[15].

The area that each VNC occupies in Figure 9 indicates the degree a VNC can vary in the direction of both dimensions. In the mobile operator driven configuration, for example, the mobile operator can have tight control of traffic going through

[13] http://www.boingo.com/

[14] http://www.joikuspot.com/aboutJoikuSpot.php (accessed 21st of January 2010).

[15] It should be noted that this mapping is only meant to be directional and thus does represent absolute values.

wireless local area access points and route it through its own network thus moving towards integrated access. Alternatively it can allow more control in the edges with direct access to the internet thus, in turn, moving towards fragmented access. Examples of increases in vertical integration are mobile or fixed-mobile operators restricting service usage to their own services or portals to other services, or locking a device to their own access network. On the other hand they can move towards a horizontal industry structure by allowing more freedom for the end-users in their use and selection of services.

A given user can be in possession of many devices and be part of different VNCs meaning that the described VNCs co-exist and also compete with each other over the end-users and devices. One way of understanding the current market situation for wireless access provisioning and relative success of each VNC is to somehow quantify the amount of value each is capturing. The division of the entire wireless access market could be quantified for example based on number of users, generated revenue, transmitted data volume in bits or revenue per bit of each VNC.

As the demand for wireless access keeps on increasing rapidly it is likely that co-operation and mutually beneficial agreements across these configurations are needed so that the existing wireless access infrastructure can be leveraged optimally. Thus the corresponding future technologies and regulatory policies should be designed in a way that enables sufficient interoperability and revenue sharing between actors driving the Value Network Configurations.

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