An Overview of different Business Models for public Wi-Fi and their Implications on Indirect Revenue

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Abstract

The importance of public Wi-Fi for providing service to customers and mobile data offloading is steadily increasing. This paper aimed at analyzing the business model of select cases of customer-facing and municipal Wi-Fi networks with respect to physical setting, network ownership, service provisioning, (in)direct revenues, and cooperational benefits. Depending on the setting, different sources of indirect revenue can be identified, in particular with respect to the difference between customer-facing and municipal Wi-Fi. By comparing the cases according to these parameters, the paper concludes that successful public Wi-Fi projects make extensive use of cooperational benefits, as they reduce the economic difficulty of public Wi-Fi deployment by keeping costs low, increasing indirect revenue, and decreasing the likelihood of lawsuits against municipalities, therefore contributing to the formation of free municipal Wi-Fi. In municipal Wi-Fi, these benefits emerge as a result of the distinction between network owner and service provider. Instead of relying on tax-funded public service provisioning and possibly risking a lawsuit on the grounds of distorting competition, municipal Wi-Fi initiatives should therefore seek to cooperate with private ISPs.

Keywords: public Wi-Fi, municipal Wi-Fi, cooperation, indirect effects, indirect revenue, business models

1 Introduction

According to Cisco [1], the total mobile data traffic worldwide grew by 63 % in 2016, following a 74 % increase in 2015. As we can expect this trend to continue, 4G mobile data networks will struggle with growing problems of network congestion. It is to be expected that this problem increases by the discontinuation of roaming fees when travelers from countries where data pricing is low can use mobile data networks in foreign countries where mobile traffic is expensive at the same price they would pay in their home country [2]. As there is an interdependence between mobile data allowances and network congestion, mobile network operators have a strong incentive to offload mobile traffic onto a fixed network. This explains the growing importance of Wireless Fidelity (Wi-Fi) in public settings.

Mobile data offloading is defined as the transmission of mobile data using Wi-Fi or femtocells, where the data would otherwise be transmitted over a cellular network [3]. For this purpose, Wi-Fi provides a cheap solution due to the relatively low equipment costs and the lack of license fees in the 2.4 GHz and 5 GHz

radio bands. Cisco states that in the last year, 60 % of the total mobile data traffic coming from cellular devices was offloaded using either Wi-Fi or femtocells, also with an increasing trend [1].

Another advantage is that Wi-Fi can bridge the last mile in regions where broadband extension has not sufficiently progressed yet [4] [5], thus playing an important role in closing the digital divide [6]. Furthermore, Wi-Fi allows business owners to offer Internet access to their customers and to connect electronic devices used by employees without rolling out a cable network in the last mile. While in the early days of Wi-Fi in businesses such as cafés, restaurants and hotels, Internet access was either paid for by the customer or closely tied to the purchase of products, free Wi-Fi has prevailed and now belongs to one of the services that are expected by many customers [7]. Following the success of Wi-Fi in small businesses, attempts have been made to roll out large-scale Wi-Fi networks in the centers of public life, like city centers or train stations. In a broader sense, this can also include privately owned venues with a high volume of visitors, such as shopping malls and sports stadiums.

By analyzing their respective business models, we draw comparisons between customer-facing Wi-Fi on private venues and municipal Wi-Fi projects. For this purpose, we present select cases of large-scale public Wi-Fi networks under the aspect of partnerships between site owners, service providers and other potential stakeholders. Particularly, we want to investigate the cooperational benefits that result from such partnerships in the light of indirect revenue streams and the various business models of Wi-Fi networks.

This paper is structured as follows: in the remainder of section 1, we explain the concepts of indirect revenue that arises as a result of public Wi-Fi and the emergence of cooperational benefits between the different stakeholders of a public Wi-Fi network, followed by a general introduction to business models of public Wi-Fi. In section 2, we investigate the business models of customer-facing Wi-Fi in different settings (small businesses, a large shopping mall, and a football stadium). Section 3 investigates different business models for municipal Wi-Fi and how they shape the relationship between stakeholders with respect to cooperational benefits. In section 4, we analyze our findings, section 5 summarizes this paper.

1.1 Direct and indirect revenue

As with any business venture, in order for Wi-Fi deployment to be economically feasible, the sum of all revenues need to weigh up the costs. The most influential cost drivers for Wi-Fi networks are coverage area, the number of users that are to be served by the network and the desired quality of service, as these factors ultimately decide over the number of wireless access points (WAPs) that need to be installed and connected to the fixed network, as well as the quality of the equipment that is needed.

Revenues can be broken down into direct and indirect sources of revenue. While commercial telcos that deploy Wi-Fi networks are primarily interested in generating direct revenue from the sale of access to their network, business owners and municipalities who roll out public Wi-Fi networks are looking for indirect revenue. Under indirect revenue, we understand any sources of revenue that do not stem from the main business activity (such as selling network subscriptions) itself. The sources of such indirect revenue can be identified depending on the initiators of a Wi-Fi project and their intentions behind Wi-Fi deployment, as well as the physical setting of a Wi-Fi network. While business owners are primarily interested in financial sources of indirect revenue (higher sales, higher customer satisfaction and improved communication with the customers, positive effects on brand image, efficiency benefits, cost

reductions, etc.), municipalities look at indirect revenues from a much broader, more economical perspective. Potential sources of indirect revenue for municipal Wi-Fi could be a stimulus to the local economy, an alleviation of the digital divide, or a higher attractiveness of the region for businesses and educated citizens. As such, we distinguish between customer-facing, and municipal Wi-Fi.

Tahon et al. have identified four main drivers for indirect revenue in municipal Wi-Fi [8]. There is a fixed indirect revenue which stems from the network itself as it allows for efficiency gains and cost reductions. Secondly, indirect revenues are driven by the number of users on the network, where the economic impact of an application can be assessed based on this number. This is for example the case for e-government platforms, when using those results in cost savings per user. A third driver is the quality of the Wi-Fi network which can be assessed on the coverage area and bandwidth, as an increased quality allows for more diverse and demanding applications to function, such as e-health and video streaming services. The final part of the indirect revenues generated by a municipal Wi-Fi network is investment-driven: investing into a network provides a stimulus for telecommunications companies and thus, indirectly, the regional economy as a whole, whereby a part of the investment will automatically flow back to the government through the means of taxation.

For customer-facing Wi-Fi, there are two possible business models. One focuses on the generation of direct revenue by charging customers for Internet access ("premium Wi-Fi"), or by showing paid advertisements ("freemium Wi-Fi"). This can be done in collaboration with an Internet service provider who owns and operates the network and who gets to keep the direct revenue, while business owners profit from the indirect revenue the network generates. The other possibility is that business owners themselves take the role of the network owner. This will typically (however not necessarily) lead to free Wi-Fi access being offered to customers. Despite the complete lack of any direct revenue streams, this model has the advantage that the Wi-Fi network will generate more indirect revenue than the premium/freemium model as customers typically prefer free Wi-Fi over paid Wi-Fi services [9]. An alternative to a direct business partnership with an ISP can be a partnership with a company that merely specializes on providing and installing the Wi-Fi equipment, while relying on an external ISP for the backhauling. In this case, both the option of providing free Wi-Fi access, or generating direct revenue through a premium or freemium business model are possible as well. While in the first option, the partner company simply sells the Wi-Fi equipment and its know-how to the venue owner, the latter option provides the possibility of cost and revenue splits between the partners.

Since technology progresses, Wi-Fi projects are only suited for a duration between 5 and 10 years, as after this typical time period, the equipment will break down or become outdated. In order for such a project to yield a net profit, the sum of all revenue streams (direct and indirect) after this time span must exceed the total costs of the project, i.e. the sum of all capital and operational expenditures. When faced with the two possibilities of either offering premium/freemium, or free Wi-Fi, the difference between the indirect revenue from premium/freemium Wi-Fi and free Wi-Fi is what motivates business owners to choose the free Wi-Fi solution. If this difference is lower than the total costs, business owners will rather be inclined to opt for a partnership with an ISP, while if the difference is higher than the total costs, they are better off with free Wi-Fi. Seeing the overwhelming prevalence of free Wi-Fi networks in the current years, we can safely assume that the latter is the case almost universally for small businesses and increasingly for larger businesses such as sports stadiums and shopping malls.

Alongside customer-facing Wi-Fi, it is also possible to roll out Wi-Fi on a large-scale municipal basis. This however constitutes a bigger economical challenge, as municipal Wi-Fi needs to cover a larger area that is potentially less densely populated than in a business venue. While, in this case, direct revenues can rather easily be estimated ex-ante by forecasting the expected number of users and the revenue per user, it is very difficult to predict how much indirect revenue a network will generate due to the intangible nature of these benefits and the lack of reliable information from prior cases.

Given the broader and more diverse nature of sources for indirect revenue in municipal Wi-Fi networks, we expect the total indirect revenue calculated on a per-user basis to be higher in comparison to customer-facing Wi-Fi. Since most customer-oriented free Wi-Fi networks seem to be profitable (i.e. the indirect revenue per user surpasses the costs per user), we deduct that the per-user costs of a customer-facing Wi-Fi network can serve a lower boundary for estimating the indirect revenue per user in a municipal Wi-Fi network. This does however not mean that, if a customer-facing Wi-Fi network is profitable, a municipal network is automatically profitable as well due to its higher costs.

1.2 Cooperational Benefits in Public Wi-Fi

In general, the most common form of cooperational benefits occur when monetary units are exchanged for goods or services: the seller has an abundance of a commodity and offers to sell the commodity for a certain amount of money because the money has more utility for him than the commodity (i.e. he personally assigns a higher value to the money than to the commodity). Likewise, the buyer trades the money in, because the commodity has a higher utility for him than the money. By cooperating with each other, both the buyer and the seller thus gain a net benefit in utility.

In the context of public Wi-Fi networks, similar situations can occur, where two or more actors can gain such cooperational benefits. In a similar fashion to the example above, this is usually based in the trading of commodities for either other commodities and/or monetary units. For municipal Wi-Fi for example, a Wireless Internet Service Provider can provide Internet access and Wi-Fi equipment, while the municipality provides the sites where the Wireless Access Points and the backhauling network can be installed, such as lamp posts and public buildings.

Another type of commodities that can be traded for a mutual benefit are stipulations that state who can access the network for how long at which costs. Typically this leads to an either limited or unlimited time of free Internet access. Since a commercial network operator cannot charge any fees during that time, stipulations lead to a decrease in direct revenue, but at the same time increase the attractiveness, and hence the indirect revenue of a Wi-Fi network.

Whenever the traded commodities do not have a comparable value, a compensatory payment may be administered in order to ensure that both parties profit from the cooperation. Occasionally, a municipality can also subsidize the construction of public Wi-Fi, this might however not always be legally possible. In this case, the municipality may cover a share of the costs in exchange for an equivalent share of the direct revenue from offering Internet access to the inhabitants and tourists in the city.

1.3 What constitutes the business case for Wi-Fi: how free is "free" Wi-Fi really?

The problem when rolling out Wi-Fi is that, at some point, somebody has to pay for the arising CapEx and OpEx costs. While publically-owned Wi-Fi networks are funded by taxes, for private businesses, it is typically the customer who ultimately pays a higher price when the costs of running a business rise, as businesses will always pass on these costs to the customer. When we talk about indirect revenue in small businesses, what we mean is that business owners offer free Wi-Fi in the hopes of causing a higher willingness to pay for the offered goods and services in customers. This can translate into a higher number of customers who then may pay a higher price, or buy a larger quantity of a product, but the Wi-Fi is certainly not free.

Seeing the widespread success of free Wi-Fi in small businesses, we assume that this strategy has worked out so far. In fact, this business model seems to be so successful that by now, commercial telcos are under heavy competition by companies like AmpThink[1] or Ruckus[2] that specialize on providing Wi-Fi solutions for businesses, while relying on ISPs only for backhauling. And yet, mobile network operators increasingly depend on offloading mobile data through public Wi-Fi networks in order to decongest their mobile network. Yu et al. [10] have determined that therefore, mobile network operators might even be willing to pay business owners for allowing them to deploy carrier-grade Wi-Fi equipment on their premises. The result of this would then be a truly free Wi-Fi network that is funded by the cooperational benefits between the network operator and the business owner.

We believe that such cooperational benefits have not been exploited thoroughly in past Wi-Fi projects, which is the reason for the slow and often unsuccessful progress in the deployment of public Wi-Fi. In the following, we want to present some cases of existing Wi-Fi networks under the aspect of how these networks profit from the cooperational benefits between different stakeholders.

2 Case studies part 1: Customer-facing Wi-Fi

Depending on the setting of a business, deploying customer-facing Wi-Fi opens up different possibilities of generating indirect revenue. In this section we will present three such business settings (small businesses, malls and sports stadiums) and the implications on indirect revenue and cooperational benefits. Instead of buying and installing equipment themselves, business owners can hire a company that provides equipment and know-how, which is especially worthwhile for larger business and may provide opportunities for cooperational benefits. Such a company may or may not be an ISP with an own backhauling network. If this is not the case, a business subscription with an ISP is necessary, which however does not differ from a business subscription for a fixed network.

Another question in light of the business model of customer-facing Wi-Fi is whether the business owner or the partner company wants to generate direct revenue by selling network subscriptions or showing advertising, or if the business owner wants to rely solely on indirect revenue in order to cope with the costs of deploying Wi-Fi.

1 www.ampthink.com
2 www.ruckuswireless.com

2.1 Wi-Fi in Small Businesses

In 2014, Devicescape surveyed over 400 small business owners who had deployed free Wi-Fi for their customers [11]. Among the respondents, 62 % stated that customers spend more time on their premises since they started offering Wi-Fi. At first glance, it might rather be seen as a disadvantage than an advantage, especially for enterprises in the gastronomic sector, when customers occupy their table for a longer time, possibly without buying anything. However, 50 % of the business owners responded that introducing Wi-Fi has led to an increase in sales per customer, so this should not be seen as much of a problem.

On a further note, the survey splits up the respondents according to the main reason they have given for deploying a customer-facing Wi-Fi. The three categories participants were grouped in were “increasing foot traffic”, “improving sales” and “providing additional customer service”. In all three groups, more than two thirds of the respondents state that the introduction of Wi-Fi was a success. Overall, small business owners are beginning to see Wi-Fi as a competitive requirement, with 77 % of the participants judging that a customer-facing Wi-Fi has a high importance for their business.

It should be noted that a higher amount of money spent per customer does not necessarily transfer into a higher total revenue. For example, a crowded restaurant where visitors spend a longer time due to free Wi-Fi, only consuming a few drinks, might actually be losing revenue due to a table being blocked that would otherwise be filled with customers who order a full meal. Nevertheless, not offering Wi-Fi might bear the risk of losing customers to restaurants that do offer free Wi-Fi. Judging by the widespread availability of free Wi-Fi, we assume that most business owners are better off with, than without customer-facing Wi-Fi. This is however influenced by the competition from LTE: when using the cellular network becomes affordable, the value of Wi-Fi decreases sharply, unless business owners can provide a better Quality of Service than the competing LTE network.

2.2 Ghelamco Arena

Ghelamco Arena, home of the football club KAA Gent, has set a prime example for stadium Wi-Fi, after numerous complaints had been received over the complete lack of cell phone connectivity inside the venue [12]. While it is, due to technical limitations, very difficult to deploy a sufficiently scaled Wi-Fi network for such a high number of users in a confined space, a high user density has also some economical upsides.

The main cost driver for Wi-Fi networks is the coverage area, while the main driver for direct and indirect revenue is the number of users. It is therefore easier to construct an economically feasible Wi-Fi network, when the user density is high, which in turn makes it possible (and necessary) to install-high end equipment. As such, a partnership with Telenet, the biggest cable ISP in Belgium, has been established in order for Ghelamco Arena to become the first European sports stadium with a free Wi-Fi network built according to Wave 2 of the 802.11ac standard.

At a sold-out football match in early 2016, the network quality was tested: during the match, the 20.000 visitors have transmitted a total of 186 GB with an average throughput of 50 Mbps [13]. It should be noted that, while the average throughput in sports stadiums is comparably low since people come to the stadium primarily to watch a game, the network must be able to handle the peaks that emerge when, for example,

one team scores a goal and a large number of fans want to update their social media status or watch replay videos on their devices.

Previously, Telenet had deployed a Wi-Fi network that covered selected spots in the stadium and that was freely accessible only to Telenet customers. The source of indirect revenue in this case consists of new potential subscribers and reduced churn. The new iteration of their stadium Wi-Fi however was set to cover the whole stadium and provide free Internet access to every visitor. It can be assumed that most football fans who visit the stadium, do so regardless of whether there is Wi-Fi or not. Most of the classical sources of indirect revenue are therefore not open in stadiums, besides a higher fan satisfaction and higher fan involvement through social media. Should the indirect revenue not suffice to back off the costs of Wi-Fi deployment, the club could do so by raising ticket prices accordingly.

The aim of the project in Ghelamco Arena was to provide a high number of users with the ability to receive video streams on their mobile devices. For this purpose, Telenet promotes a mobile app called Play Sports that lets fans stream highlights from the game they are watching in the stadium and live-stream other sports matches that take place simultaneously, for a monthly subscription fee. This can be categorized as an additional indirect revenue stream for Telenet. In the case of football clubs, the partnership with an ISP can also be negotiated on the basis of a sponsorship deal, for example in exchange for displaying sideline-ads or conceding the naming rights for one of the stands, as was the case in Ghelamco Arena. Since sponsoring is one of the main sources of revenue for football clubs, recruiting a new sponsor, or improving the partnership with an existing sponsor by rolling out a Wi-Fi network can be seen as an additional source of indirect revenue on the side of the stadium.

Another example of such sponsorship led to Belgium's first major-league football stadium to offer free Wi-Fi in 2015, when Club Brugge teamed up with Proximus as ISP and Cisco as equipment provider [14].

2.3 Mall of America

While football clubs can rely on such sponsorship deals or pass on the price of deploying Wi-Fi to the visitors through the ticket price, the economic case for public Wi-Fi in shopping malls becomes more difficult, especially if a large area is meant to be covered. Currently, the most visited shopping mall worldwide is Mall of America with an area of 390.000 m^2 and over 40 million visitors per year. They introduced free Wi-Fi in 2015, also not before having received massive complaints from customers about the lack of connectivity. For this purpose, Mall of America established a partnership with AmpThink, a company that specializes in building large-scale Wi-Fi networks in order to deploy over 600 wireless access points. After the network had been operational for half a year, AmpThink reported a total traffic of 486 TB distributed over 793,750 wireless sessions, or roughly 0.6 GB per session.

A contractor like AmpThink who specifically focuses on large-scale public Wi-Fi can help to find a technically well-functioning solution while minimizing the costs. Furthermore, additional streams of indirect revenue can be discovered in mall Wi-Fi. For example, the Cisco equipment used in the Mall of America Wi-Fi network is capable of monitoring location data from users for analytic purposes. Furthermore, video screens have been installed that allow the mall to display customized advertisements and other information based on the information gathered from the interaction between the customers and the network. By specifically targeting customers with the right ads, sales to users that are connected to the Wi-Fi network can be boosted.

Theoretically, it might be possible for sponsorship deals here as well, but such a partnership does not come as naturally about as with football clubs, where sponsorship constitutes an integral part of their direct revenue. At the same time, such a sponsorship deal uses up advertising space that would be more valuable if it was filled with customized ads that are based on the usage data gathered from the Wi-Fi network. That is not to say that the equipment suppliers and ISPs cannot agree with a mall owner on an exchange of advertising space for a cost reduction on the Wi-Fi network, but it is unlikely that this could cover the whole costs.

3 Case studies part 2: Municipal Wi-Fi

In a second selection of case studies, we focus on municipal Wi-Fi, typically initiated (and sometimes exploited) by a local or regional authority, and covering a larger area than customer-facing Wi-Fi. In the analysis of these municipal Wi-Fi cases, we will specifically focus on the setting (coverage area) and the business model employed.

For the setting of municipal Wi-Fi, we distinguish between Wi-Fi clouds and Wi-Fi hotzones. While with a cloud, the whole city, or at least whole districts are covered, hotzones only provide coverage for the centers of public life, such as administrative buildings, schools, libraries and shopping areas. The economic difficulty of hotzone-based Wi-Fi is lower since only small areas with a high user density need to be covered. Hotzones can therefore be regarded as an entry point for municipalities that want to start rolling out a network and then gradually expand the coverage area according to their economic capabilities. In a similar manner, hotzone-based Wi-Fi can serve as a fallback solution in cases where Wi-Fi clouds have failed.

Economically speaking, the most complex and most difficult case is a Wi-Fi cloud, as such a project incurs the highest costs, but also offers the broadest range of possible scenarios for cooperation between public and private players. The costs that are associated with covering large residential areas with a low user density makes it virtually necessary to exploit cooperational benefits. However, to which degree this is possible depends mainly which stakeholders take the role of the network owner and the service provider [15] [16], which is essential for the business model. Each case study described below is hence characterized by its business model, in which the first part refers to the network owner, the second part to the service provider. Network owner here refers to the owner of the Wireless Access Points (WAPs) and the peripheral equipment like switches and controllers. This can be a private company, a public body, or a multitude of private and public actors (open site model). The service provider owns the backhauling network and thus provides access to the Internet for users that are connected to the Wi-Fi network. This can again be a private or public ISP, or a multitude of ISPs (wholesale model).

While private companies naturally have an interest to reap cooperational benefits whenever possible, municipalities who want to exert a maximum of control over the public Wi-Fi, might keep the service provisioning in public hands in order to offer unlimited free Wi-Fi access to citizens. Municipalities who choose this option are prone to ignore all possible scenarios of cooperation with private parties that might perhaps not lead to free Wi-Fi, but to an economically more favorable outcome in terms of overall public welfare [17]. This is in part because private network operators are unlikely to expand to an area where there is unfair competition by a tax-funded free Wi-Fi network.

Additionally, governmental regulations shape the relationship between the different stakeholders of public Wi-Fi, which is why private network operators are heavily lobbying for regulations that prevent municipalities from offering free Wi-Fi [16]. On a further note, liability laws under which either venue owners or network operators can be held responsible for criminal activities and copyright infringements that are being committed over their network, might act as a deterrent for private companies [18]. It is therefore also a governmental issue to enable the natural growth of collaborative public Wi-Fi projects.

3.1 Private-Private: OZone (Paris)

In a private-private business model, both of the role of network owner, as well as service provider are taken by commercial telcos, likely both by the same telco. In order to roll out a public Wi-Fi network, one first needs to obtain access to the public infrastructure, such as lamp posts for installing access points. This can be achieved by paying the municipality a previously agreed sum, as was the case for the OZone network in Paris. In addition to the public infrastructure, OZone installed multi-radio antennas on the rooftops of private buildings in exchange for allowing the owners of the buildings free access to the network. By charging subscription fees, OZone was able to build a commercially successful wireless mesh network that spanned the whole city [18].

The advantages of having a private telco that wants to roll out such a municipal Wi-Fi network are obvious from the city's viewpoint: on the one hand, the network generates indirect revenue, while the city receives direct revenue from the telco for renting out the infrastructure. On the flip side, the city has next to no influence on the network and in cities that are less densely populated than Paris, there might not be any commercial telcos who are interested in deploying a Wi-Fi network. In order to stimulate this, a municipality may preemptively choose to open all public infrastructure to any telco who wants to roll out a network. In such a case of an open-site model, there will be ideally more than one telco interested in rolling out a network, so that they can, collaboratively, cover a larger area. Overall, the open-site model can provide a solution for cities who don't want to get involved too much financially, however the municipality will not have a lot of influence over the networks.

3.2 Public-Public: Iperbole (Bologna), Cyber Spot (St. Cloud)

If a municipality wants to maximize its control over the network, which usually leads to free Wi-Fi, there is the option to keep both the network ownership and the service provisioning in public hands. A prime example for this is the Iperbole network in Bologna, Italy [19]. In this case, the city rolled out a Wi-Fi cloud that spanned the historic city center, while the role of the service provider was taken by a public company. Such a public-public business model typically leads to the maximization of indirect revenue for the municipality by offering free Internet access to inhabitants, tourists and businesses.

However, these endeavors are not unproblematic, in a legal sense, as this might cause inhabitants of the city to replace their broadband subscription with Wi-Fi, and interfere with the deployment of private commercial Wi-Fi. Networks that are based on the public-public model heavily distort the competition in the private telecommunications market and subsequently, the city of Bologna has been sued by four different ISPs over losses of profit [19].

On top of the legal problems that might arise from the public-public model, the municipality (if applicable in cooperation with a public ISP) is the sole bearer of the costs, which means that this type of "free" Internet access needs to be funded with taxes. In the case of the Cyber Spot network in St. Cloud, Florida, the city decided to discontinue the project after three years, although initially successful. The network provided both indoor and outdoor coverage for the whole city, however the yearly OpEx costs of $600.000 were deemed unsustainable under the city's budget limitations [20].

Overall, while the public-public model might increase a municipality's indirect revenue in comparison to other business models, there is not much room for cooperational benefits between private and public stakeholders, not least because private telcos are typically opposed to cities who offer free Wi-Fi.

3.3 Wholesale: panOULU

A better solution might be the public-wholesale model where the municipality rolls out a Wi-Fi network and then outsources the service provisioning to a group of commercial ISPs who then compete for customers in a wholesale market.

This business model was perfectly implemented by the panOULU network in the city of Oulu, Finland. In this case, the four ISPs market not to regular Internet subscribers, but business owners who want to set up a hotspot, while Internet access for regular citizens is free. This collaboration between a multitude of public institutions and private businesses provides the maximum of cooperational benefits and could therefore serve as a role model for cities that want to start deploying Wi-Fi access points.

The big disadvantage of this business model is that it requires huge collaborative efforts that cannot be established over night [21]. The panOULU network originally started out as a research project conducted by the University of Oulu. For this project, six 802.11b wireless access points were installed around the Rotuaari pedestrian zone in 2001. The city contributed to the project by allowing the research group to install APs in public buildings and a private ISP agreed to sponsor the backhauling. By 2003, the RotuaariWLAN has grown to 20 APs, while at the same time, access points were being deployed at the University campus, the Polytechnic and a public library. These Wi-Fi networks then joined forces and appeared afterwards under a common SSID. By now, the panOULU network covers the whole city.

As the collaboration between the academic institutes, the city, and several private companies were gradually expanded, it was possible to deploy even more access points around the city and by 2006, the wholesale model was implemented. The advantages of this wholesale subscription model were that ISPs would rather join the network, than turn against the development of municipal Wi-Fi. Furthermore, local businesses were now, at a reasonable price, able to deploy their own access points, thus funding the expansion of the network even more. This example demonstrates the importance and the clear advantages of having a collaboration between a multitude of different stakeholders, in order to successfully build a municipal Wi-Fi network, as the mutual benefits that result from the collaboration keep reinforcing investments into the network.

3.4 Wholesale: The Cloud (Karlskrona)

A similar business model has been implemented in the city of Karlskrona, Sweden when *The Cloud*, a private wireless network operator, joined forces with *Affärsverken Karlskrona AB*, a city-owned fixed

network operator in order to create a hotzone based municipal Wi-Fi network [22]. This allows the public ISP to cost-efficiently expand to municipal Wi-Fi, while The Cloud, who provides the equipment gets cost-efficient access to a backhauling network.

While The Cloud itself offers subscription-based network access, they allow other telcos to use the network in order to sell subscription packages as well and grant Wi-Fi access to preexisting customers, making this case a public-wholesale business model. Users who are not yet affiliated with one of those operators can choose one of the offered subscription packages or can buy the subscription package directly from The Cloud. Since The Cloud, who controls the network, has a natural interest that users buy the subscription directly from them and not from one of the other ISPs, a conflict of interest might arise here. This is however limited by Affärsverken acting as a regulating body.

4 Analysis of the Case Studies

Table 1 lists the cases that were examined in this paper with regards to the physical setting, network ownership, service provisioning, the direct and indirect revenues that arise from this particular business model and the cooperational benefits that arise between the stakeholders.

Table 1: Comparison of different Wi-Fi projects in regard to business model and cooperational benefits

	Setting	Ownership	Service Provisioning	Direct Revenues	Indirect Revenues	Cooperational Benefits
Ghelamco Arena, Ghent	Stadium	Private	Private	---	Fan engagement, PlaySports App	Sponsorship deal, additional IR from PlaySports app
Mall of America, Minnesota	Mall	Private	Private	---	Sales, customized advertisement	Business partnership
OZone, Paris	Municipal cloud	Private	Private	Subscription fees, fees for site access	Municipal Wi-Fi	---
Iperbole, Bologna	City center	Public	Public	---	Municipal Wi-Fi	---
CyberSpot, St. Cloud	Municipal cloud	Public	Public	---	Municipal Wi-Fi	---
panOULU, Oulu	Municipal cloud	Mixed	Wholesale	Business subscriptions	Municipal Wi-Fi, own hotspot for subscribers	Various: city, academia, ISPs and local businesses
The Cloud, Karlskrona	Municipal hotzones	Public	Wholesale	Subscription fees	Municipal Wi-Fi	Wi-Fi extension for public and external ISPs, backhauling for wireless operator

Depending on the setting of a Wi-Fi network, different potential sources of indirect revenue emerge. For example, the option to promote a sports app is a source that is specific to stadium Wi-Fi, while customized advertising is specific to malls. Additionally, through business partnerships or sponsorship deals, cooperational benefits can arise. This is especially distinctive for municipal Wi-Fi with mixed business models, when there is a partnership between the network owner(s) and service provider(s).

Additionally, there is the option of generating direct revenue by rolling out Wi-Fi by either showing advertisement, or charging subscription fees to users.

In order for cooperational benefits to arise, the partners of such a cooperational project need to have different interests (in terms of direct and indirect revenue) and different resources to contribute to the Wi-Fi network. Otherwise, a competition would likely ensue between the stakeholders for securing the maximum share of the created value, while contributing as little as possible to the network.

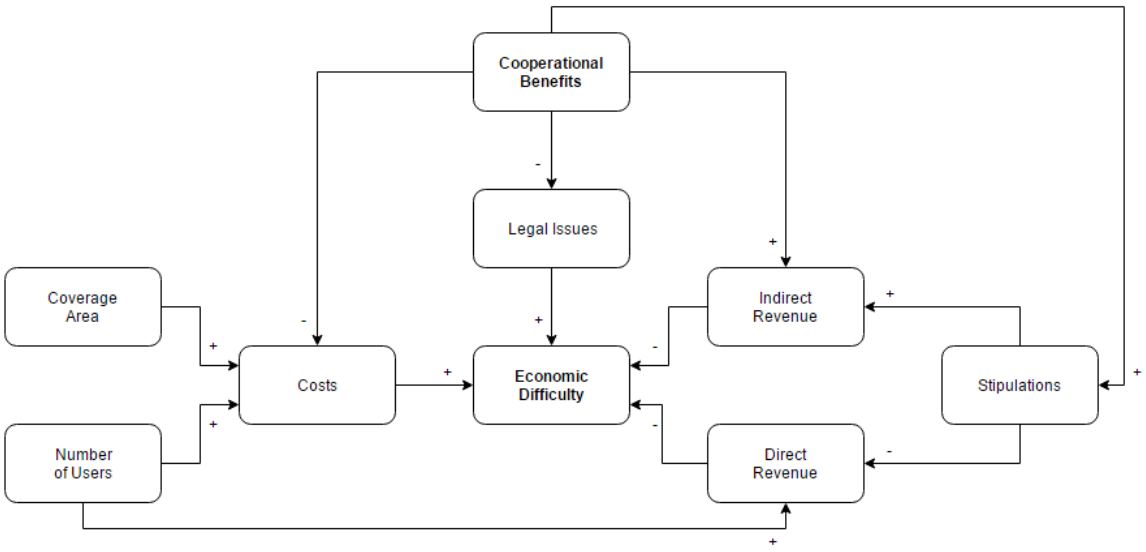
An exemplary case of collaborative Wi-Fi has been set up in the Finnish city of Oulu, where several smaller Wi-Fi networks have been joined in order to create one big municipal Wi-Fi project, where, next to the academic institutions and the city, ISPs and local businesses can freely contribute their resources and reap indirect or direct revenues accordingly. On the other hand, the case of the Iperbole network in Bologna demonstrates how cooperational benefits are made impossible when network ownership and service provision are kept in public hands, as this approach alienates private telecommunication providers who would otherwise expand their fixed or mobile coverage in the city, or ideally, contribute to a collaborative Wi-Fi project. A solution to this would be to open up the network to private ISPs under a wholesale business model, such as in Oulu or Karlskrona.

While private business owners typically search for the most profitable solution when deploying customer-facing Wi-Fi and are thus always open for cooperation, there is often no incentive for governmental bodies to allocate tax funds in an economically ideal manner when they have the goal of providing free Internet access. As such, the procedure in St. Cloud, where the city deployed a municipal Wi-Fi cloud only to discontinue the project after a few years due to the OpEx costs (that should have been known to the city before the start of the project), should be considered a waste of taxes.

Figure 1 illustrates the components that comprise the costs as well as the direct and indirect revenues that are associated with a public Wi-Fi deployment and ultimately determine the economic difficulty of the project. As long as the total sum of direct and indirect revenues is higher than the total costs, a Wi-Fi network is, in theory, economically viable. This however does not necessarily mean that all stakeholders naturally profit from participating in Wi-Fi deployment when profit margins are low, hence the term economic difficulty. In that case, monetary compensations are needed in order to ensure cooperation between the stakeholders.

Cooperational benefits can influence this by keeping the costs low (for example when sponsorship deals take place or existing Wi-Fi networks are joined) or by providing additional sources of indirect revenue (such as the PlaySports app in Ghelamco Arena). As a result of this, cooperational benefits facilitate the establishment of stipulations that allow users to access the network for free or at a cheaper price. On a further note, integrating private ISPs into municipal Wi-Fi projects and ensuring that they profit from such arrangements decreases the chance that the city has to fight legal battles on the grounds of distorting competition.

Figure 1: Impact of cooperational benefits on the business model of public Wi-Fi



5 Conclusions

The importance of public Wi-Fi for customer satisfaction and mobile data offloading keeps increasing. This creates an incentive to roll out Wi-Fi on a large scale. With an increasing coverage area (and thus increasing costs), the economic complexity of public Wi-Fi networks increases accordingly. At the same time, we can identify a growing number of high-value stakeholders and possibilities to generate indirect revenue, especially in the case of municipal Wi-Fi clouds. Those stakeholders can include private telcos, local businesses, universities or the municipality itself. By using a municipal Wi-Fi network as a tool for collaboration between these stakeholders, cooperational benefits arise that may be an important factor in the success of a Wi-Fi project. The degree to which cooperational benefits and indirect revenue can emerge depends strongly on the setting of the public Wi-Fi network and, in the case of municipal Wi-Fi, the distinction between network owner and service provider.

By analyzing different cases of public Wi-Fi, we conclude that cooperational benefits may constitute a source of indirect revenue or decrease the costs of rolling out a network by making use of an already existing infrastructure, thus having an impact on the economic difficulty of a public Wi-Fi project. If the sum of all direct and indirect revenues surpasses the total costs, such a project is in any case economically feasible, and it is only a matter of sharing this net economic profit among the stakeholders. By ensuring that private network operators have a positive outcome from collaborating with municipal Wi-Fi projects, the likelihood of lawsuits can furthermore be decreased, hence enabling municipalities to offer free Internet access.

In the next steps of our research, we will try to find a way how to approximate the monetary value of indirect revenues and cooperational benefits for the further use in the game theoretical analysis of public Wi-Fi networks. By studying and comparing existing municipal Wi-Fi networks, we conclude that the

largest and most successful municipal Wi-Fi projects make extensive use of these cooperational benefits, rather than trying to construct and operate a network on their own. Mobile network operators are currently developing a natural interest in deploying public Wi-Fi in order to combat the growing problem of network congestion and could be valuable contributors to municipal Wi-Fi rollout. It therefore remains an open question why some municipalities still insist on offering tax-funded Wi-Fi under public service provisioning, thereby creating an uncompetitive market situation that stifles the formation of collaborative Wi-Fi projects with the help of private companies.

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