P2P-based Roaming Between Home WLAN Hotspots

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Abstract

The increased amount of broadband Internet connections at home, combined with the low cost of WLAN access points and other WLAN hardware, has made it possible for individual end-users to contribute to the wireless landscape by allowing open access to their WLAN access points. Consumers' WLAN access points and emerging handsets equipped with WLAN capability provide an opportunity for P2P-type of wireless coverage. Current metropolitan areas are already to some extent covered by consumer home WLAN networks and can ideally form one big network which then can be used freely by members of a community. This paper concentrates on describing the current situation in P2P-based roaming between home WLAN hotspots, what are its pros and cons, and why it is being done.

The paper starts by introducing the WLAN technology and some concepts regarding sharing of WLAN access points in a P2P manner. It then goes on by defining what a business model is, after which it briefly goes through the idea and reason behind P2P-based roaming between home WLAN hotspots. Then an analysis of proposed peering frameworks and offerings is given and a comparison of these. The offerings that are described and analyzed in more detail are the P2PWNC framework, and the offerings by OpenSpark, FON, and LinSpot. At the end of the paper also some regulatory issues are mentioned.

Keywords: WLAN, P2P-based roaming, access point sharing, business model.

1   Introduction

Wireless LAN (WLAN) networks enable end-users to obtain high-speed Internet access at different locations, both indoors and outdoors, through different devices. The coverage of these WLAN networks is constantly increasing and thus enabling the end-users to get connected to the Internet almost anywhere, at least theoretically. The increased amount of broadband Internet connections at home, combined with the low cost of WLAN access points and other WLAN hardware, has made it possible for individual end-users to contribute to the wireless landscape by allowing open access to their WLAN access points.

The WLAN technology has during the past ten years continuously exceeded its expectations. Almost every laptop computer today has WLAN included and the technology is also becoming more common in smaller devices such as mobile handsets. A WLAN access point can be deployed at low cost to offer Internet connectivity practically anywhere where there is a broadband connection.

WLAN, as a technology, is still evolving rapidly and new standards are being created to improve its capabilities. Security for example has been a big issue. However, many of the problems related to security have already been solved. Also improvements in quality of service, roaming capability, and improved bandwidth have been considered, i.e. the technology is improving and it will also in the future represent a cost efficient alternative for wireless communications.

WLAN technology can be used in a variety of ways, both as commercial offerings and for free, e.g. as:

- Operator WLAN offerings;
- Municipal WLAN;
- Corporate WLAN;
- Free WLAN networks by hotels, libraries, cafés etc.;
- WLAN broadband connections (as a substitute for e.g. xDSL);
- Home WLAN sharing.

However, this paper concentrates only on describing the current situation in sharing of home WLAN access points in a peer-to-peer (P2P) manner.

2   Business Models

The term *business model* is known for not being used consistently. Also, authors writing about business models often do not even give a definition of the term. Therefore, before going any further a short definition of what is meant by a business model will be given.

One definition of a business model, that is relevant in a technology based environment, is given by Chesbrough & Rosenbloom [1]. The key ideas of this definition can be seen in Figure 1 below.
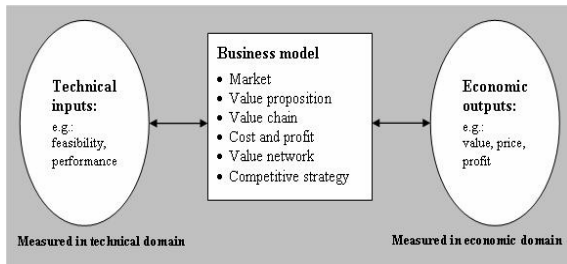

Figure 1. Business model mediates between the technical and economic domains. [1]

Here, the functions of a business model are to:

- Articulate the value proposition , i.e. the value created by the offering based on the technology;

- Identify the market segment, i.e. the users to whom the technology is useful and for what purpose, and specify the revenue generating mechanism(s) for the organization;

- Define the structure of the value chain within the firm required to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain;

- Estimate the cost structure and the profit potential of producing the offering, given the value proposition and value chain structure chosen;

- Describe the position of the firm within the value network linking suppliers and customers, including identification of potential complementors and competitors;

- Formulate the competitive strategy by which the innovating firm will gain and hold advantage over rivals.

The six attributes mentioned above also collectively serve additional functions, namely to justify the financial capital needed to realize the model and to define a path to scale up the business.

Timmers [2] provide another relevant definition on how a business model is constructed, however with an e-business origin. Timmers states that the business model is:

- An architecture for the product, service, and information flows, including a description of various business actors and their roles;

- A description of potential benefits for the various business actors;

- A description of the sources of revenues.

Some work has been done on classifying business models, however, mostly in the e-commerce and Internet domains. Business models based on trust systems and consumer-driven business models have not been studied deeply though. The problem with these kinds of business models is that it can e.g. be hard to identify the profit potential. The value of these business models can be easy to explain from the end-user perspective, however, making money out of them can be considered much harder.

3 P2P-based Roaming Between Home WLAN Hotspots: Basic Concepts

Consumers' WLAN access points and mobile handsets provide an opportunity for P2P type of wireless coverage, either in fixed hotspots or random locations. Current metropolitan areas are to some extent already covered by consumer WLAN networks and can ideally form one large network which then can be used freely by e.g. neighbors, visitors and mobile users.

WLAN, as a technology, already enables individuals to share their broadband Internet access to their peers. Although this is straightforward technically, two broader issues arise: [3]

1. A scheme for P2P-based sharing of resources must take into account the selfish tendency (i.e. free-riding), which is especially relevant in electronically mediated communities;

2. Any scheme for the P2P-based sharing of resources that is centrally controlled may give birth to mutually inaccessible systems.

To make P2P-based roaming between home WLAN hotspots happen, the first step is to create a community of individuals who share their home WLAN access points between each others. The next step is to get home WLAN access point owners to join the community. By joining a community of individuals who offer open access to their home WLAN access points members of the community gain by getting access to other members' WLAN access points. The members of the community are then able to get connected to broadband Internet services more widely without any additional costs and hence, get more value out of their connection. One argument could be that why should someone pay for Internet access on the go when he/she already has paid for it at home?

One proposal for P2P-based roaming between home WLAN hotspots is the P2P wireless network confederation (P2PWNC) scheme explained in detail later on [3]. WLAN offerings offered by municipalities are currently also being considered and deployed. These networks can offer unified and citywide WLAN access

to citizens and visitors alike. [4, 5, 6]. Other related efforts include the various free networks [7] that are being deployed in cities worldwide. The free hotspots that are part of these free networks are usually set up without centralized coordination. The problem with free networks, however, is that they rely on the altruism of their participants, which can hinder their deployment [3].

Two commercial offerings, LinSpot [8] and Netshare [9], offer similarities to e.g. the P2PWNC proposal. Out of these two, LinSpot will be analyzed some more later on in this paper. With these services, users are encouraged to share their residential hotspots with nearby visitors and receive compensation for their contribution. In principle, this model is no different from hotspot aggregation, as it relies on centralized brokers. [3]

Another sharing scheme or community of WLAN networks is offered by FON [10]. FON is currently the largest WLAN community in the world. The members of the FON community share their wireless Internet access at home and, in return, enjoy free WLAN wherever they find another so called Fonero's access point. Another offering that will be discussed and analyzed in more detail in this paper is OpenSpark [11].

4 Analysis of Proposed Peering Frameworks and Offerings

4.1 P2P Wireless Network Confederation

The P2P Wireless Network Confederation framework [3], or shortly P2PWNC, is a design for a hotspot peering scheme that is fully self-organized and provides collaboration incentives to selfish peers. The goal is to promote cooperation in a resource-sharing community of autonomous peers where the peers can both provide and consume the resource in question.

Briefly, the proposal is this: peers, i.e. owners of home WLAN access points should organize into small groups that are called teams, and start playing a game (in the game-theoretic sense) with three simple rules [3]:

1. Each team must operate and maintain a number of WLAN access points;

2. Members of teams may be freely serviced by WLAN access points belonging to other teams only if they can prove that their team also freely services members from other teams;

3. There is no referee.

The underlying assumption of this game is that the threat of exclusion and the promise of free roaming are good enough reasons to share one's WLAN access points with others.

There is no assumed P2PWNC authority. Hence, P2PWNC peers would be tempted to under-provide. This issue is solved by following a simple protocol that is

secured by standard cryptographic primitives that enables contributing peers to detect and exclude such free-riders from the P2PWNC system. This provides incentives for the P2PWNC system to grow as more willing collaborators joined it. By eliminating centralized brokers from the P2P sharing scheme it could allow for unified roaming system to emerge.

4.2 OpenSpark

OpenSpark [11] is a community of wireless Internet users administered by MP-MasterPlanet [12]. To become a member of the OpenSpark community one needs to offer his/her WLAN access point to other community members. By doing this the member of the OpenSpark community gets one OpenSpark user-ID. The OpenSpark architecture to the Internet can be ssen from Figure 2 below.
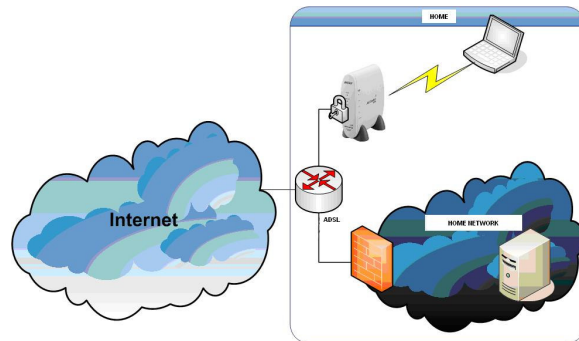

Figure 2. OpenSpark architecture to the Internet. (Modified from [11])

With the OpenSpark user-ID the members of the community can use the Internet through all OpenSpark access points. With the OpenSpark access point the user of the wireless network service is prompted with the same look-and-feel to the network regardless of where he/she logs on to the service. The OpenSpark access points are ordered from an online store.

Other features of the OpenSpark base station include e.g.:

- User identification through SSL secured WWW connection;

- Web-based administration;

- Centralized user database;

- Additional user-IDs for visitors and family members.

The OpenSpark access point use existing broadband connections. Restrictions in the use of broadband connection are as follows:

- A public IP-address is needed, however, the IP-address can be either static or dynamic;

- Traffic on the broadband connection should not be restricted in any way.

A member of the OpenSpark community is offered a secure wireless network at home, a broadband connection that is available also outside of the home, and access to all OpenSpark access points free of charge.

4.3 FON

FON [10] is the largest WLAN community in the world. The members of the FON community are called Foneros. To become a Fonero one needs to buy a La Fonera, which is a so called FON Social Router. The router enables a new member of the FON community to share his/her home broadband connection with other Foneros. Then when a Fonero is away from home and he/she needs Internet access, he/she just needs to log on to a FON access point, and use Internet connectivity for free by remembering a login and a password.

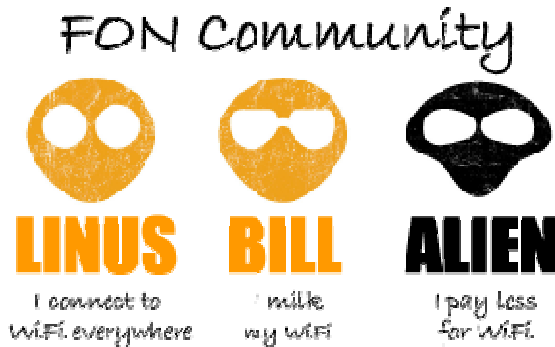There are three types of Foneros as illustrated in Figure 3:

Figure 3. Types of Foneros in the FON community [10]

Explanations of the types of Foneros in the FON community:

- Linus: Most of the users are Linuses. A Linus shares his/her WLAN at home and in return gets free WLAN wherever he/she may find another FON access point.

- Alien: Aliens are those that do not share their WLAN. They are charged for the access to the FON community.

- Bills: Bills are in business and want to get additional revenues by charging Aliens for their access to their WLANs. Instead of access, Bills get a share of the money that Aliens pay to access the community through their FON access point.

The charge for access is based on the account status of the "home" router. A Linus has free access to any FON router, regardless of if the owner of the router is a Bill or a Linus. If you are a Bill you have to pay per day

regardless of if the router you are connected to belongs to a Linus or another Bill.

The La Fonera offers two wireless network signals (SSIDs), one private and one public. The private signal is encrypted using WPA and the public signal is accessible to Foneros only. The public signal is the one that turns the broadband connection into a FON access point.

4.4 LinSpot

LinSpot [8] is a free software for selling an end-users wireless Internet access. It is based on P2P principles and it uses a combination of different technologies to turn the wireless Internet into a so called "paid-for Internet" access point and let the end-user benefit from it. Hence, LinSpot is not about offering free connection to WLAN access point, but to offer Internet connectivity at a reasonable price, i.e. LinSpot uses the consumer-to-consumer business model to let the end-users earn money.

To start using LinSpot the end-user only needs to download a software, and after that, complete an installation process. The payment transactions for the connectivity charges are handled securely with end-to-end encryption. The features of LinSpot include e.g.:

- A free software with automatic software updates;

- Possibility to earn instant money for shared wireless access;

- Works with all WLAN access points, including NAT and network configurations;

- Free access for an unlimited amount of wireless users which is controlled by the end-user;

Some of the features from a visitor's point of view and what they experience when they connect to a LinSpot network:

- Prices are less than half those of the typical commercial hotspot providers;

- Works on all operating systems;

- No need to download and install any software, as LinSpot works with standard IP protocols;

- Easy 3 steps: configure proxy, select access time and enter payment information;

- Customers get access to other places on the world wide LinSpot network;

- No startup costs or recurring subscription fees;

- No advertisements, no spyware.

LinSpot delivers consumer-to-consumer technology for end users WLAN equipment. A 15% share from the visitors goes to LinSpot to pay for the development of

new versions, the LinSpot servers, marketing of the network and profit.

4.5 Comparison

Table 1 shows a comparison of the framework/offerings that have been discussed in this chapter.

	P2PWNC	OpenSpark	FON	LinSpot
Business model	None Free wireless Internet connectivity	Free wireless Internet connectivity Sale of access points	Free wireless Internet connectivity as either: - Linus - Bill - Alien Sale of access points	Free wireless Internet connectivity Possibility to earn from sharing (15% share from visitors)
Administration	No authority	Centralized	Centralized	Centralized
Roaming with other communities	No	Yes	No	No
Framework/ offering	Framework	Offering	Offering	Offering

Table 1. Comparison of proposed peering framework and offerings.

FON and LinSpot are the only offerings that make it possible for WLAN access point owners to earn money. However, these two offerings are centralized in nature (also OpenSpark) which could make it hard for a unified roaming system to emerge. However, OpenSpark community and SparkNet [12] communities can roam between each others access points.

By comparing these framework/offerings to a subset of the definition of a business model by Chesbrough & Rosenbloom [1], many issues arise. The value proposition is clear in each of the cases. The value that is created is free, at least in most of the cases, roaming between WLAN access points. The market segment to which the technology is useful is also clear, i.e. home WLAN hotspot owners who also own e.g. a laptop computer or a handheld equipped with WLAN. The revenue generating mechanism(s) for the framework/offerings are, however, not so clear. This also goes to the profit potential of producing the offering, given the value proposition. Sale of community WLAN access points is one possibility, revenue sharing from paid access is another. However, the gain significantly through only these would require a large community. Other possibilities could for instance include advertisement and possibly also chargeable value added services.

5 Regulatory Issues

Sharing of WLAN access points sounds promising, at least from the consumer's point of view. However, there might be some regulatory obstacles that need to be tackled, e.g. the Internet service provider's Terms of Service (ToS) may not allow sharing of broadband connection with others.

Usually an Internet service provider has the right to offer a service according to its own wishes. This means that the Internet service provider can restrict the service that they offer in some way through the ToS contract. For example some Internet service providers do not allow for the end-user to have an own server, or only if the end-user pays an additional fee. Some providers again explicitly prohibit buying Internet connectivity from them and then sharing it with others.

However, there are providers that have agreed to support cooperation with e.g. OpenSpark and FON. The communities need to actively encourage and drive the Internet service providers to allow WLAN sharing. However, one always needs to remember that regulation is man made and it can always be changed. The question here is, will the regulative framework change so that it will encourage P2P-based roaming between home WLAN hotspots?

6 Conclusions

The large amount of home WLAN access points and the fact that WLAN is becoming more common in smaller devices, such as mobile handsets, provide an opportunity for P2P-type of wireless coverage. Current metropolitan areas are already to some extent covered by consumer WLAN networks and can ideally form one big network which then can be used freely by e.g. neighbors, visitors and mobile users.

This paper introduced the concepts of P2P-based roaming between home WLAN hotspots. The reason why this is of interest is that it makes it possible for individuals to gain substantially by getting access to other individuals' WLAN access points and hence be able to get connected to broadband Internet services widely, which to some extent can be considered self-organized.

This can be done by creating a community of individuals who share their WLAN access points and hence get more value out of their connection. However, any scheme for P2P-based sharing of WLAN access points that is centrally controlled may give birth to mutually inaccessible systems. This can make it hard for this kind of WLAN sharing to become a global phenomenon. Another problem is the actual building of community and the network effects associated with it. The actual business model is not clear and many issues are still in the open. Also the regulation causes some problems.

What will be of interest in the future is how these communities will be able to grow and how much. Also, will there be changes in regulative frameworks that encourage this kind of sharing of home WLAN access points.

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