

Mobile Guides for Locating Network Hotspots

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ABSTRACT

Mobile guides research concerns guiding users in physical spaces and finding services from physical places. We have found in user studies that as mobile networks evolve to hotspot networks, there is a rapidly increasing need to locate a high-speed network, such as a public WLAN hotspot. Instead of creating a dedicated tool for locating network hotspots, we argue for the mobile guides systems to provide information also about the networks neighborhood. If the mobile guide system recognizes the network hotspots, it can also benefit from using them. If the hotspot network is dense enough, the mobile guide can utilize the hotspot location information to determine the user location. Also, when connected to WLAN, the client-based guide system will be able to communicate with the mobile guide server in an efficient way. In this paper, we outline some user requirements for locating network hotspots and hope to inspire developers to consider including a hotspot locator into mobile guides.

Keywords

Mobile Guides, Network hotspots, Hotspot locator.

1. INTRODUCTION

Telecommunications networks have traditionally been wide area networks, with range of tens of kilometers. There is a rapid development, however, of short-range high-speed networks coming into use for mobile users. A typical example is WLAN (Wireless Local Area Network), the range of which is about 30 meters or less. Some WLANs are invisible to outsiders, so only specified users or devices can see and connect to the network. Public WLAN networks, which either require registration or are open for anyone, are more interesting for mobile guides. In many public hotspots, you have to pay for the connection, but increasingly many WLAN hotspots are free for everyone, as cities and states establish free hotspots for their citizens.

WLAN hotspots are common especially in the United States, where people have realized the problem of locating the invisible hotspots. There are several activities ongoing to solve this problem, but none of them is perfect, as shown in section 2.

1.1 Terminology

In this paper, we use WLAN as an example of a short-range wireless network. We could also talk about WiFi (Wireless Fidelity) networks, but currently all WiFi networks are using WLAN technology. A "WiFi product" is compatible with the IEEE 802.11 standard specifications. In the future, other WiFi networks will become available, such as WiMAX. Although the network coverage area may grow, similar hotspot locating problems will stay.

A WLAN access point is the physical device that connects wireless devices to a wired network. A WLAN hotspot is an area covered by an access point. A hotspot locator is a tool that helps users to locate a WiFi hotspot, even miles off. A signal detector is a tool that informs the user about signal existence in proximity of an access point.

2. CURRENT WAYS TO FIND A HOTSPOT

To better understand WiFi culture and end-user needs, we used contextual inquiry method with 15 participants. The sample size in these kinds of studies is typically 10 to 20 only [3], but the profiles of participants are diverse. We searched for variation in ages, genders, professions, devices, and use locations. First, we interviewed nine WLAN hotspot users in October 2004 in the Boston area. Two of them owned a PDA (Personal Digital Assistant) with WLAN connectivity, while the rest used a laptop computer in hotspots. We also conducted a similar user study in March 2005 in Helsinki, Finland, where we interviewed six people using Nokia 9500 Communicator for connecting to WLAN. There were not many public WLAN hotspots in Helsinki area at the time, so the interviewees were not actively searching for public hotspots. They mainly used the WLAN at home and at work, or in one public place they knew provided a free WLAN hotspot.

Especially the Boston interviewees reported several ways of getting information about WLAN hotspots:

1. Word of mouth
2. A Web site
3. Advertisements in media
4. Signs or staff at the hotspot
5. Signal detector on my device

In the following subsections, we analyze the pros and cons of each of these methods, which will help us to gather the requirements for a good hotspot locator.

2.1 Word of mouth

As soon as a critical mass of people around you is using network hotspots, word of mouth is a powerful method to distribute non-technical information about good hotspots. Non-technical information is important, since in our study, people did not want to enter a place that was not suitable for their style. One interviewee was even ready to pay for the connection because he loved the climate of a cozy café. He refused to go to a polished café with a free WLAN connection in the next block.

The information about a place suitable for you is easiest to get from your friends, but when all these known places are too far

away, you would appreciate to consult opinions of also unknown people who have visited the places nearby.

It seems to be common knowledge that WLAN hotspots exist at airports and in hotels. Most probably the knowledge about this relation between place category and WLAN availability originates from word of mouth as well.

2.2 A Web site

Even though a technology is not widely used, the Web often provides quite a bit of useful information about it. This is the case with WLAN hotspots. There are lots of web sites that offer maps of WLAN hotspots, e.g. [6],[7]. In most cases, the sites depend upon their readers to get the hotspot information from various locations.

The main problem with using a Web site as a source of information is that you must get connected in order to find the needed information to get connected. If you were not careful enough to check the site before getting on the road, you need to connect via whatever network available. Many people are using WLAN because they either do not have any other way to connect with their WLAN device, or do not want to pay for the data connection over cellular telecommunications network. In an optimal case, we should not trust users to be connected when acquiring for the information about the networks nearby, or at least minimize the amount of information transferred via a telecommunications network.

2.3 Advertisements in media

Advertisements in media make people aware about specific WLAN hotspots and can also deliver non-technical information about the hotspot. With a good campaign, e.g. Starbucks chain has succeeded to attract many WLAN customers, even though the connection is not free of charge [4]. Two out of nine interviewees in Boston were not aware of many free hotspots, so they used Starbucks hotspots.

2.4 Signs or staff at the hotspot

Most public hotspot providers do not advertise the WLAN existence in media, but only put signs on the front door, inner walls, or on the tables about the hotspot availability (Figures 1,2).



Figure 1. The Wi-Fi hotspot logo by the Wi-Fi Alliance intended for making a hotspot visible.



Figure 2. An example of a table sign including the instructions to connect to the WLAN network.

In cafés or restaurants, people may ask the waitress if they provide a hotspot there. Surprisingly many interviewees both in the U.S. and in Finland complained that the waitresses do not know about WLAN existence, even if the place provides one.

The main problem of on-site indicators is that finding new hotspots is not very efficient. If you need to find a WLAN nearby, you need to walk around and visit several probable places one by one.

It is good to remember that some companies and home WLAN owners deliberately want to hide their network from others. For example, many car repair shops in the U.S. now provide free WLAN access for customers who need to wait for their cars to get fixed. These places might not want to attract too many people to come to their hotspot, but only the real customers will get the access to their network.

Home WLANs are close to car repair shops when it comes to network sharing policy. Private people often let their visitors connect via their closed wireless network by communicating the needed passwords face to face. Only technically advanced people are able to grant one-time access rights for their visitors today.

2.5 Signal detector on your device

When our interviewees wanted to know whether WLAN is available at the current location, and no other information about its existence was available, they checked the network availability from their WLAN device. With laptop users, it was not surprising that they preferred to ask waiters or people around them rather than open and boot their laptop perhaps just to see if signal is available.

The task was much easier for PDA and Communicator users. PDA users seemed to be happy to see their PDA led lights illuminate when the device detects WLAN signal. If the detector is on all the time, it will consume the battery, however.

Because the WLAN signal also reaches outside the building, it is easy to just walk or drive by the probable places and to check when the indicator shows a signal. Some people have made this signal discovery a hobby, called wardriving [2]. Wardrivers may use different pieces of available software making the activity easier. They send the information of found networks to a web site that provides maps of the hotspots for the public.

Once the network hotspot signal is located, it might be just a weak one. In this case, you want to know where the signal source is located, or at least to find your way to a stronger signal. Network name might reveal the source of the signal (e.g. a name of a nearby Café), but if the name is obscure some help from the system would be appreciated. Also finding the way to a stronger signal might be hard without any external help: it often leads to a peculiar act of walking around with an open laptop to spot a better signal. Obviously, a directional signal source locator or some other intelligent system (like mobile guide) would help here.

Directional signal detectors do exist. There are specific devices sold solely for the purpose of detecting the WLAN signal when the user presses a button (Figure 3). The smallest, non-directional ones fit the key chain and cost around 20 Euros. The signal detectors with a directional antenna are a bit larger in size and also a bit more expensive (Figure 4). None of our interviewees used them, and it seems not many people have enough of interest

in finding unknown WLAN hotspots to buy and carry a separate device with them.



Figure 3. A key chain WLAN Seeker by Mobile Edge



Figure 4. A directional Hawking WiFi Locator

2.6 Other findings

Once the user has found a hotspot, s/he needs to make the decision to use that connection or not. As we mentioned earlier, the climate of the public hotspot place is an important decision criteria. The price of the connection and the needed effort to log in are also important. If the network requires login, and you do not know the needed passwords, you will probably try to find another hotspot where getting connected would be easier. The security of a public network was of less interest for the people we interviewed, but many assumed falsely that once you have logged in, your traffic is secured. In the future, trusting the WiFi provider will probably be a more important criterion.

It was an interesting finding both in the U.S. and in Finland that locating network hotspots seems to be so exciting for people that they do it for fun. Especially at home, people want to monitor if some other WLAN reaches their home. People seem to go and check how far does their own home WLAN reach, and what other networks are available along the home street. Checking the names of available networks is especially interesting, since home networks are often named in an amusing way.

3. WHAT IS NEEDED

Before going into details, the first question is whether we will need a hotspot locator in the first place. One may argue that hotspot locators will become obsolete as hotspots will cover the whole neighborhood: if WiFi hotspots are everywhere, you do not have to search for one. We are a bit skeptical with this scenario, however. First, short-range networks will not be everywhere. They will cover city centers, but hardly all suburban areas, not to mention the countryside. Second, WiFi network existence does not mean it is an open network that anyone can freely access. There will be hotspots where you need to login or even pay for, but you might want to do that to get less crowded or more secure connection. Users should be able to search for these types of hotspots, or just the open ones. Third, when you are looking for a place where you feel most comfortable in, a hotspot locator with access to user comments and ratings will be a great tool. This all means that a tool for locating network hotspots is needed in the future as well.

Based on the study findings described in the previous section, we outline some requirements that would fulfill end user needs for locating network hotspots. We do not describe technical details, but rather list the user requirements for an optimal system.

3.1 Locating distant networks

People often want to know about a network hotspot even if its signal is not currently available. This is the case when the user is searching for a hotspot, but either no networks are reaching the current position or the user wants to choose a place where s/he feels most comfortable or trusts the most, for example. The current signal detector tools work only within a relatively short range, and a thick brick wall may block the signal of even a nearby network. Today, only a Web site would be able to give information of distant hotspots, but optimally, the information should be location-sensitive and available even offline.

This means that a positioning tool and a database containing hotspot locations is needed. When the user requests to see the networks of the current location, the system should show the nearest networks e.g. on a map.

3.2 Notification of a new hotspot

Because WiFi network hotspots come and go, the hotspots database is probably not always up to date. That is why a real-time signal detector would be a useful tool in addition to the map-based hotspot locator. If the user is actively searching for a hotspot, s/he should be able to set the signal detector to give audio, visual, or haptic feedback when a signal is found.

The signal detector could update the client based hotspots database. The detector could be active even if the device is in a pocket or a bag, if the battery power and the user allow the constant detection. Every now and then, the client could send the updates to the central hotspots database.

3.3 Direction to a stronger signal

Once you are close to a hotspot but the signal is still weak, you would appreciate the information about the exact location of the source of the signal, because it helps you to pick a seat where the signal is of a good quality. If you were walking on the street, the direction together with the network name helps you to find out which of the nearby companies provides this network.

An interesting use case for this feature is finding the needed physical place, not the network itself, when close by. If you are searching for a specific place, whether a company or a private home with WLAN, and think you are close by, you could check whether the WLAN is visible at the current location. If the network has an informative name, e.g. the name of the company or the surname of the homeowner, you can find the exact location of the physical place by following the direction of the signal source.

There are two options for communicating the signal source: showing just the direction to the stronger signal, or showing a detailed map with the exact location of the signal source. The latter is technically much more demanding to implement. In order to work well, the map should be really detailed (i.e. room shape and even furniture), and the position information about the signal source should be very accurate. Even if this worked, we do not know whether the users would still prefer just an arrow to a stronger signal, because interpreting and interacting with a map may be too challenging while on the move. A combination of a map and an arrow might be an option for cases in which the map helps you to find the shortest path to the destination.

3.4 Receiving information about hotspots

Plain information about the signal existence in a certain location is rarely enough to help the user decide whether to use that connection. Some standard information is available from the network access point itself (name, security), but a good hotspot locator would provide also non-technical information about the hotspot. The best option would be to have such a network standard that an access point could share all the needed information about the network before connection establishment. Otherwise, the hotspot locator system should provide and maintain this information.

Network name

The network name (SSID, Service Set Identifier) alone can provide enough of information to make a decision to connect. If it describes the owner of the network and the user trusts the owner (e.g. Starbucks), it is a simple case. This is not always the case, however. For security and privacy reasons, some WLANs do not publish their name. In this case, the signal indicator can only see that there is a network signal at the current location but has no means to connect it, if the user does not know the SSID. Many networks today have non-informative names such as WLAN, Wireless, or ArqS51. If the user wants to connect one of these networks, more information about the hotspot is needed.

Need for login

An easy connection is not possible if the network requires login and you do not have the passwords yet. Unfortunately, the current systems do not communicate the login requirement in an intuitive way. There may be a lock sign attached to a closed network, but it does not always mean that you need to login manually. This is because if you have visited the network before, the network may recognize your device and let you in, or your device logs you in automatically.

Connection security

Security does not go hand in hand with the need for login, although one could imagine so [1]. This fact should be made clearer by providing the connection security information separately from the login information.

Connection cost

Price of the connection is an important criterion for decision-making, yet it is not available via the standard information that a WLAN access point shares about itself. If the network does not require login, it normally does not require payment either. User identification and billing techniques may, however, make it possible some day to charge for connection usage even without a separate login. So, the pricing information should be separately available in any case.

Human commentary

If the hotspot locator tool wants to help users to locate a public hotspot of a specific type, the simplest way is to allow the hotspot provider to publish a free format description of the place. It will act as an advertisement and is not highly reliable from the end user's point of view. A piece of more reliable information would be to see how other people like the hotspot. A simple rating system available for the hotspot visitors would be easy to use and useful, but not all hotspot providers want this to be a standard feature of the access point. Rating might need to be a feature of the locator system itself. Once a rating system is in place, it would be very interesting to let people share also free form comments about the place.

Note that all this information should be available before connecting to the network, because it should help the user to make the decision whether to connect or not. On the other hand, connection establishment might not be the goal of the user at all. People seemed to like checking the invisible networks around, so the hotspot locator tool may also be used just for fun, not necessarily for connecting to Internet.

3.5 Sharing information about hotspots

As mentioned above, ratings and comments from hotspot visitors would be an interesting service. Once you are at the hotspot, or after visiting one, you might want to rate the hotspot and even write some comments about it. Because this is an action that you might want to do afterwards, it should optimally be a feature of the hotspot locator system, not a service provided by the hotspot itself. Also, the hotspot owner might not be willing to provide such a system as part of the hotspot, or at least the owner wants to be able to remove the negative comments from the database.

We mentioned the need for sharing information about new or disappeared hotspots in subsection 3.2. With the permission from the user, the system could send the new piece of information to the central hotspots database so that all hotspot locator users would benefit from it. Because many WiFi networks are fast and free of charge (or charged by connection time and not by the amount of transferred data), the WiFi connection provides an excellent channel for the hotspot locator system to exchange information in an economic way between the client and the server.

4. WHY TO COMBINE MOBILE GUIDES AND HOTSPOT LOCATORS

After examining the requirements for a hotspot locator, we argue that hotspot locators should be combined with mobile guides. A good hotspot locator would need the functionality of a mobile guide, and mobile guides would greatly benefit from an embedded hotspot locator tool.

4.1 Mobile guide to help a hotspot locator

The main reason for making a hotspot locator part of the mobile guide is that mobile guides already have the location-based information needed for a good hotspot locator. Purchasing and carrying a separate accessory just for finding a place to connect seems not to be tempting for users, at least none of our interviewees carried one. One reason for the low motivation might be that the dedicated signal indicator devices lack the ability to guide users to distant hotspots; they show the signal existence only when very close to the hotspot. A mobile guide with access to a hotspot database and the means to guide the user to the right location would serve the user better.

Many of the user requirements for a hotspot locator are similar to ones for mobile guides. Implementing guidance systems separately for a physical café and for its WLAN hotspot would be waste of effort and difficult for WLAN users to understand. The end user experience would improve if the user did not need to manage and learn several separate systems, each of which has a different type of a user interface and a set of features.

One of the biggest challenges for a network hotspot locator is building the hotspot database and maintaining it. Databases must be updated frequently, since new hotspots emerge regularly and the existing ones move from one place to another or are removed.

Mobile guides could also be used for creating the hotspot database and keeping it up-to-date. An interactive hotspot locator system would allow the users to correct the existing information while moving around in the city, maybe even automatically in the background.

4.2 Hotspot locator to help a mobile guide

Typical mobile guides contain so much information (maps, tourist information etc.) that all of it cannot be stored in the client application itself, but a server must be used. In order to access the data on the server, a network connection is needed. WiFi hotspots provide an easy and efficient way to connect to the network, thus locating them would greatly benefit a mobile guide system.

Another major benefit is using the WiFi hotspots for positioning. Traditionally, mobile guides use GPS (Global Positioning System) for locating the user and the points of interest. As the coverage of WiFi hotspots is getting wider and the covered cells begin to overlap, a new way of positioning, WPS (WiFi Positioning System) becomes possible.

WPS works analogous to GPS, but instead of satellites, it uses WLAN hotspots as "landmarks" to calculate the current position of any WiFi-enabled device [5]. In order for this to work, a hotspot database must be in place. If mobile guides are to be used to locate WiFi hotspots, they will contain a hotspot database, which could be used for positioning as well.

WPS is especially suitable for urban areas, where high buildings disturb the GPS signals, and for indoors, where thick walls and ceilings might prevent the usage of GPS completely. Both of these areas are important usage environments for many mobile guides. Another positive and cost-saving aspect is that WPS does not require any specialized hardware because all location-calculations are made with software.

Mobile guides are often advertised as tools for people who do not know the neighborhood, like for tourists. Hotspot locators, in turn, are used even at home and on the home street. Daily use cases are probably more frequent for hotspot locators than for plain mobile guides.

5. CONCLUSION

In this paper, we presented a set of current ways to locate WiFi hotspots, and analysed their pros and cons. We found that it is not enough to inform the user about the current existence of a WiFi signal, but users should be able to locate a hotspot miles away. A mobile guide is needed to get there.

Although the density of hotspots will increase in the future, we are not too optimistic of totally getting rid of hotspot locators. According to our findings, people want to find a hotspot that offers a free connection and a nice atmosphere. In the future, we believe they will also want to find a place that they think provides a secure and uncongested connection. These types of hotspots will not be available everywhere, so we believe a smart hotspot locator will be a useful tool also in the jungle of hotspots of the future.

In our analysis, getting information about WiFi hotspots turned out to be very similar to getting information about the physical surroundings and services. A map and positioning system is needed for both. The map can be provided by the current mobile

guides. Also a system where visitors can leave comments and a rating for the place is common for both a hotspot locator and a mobile guide.

A mobile guide would benefit from keeping track of WiFi hotspots by using the hotspots database and signal information for positioning in places where GPS does not work. Once a WiFi hotspot is found, the mobile guide can utilize the fast and inexpensive connection for exchanging information with the mobile guide server.

We hope that our paper provides inspiration for researchers of mobile guides and leads to fruitful experiments of locating the invisible in our neighborhood.

6. FUTURE RESEARCH

We have been unable to find a mobile guide system that would support locating wireless networks. Once a prototype system would be in place, there are many fascinating topics to be investigated, such as:

1. Usefulness of a hotspot locator in a mobile guide
2. Informing the user about hotspots
3. What criteria people use most in choosing a hotspot?
4. What makes a hotspot trustworthy?
5. What kind of information people share in a hotspot commentary system?
6. Privacy and security issues with hotspot locators
7. Methods to keep the hotspots database up to date
8. Using hotspot information for positioning

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