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Sameer Verma
San Francisco State University

Paul Beckman
San Francisco State University

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A FRAMEWORK FOR COMPARING WIRELESS INTERNET SERVICE PROVIDERS WITH NEIGHBORHOOD AREA NETWORKS

Sameer Verma and Paul Beckman
Information System and Business Analysis
College of Business
San Francisco State University
sverma@sfsu.edu pbeckman@sfsu.edu

Abstract

Local wireless networking using the unlicensed 802.11 range of frequencies has reached levels of technology, economics, and simplicity, such that residential home users can and do construct their own. Their increasing popularity has produced two fundamentally different models by which local residential areas can be connected with high-speed wireless networks. One model is a wireless extension of the for-profit concept of an ISP (internet service provider); the other is a not-for-profit organization called a NAN (neighborhood area network). While the two models are completely different in their profit motives, they can become competitors for the same end-using customer.

This research paper uses a framework of dimensions along which this very new area of wireless bandwidth provision can be investigated. The framework consists of four dimensions (technological, financial, legal, and social) with which to compare each of the two models. The goal of the project is to lay a foundation by which future research can predict the efficacy of either model or extract characteristics along any of the four dimensions that would suggest successful hybrid business models.

Introduction

The area of wireless networks has promised a physical disconnection from the office and specifically from one's desk. This technology has allowed mobile users to operate their laptops or handheld devices while traveling or working away from the office. However, most wireless services come at a cost. Service providers have to pay a licensing fee to the Federal Communications Commission (FCC) and this cost is passed on to the consumer as a service charge. Recently, the FCC decided to release some bands in the frequency spectrum as unlicensed (FCC, 2001). These bands are now available for public use. This availability gave rise to the idea of wireless networks that could be run internally by companies without incurring monthly service charges. Such networks would merely be extensions of their existing wired networks. This technology is now standardized under the IEEE 802.11 banner (IEEE, 1999).

A somewhat recent incarnation of the general IEEE 802.11 standard is the IEEE 802.11b category that provides theoretical speeds of 11 Mbps (which comes close to 10BaseT), runs in the unlicensed 2.4 GHz spectrum, and provides service in an approximate radius of 500 feet. This technology is commercially labeled "Wi-Fi". Small companies have taken to Wi-Fi technology to extend their existing networks beyond Ethernet LANs. Wireless users can now take their laptops to meeting rooms without having to worry about carrying Ethernet cable. A spin-off of corporate Wi-Fi is available for use at home. It has become very popular and is available at neighborhood computer stores as combined packages for about \$200. It allows home users to extend their existing high-speed networks based on DSL or cable modems to SoHo (small office/home office) wireless LANs.

This unexpected popularity of Wi-Fi has created a business model for wireless services at very little or no charge. Locations such as coffee shops, bookstores and public parks are now serviced by wireless ISPs, called WISPs (ABI, 2001) that provide Internet

connectivity via Wi-Fi. An alternative to a WISP (which is a commercial entity) is a cooperative neighborhood area network, or NAN, supported by the residents of the neighborhood (Pozar, 2001; Wilson, 2001). We use these statements as brief definitions and will elaborate on these concepts in the rest of this paper. The research questions we propose to address for this project are:

- 1) Along which dimensions should the two models be compared?
- 2) Along those dimensions, what are the significant differences between the two models?
- 3) How do these differences impact each model?
- 4) Are there other new approaches that can combine the strengths of the two models, while avoiding their weaknesses?

This paper defines and discusses WISPs and NANs. It compares these service concepts along technological, financial, legal, and social dimensions. This paper uses a framework based on these four dimensions and uses it to examine the strengths and weaknesses of the two models. We hope to learn more about these models and prioritize the importance of the dimensions of the framework.

Technological Dimension

Technology aspects of WISPs and NANs vary to some extent. The variation in technology stems from the investment made in setting up the infrastructure. As a commercial organization, a WISP generally invests in high-powered APs (access points to the wireless network with 100mW radios) running in an infrastructure mode where all the clients communicate via the common AP. NANs are more likely to use off-the-shelf APs with lower power output (35mW radios) since these are cheaper and may serve the cooperatives purposes just as well. In some cases NANs may also rely on a homegrown solution called an ad-hoc base station, which does not require as much investment. This solution does not scale very well, but that is not a primary concern in NANs.

WISPs provide some form of authentication, authorization and accounting (AAA) (IETF, 2002a). In most cases, the authentication is supported by industry strength encrypted services (IETF, 2002b). The authorization may be via a simple login or a smart card (Chan, 1997). The accounting for login, time spent online, and location identification can be logged or integrated into existing accounting systems using protocols such as RADIUS (IETF, 2002a). NANs do not provide such extensive services, since the need is not present. At most, the user may have to agree to an acceptable use policy before being allowed to use the service. The absence of such AAA support services reduces the barrier to entry for setting up a NAN or adding another node to an existing one.

Since WISPs charge for their service, they rely on high-speed lines for connectivity to the Internet, called backhaul. They may also rely on Quality of Service (QoS) approaches to provide guaranteed bandwidth. NANs, on the other hand, use residential broadband or shared access on an existing commercial service that may run to some member's SoHo LAN. The NAN's service is therefore only as good as the DSL or cable connection of the neighbor "hosting" the NAN.

WISPs rely on centralized AAA services. This allows WISPs to extend service to users beyond their locality or city. The feature of providing single sign-on across various locations is called roaming. Due to their extensive infrastructure, some WISPs are able to provide worldwide roaming. Users can connect to the WISP network from a variety of hotspots worldwide. NANs, however, cannot provide such roaming beyond their neighborhood, since they do not have the AAA infrastructure to support it.

Financial Dimension

The providers of service on a Wi-Fi network are not allowed to resell the unlicensed frequency spectrum (FCC, 2001). However, they can resell the *service* provided over this unlicensed spectrum. An early attempt at a business model in the wireless arena was to extend the existing ISP models to wireless LANs, which gave rise to the idea of WISPs (ABI, 2001). Most WISPs simply resell existing bandwidth by attaching a wireless AP to existing LANs and leave the management and maintenance aspects to third party companies (Brake, 2001). Some other WISPs have invested in vertically integrated companies, which provide the wireless APs, authentication services, network services, and the backhaul bandwidth used to feed the wireless LANs (ABI, 2001).

Within the realm of WISPs, there are several models for charging the customer. In one model, customers are charged for time they are online. In another model, users are charged a flat-fee for using the network over the period of a long-term contract. In yet another model a relationship is created with a corporation to provide all of the corporate users access at favorite off-site

locations (also known as *hotspots*) such as coffee shops, bookstores, airport lounges and hotel lobbies. These models are all extensions of existing ISP business models.

A very recent modification to the WISP business model proposes a consolidation service for authentication, authorization and accounting (AAA) (Joltage, 2002; Sifry, 2002a; Sifry, 2002b; Sputnik, 2002), but the owners of the wireless AP pay for the backhaul bandwidth and take responsibility for the legalities of running the AP. In return, they get benefits such as free roaming on all APs supported by the WISP. The WISP only provides a central authentication clearinghouse. This is similar to a “wireless franchising” scheme since the WISP does not invest in any APs, and the consumers who are willing to host the AP and pay for backhaul bandwidth get roaming benefits.

The existence of several variations to the WISP model suggests that this market is still in its infancy and is experimenting with a variety of approaches to making wireless networking profitable.

The financial aspects of NANs do not focus on the LAN infrastructure. Typically, if a neighborhood were set up a NAN, it would consist of a small collection of wireless APs at popular hotspots such as mom-and-pop cafes, bookstores, parks, small businesses and other community-oriented, not-for-profit locations such as libraries, and schools. In these cases the owner of the AP pays for the backhaul bandwidth and is supported by the rest of the community via donations or privileges. This model revolves more along the lines of a cooperative (Brake, 2001; Wilson, 2001). More specifically, the NAN co-op consists of a two-tier model with one category that provides the access, and the other category that uses this network. Users are not billed for either their bandwidth usage or for the time they stay online. There are simply billed for a service that is provided to them on an implicit agreement. Often, this fee is in the form of a donation or in exchange of privileges such as hours worked for the NAN, office space, or even food. They may also donate money to the co-op as a collective and expect to get collective services in return. There are no ISPs that the co-op works with directly; there is no monthly billing; and the level of accountability is shared throughout community.

Legal Dimension

Licensing

In the United States, the FCC regulates the use of radio frequencies (FCC, 2001). WISPs and NANs that use the 2.4 GHz range of frequencies are therefore bound by FCC rules, and must adhere to their restrictions on power output. The general attempt of part 15 of the FCC stipulations is to distribute power over frequency ranges, time, and/or geography, in order to limit interference from the transmitting device to other devices already using that particular frequency or frequency range.

The section of the part 15 regulations that is generally the most restrictive on the frequency ranges used by WISPs and NANs requires that omnidirectional antenna (antennas that emit electromagnetic radiation in all horizontal directions) using the 2.4 GHz frequency range are limited in power to 1 watt. Directional antennas are allowed a slightly higher power limit.

The main advantage of using the 2.4 GHz ranges of frequencies is that, although the FCC regulates them, operators of such equipment do not require FCC licenses (Werbach, 2001). This means that users, if their equipment meets FCC regulations, may set up wireless networks without having to meet any additional legal requirements.

With respect to WISPs and NANs, both types of organizations are free from governmental oversight in the area of licensing. However, both must follow FCC regulations in the technical characteristics of their equipment. For example, devices emitting electromagnetic radiation cannot interfere with other devices and must accept interference from other such devices.

Acceptable Use Policies

Another issue that significantly impacts the operations of WISPs versus NANs is that of acceptable use. Acceptable use policies (AUPs) (Roberts, 1999; Sifry, 2002a) are issued by ISPs who provide online bandwidth to their customers. Among other things (criminal use of bandwidth, hacking, pornography, email spam, etc.) such policies typically prohibit the subleasing of bandwidth to other users for payment without a specific written contract with the ISP.

Since WISPs are commercial organizations, they take over specific legal responsibilities from the ISP via written contracts with the ISP. In those cases, the written contract specifies the liability and accountability of each party with respect to acceptable use

of the bandwidth. Also, violators of the acceptable use policy do not put other end-users at risk of losing their wireless network access; the only people in peril are the violators themselves.

NANs, however, do not sign written contracts with ISPs for the express purpose of selling bandwidth to others. In almost all cases, most acceptable use policies stipulate that violations of the policy are the responsibility of the direct purchaser of bandwidth from the ISP, regardless of whether or not that direct purchaser knew of the violation of the policy. While this puts the NAN at possibly significant legal risk, it also provides an incentive for users of the NAN to police themselves. If they do not, they put in jeopardy the wireless access of the entire cooperative.

Social Dimension

Community Building

WISPs, as commercial organizations, are not fundamentally concerned with promoting social communities. While such communities may arise, they are an incidental outcome of the business model.

Also, due to the profit-making nature of WISPs, they have a significant motive for implementing and maintaining strict security systems. Since the WISP makes money from its subscribers, it must have a mechanism for keeping out non-paying wireless “free-riders”. One modification of this type of wireless organization is the “wireless franchising” model mentioned above. In this business model, an end-user can purchase the hardware and software required to set up an 802.11b wireless network. Part of the software that the user acquires allows that user to “sign up” other users, presumably within a physically small radius of their network (constrained by the geographical limits on their own wireless signal coverage). The commercial organization that sells the hardware and software then maintains a clearinghouse of all legitimate wireless users, and will allow all of those users to connect wirelessly to any of the networks set up by any of the organizations other end-user “franchisers” (Sifry, 2002b). In this way, the roaming wireless user can sign up with the owner of the AP that is closest to their most frequent use point, but still be able to connect any place in the world where another end-user has set up an AP. There is also an incentive to become “the first Brand X AP on your block”. Since the central clearinghouse of Brand X wireless users is accessed (for secure sign-on purposes) any time a roaming user connects outside of their “original AP”, the end-user that “recruited” them can be paid or otherwise subsidized for that roamers wireless usage. All “recruits” are charged some monthly fee (similar to the amount charged by wired ISPs); Brand X AP owners are given unlimited free bandwidth through either their own AP or when roaming.

NANs, conversely, are often set up specifically for the purpose of building additional social networks within the local physical community at large. Since they do not have the profit motive of a WISP, they have a much smaller incentive to keep out those who are not paying customers. In fact, the two-tier NAN model described above can incorporate that idea. At the top tier is the person or persons who implemented the wireless network, or are somehow in positions of significant support of the NAN. These people are allowed essentially unlimited free bandwidth, in return for their efforts at keeping the organization running. At the second tier are those people who would like local high-speed wireless access, but would rather pay a monthly fee or donate other resources, than invest substantial amounts of time and/or resources in running the organization. They receive a bandwidth slice that is limited compared to that given to tier-1 users. It is even possible to implement a third tier for those people with characteristics similar to “wireless tourists”. These users are infrequent or one-time users of the wireless network, and are not required to pay anything for their bandwidth. However, they are also quite limited in their bandwidth usage and functionality (web-surfing and email only, no downloading, etc.), as they do not contribute to the NAN in any meaningful way. With this tiered system of customers, services, and payments, the NAN can truly act as a cooperative (Pozar, 2001), with higher rewards to those who are willing to expend resources to keep the cooperative running, lesser rewards to those who are willing to contribute less, and basic services to the general public.

Location

A final issue that differentiates WISP and NAN user base is in the selection of the physical location of the local AP. By their nature as profit-making organizations, WISPs need to go where the customers are. They need to locate their APs in commercial places, such as coffeehouses and other public gathering places. Larger WISPs are even likely to sign agreements with franchised gathering places like Starbucks cafes (Weber, 2002), so that they can take advantage of the multiple locations that such organizations possess. NANs, on the other hand, are set up to serve the needs of the local residential community, and therefore need to physically place their APs in the residential neighborhood that they serve. This could be a local gathering place like a

commercial coffeehouse, but is more likely to be in the center of a residential area physically far from any type of commercial organization. The site location needs in this case are driven more by the proximity to the homes of the users than to their gathering places (Pozar, 2001).

An assessment of the current wireless coverage reveals that WISPs tend to cover commercial hotspots, while NANs service residential neighborhoods. The “franchising” model discussed earlier appears to be the only one that could be applied to commercial hotspots and residential communities.

Table 1. WISP and NAN Comparison Points

Dimensions	WISP	NAN
Technological	Better systems integration and technical support Centralized AAA services	Reliance on local talent pool Localized services
Financial	Profit incentive; possibly franchising Strong metering and billing infrastructure	Non-profit, community oriented
Legal	Explicit Acceptable Use Policies for bandwidth use.	Informal AUP. Bandwidth sharing is questionable in some cases (from the ISP that provides backhaul).
Social	Commercial hotspots such as airports, cafes. Social ties are incidental.	Primary intent is to reinforce social ties. Hotspots are around community icons such as libraries, parks, and schools.

Conclusion

At this time, one of the research goals of this project is to establish clear differences between existing and emerging business models in the wireless market. Contrary to popular belief, NANs also have a business model, since someone has to pay for the backhaul. Establishing these differences will assist in developing a framework for examining pure WISP business models, NAN sustenance approaches, and the role of hybrid, crossover approaches such as the “franchise” model. The hybrid model minimizes infrastructure costs and maximizes the diffusion of hotspots in a community. It is also evident that critical mass of users in a geographical location will play an important role in the adoption of wireless services. While WISPs approach critical mass by co-locating services at commercial hotspots, NANs spawn around communities that promise residential critical mass. These and other approaches promise to create interesting business models in the area of wireless networks.

We intend to examine other existing models to extract important dimensions from them. We will then gather feedback from knowledgeable experts in this field so that we can prioritize the importance of these dimensions. This input will hopefully give us better direction in examining the issues that are of importance to users and service providers.

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