

Wi-Fi's Promise and Broadband Divides: Reconfiguring Public Internet Access in Austin, Texas

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ABSTRACT

Although the Unlicensed National Information Infrastructure (UNII) has been identified as a strategic component of policies aiming at achieving universal broadband by 2007, few studies have explored how the rollout of public wireless broadband networks are delivering the promise of high-speed services for all. Through a multi-method case study approach, this paper delves into some of these key issues by examining the process of configuration of public Wi-Fi networks in Austin, Texas. Austin is one of the most “unwired” cities in the U.S., and increasingly known as a world-class industrial center in wireless. Our assessment of Austin’s public Wi-Fi landscape reveals that the opportunities opened by the unlicensed spectrum are materializing in two different directions. On the one hand, we found evidence of proliferation of new spaces for high-speed connectivity in the city, leading to more commercial activities and innovations benefiting the local economy. On the other hand, public Wi-Fi networks are growing in an uneven fashion, further enhancing connectivity in commercial areas and more affluent areas while leaving behind the underserved population living in less affluent neighborhoods of the city. The presence of a critical mass of early adopters, strong network collaboration between private, public and non-profit organizations, and the spillover effects of Austin tech economy are identified as main factors behind the growth of public WiFi in the city. The legacy of anti-munitelecom laws, the predominance of the commercial, venue-sponsored model, and the lack of clear solutions to extend connectivity in low-income areas are preventing the use of public Wi-Fi for enhancing access in poorer areas of the city.

INTRODUCTION

The prospects of high-speed connectivity have been with us for more than a decade but currently the service reaches only a third of the U.S. population. The Bush administration made a call for achieving universal broadband by 2007. As a part of spectrum reform, the FCC has expanded unlicensed spectrum with a policy goal to foster innovative applications delivering the fruits of high-speed services to all. Wireless fidelity (Wi-Fi) is increasingly serving as the underpinning technology for public Internet access, public safety, and other innovative applications that utilize unlicensed spectrum. However, the potential of the technology is intimately bound to the design, implementation, and uses that communities make of these network systems in localities around the country. In order to assess the ways in which local actors are taken advantage of the opportunity to extend broadband access through the unlicensed spectrum, this paper takes a close look at the configuration process of public Wi-Fi networks in an American city. We further discuss the implications of this configuration for the social and economic geography of urban areas.

Austin, Texas, serves as our case study. In the last two years, Austin has become the site of leading wireless companies in the nation. Parallel to this growth, public wireless Internet access has skyrocketed, placing the city among the most *unwired* in the country. Drawing on interviews with stakeholders (industry, nonprofits, local government, and research and educational institutions), a survey of managers of public Wi-Fi venues, and socio-geographic information of hotspots and users of these sites, this study examines the process of adoption and configuration of public Wi-Fi networks in Austin. Our purpose is to inform current debates on spectrum management calling attention to the possibilities opened for local level interventions, and their impacts in larger issues of access to high-speed services.

BACKGROUND OF THE STUDY

Since 2000, the Federal Communications Commission has reported steady advances of broadband deployment in the country.¹ However, the agency recognizes that the service is not yet ubiquitous, the relative costs of deployment remain high, and the adoption is advancing slowly.² The problem is particularly acute in historically underserved areas. Empirical studies have documented the gap in the availability of high-speed services between rural regions and metropolitan zones (Oden, Strover, Inagaki, Arosemena, & Lucas, 2002) as well as the slow progress of competition in those environments (Strover, 2003; Turner, 2005). Beyond the issue of availability lay the question of adoption and use. National surveys indicate that only a third of the adult American population uses high-speed services, and it only reaches a tenth of those living in rural areas (Horrigan, 2004; Horrigan 2005).

The Bush administration has made a call to achieve universal broadband access by 2007 (The White House, 2004). Policy directives to attain this goal include tax breaks to broadband suppliers and adopters, removing regulatory barriers for firms, and promoting new technologies

¹ Reports on the Availability of High-Speed and Advanced Telecommunications Services. Available at: <http://www.fcc.gov/broadband/706.html> Accessed April 10, 2005.

² FCC Strategic Goals: Broadband. Available at: <http://www.fcc.gov/broadband/Welcome.html> Accessed March 19, 2005.

to make broadband affordable and accessible to everyone. Wireless technologies that operate in the unlicensed spectrum—from Wi-Fi to WiMax—are identified as crucial components of this new wave of American innovation that will grant consumers “broadband access in restaurants, airports, and other public places” and in remote and rural areas (The White House, 2004, p. 12).

Praising these plans for advancing broadband services, groups such as the Consumer Federation of America and the New America Foundation warn that the current expansion of the unlicensed spectrum is not a sufficient condition to ensure affordable and extensive wireless broadband networks for rural and low-income areas. Portions of the spectrum allocated for unlicensed use (in the 5 GHz range) impose limitations to network architecture, its operation, and business models for last mile connectivity. According to these groups, such conditions and the lack of competition in local broadband markets are the main issues deterring the deployment of high-speed services using the new technology.³

The Wi-Fi Promise: Reconfiguring Access

While these issues are being debated, the development of wireless broadband infrastructure proceeds rapidly in the hands of phone companies, cable, ISPs, cooperatives, nonprofits, municipalities, and user groups. Most of the research on Wi-Fi networks has focused on the study of access models taking two possible views of wireless deployment: (1) a top-down, planned, centralized strategy carried out by traditional telecom operators, cable companies, and specialized wireless service companies; and (2) the implementation of a bottom-up, more organic, and decentralized design attributed to startup companies, some municipalities, and community-based organizations (Lehr & McKnight, 2003; Rao & Parikh, 2003; Bar & Galperin, 2004). However, results of empirical studies point to the existence of more grey areas than the black-and-white map suggested by the top-down vs. bottom up approaches. There is evidence that commercial wireless ISPs are ready to allow their clients (i.e., coffee houses, apartment buildings, and small communities) to share broadband when perceiving competitive pressures raised by the action of community wireless services (Rao & Parikh, 2003). Institutional arrangements, collaboration, and competition have significant impacts on the design, adoption, and applications that shape access to new technologies. Such decisions are informed not only by mere economic rationale but also by actors’ visions and understandings of the market and the possibilities created by technological innovations.

The excitement created by the grassroots culture of emerging wireless community networks has fueled hopes about the emergence of innovative applications and services for all. Few studies have explored the issue of applications of wireless broadband (Slam, 2004), its social impacts and the realization of the broadband promise for the underserved (Scott, Chesley, Lakshmipathy, Ramachandran, & Barranca, 2005). Through a comparative case study of three of the first cooperative Wi-Fi projects, Sandvig (2004) delves into some of these issues, concluding that the primary goal of the studied groups was to strengthen social ties and technical expertise of group members while ignoring broader social needs. The author concludes that different from the community network movement of yesteryears, Wi-Fi groups tend not to pursue larger societal

³ For a thorough explanation of the rationale behind petition of access to largest parts of the spectrum endorsed by community wireless groups, see Snider (2004); Media Access Project & the New America Foundation (2003). For a discussion of implications of current spectrum policy on innovation and access, see Cooper (2004).

goals of fostering strong democracy, social capital, and economic opportunities. Though provoking, Sandvig's observations remind us that the question of adoption cannot be reduced to mere connectivity. As Dutton, Gillett, McKnight, and Peltu (2004) have argued, the social impact of the innovation is bound to the social, cultural, and economic influences at play in the process of its design, adoption, and use. Therefore, emerging Wi-Fi access models need to be evaluated in their societal dimension considering the type of uses enabled by the providers.

Given the light-handed nature of unlicensed spectrum policy, many important decisions on infrastructure development have been left in the hands of stakeholders in local communities across the nation. We contend that some of the access models being adopted may allow communities to use broadband as a resource to overcome existing social hurdles, while other models can further reinforce social and economic barriers delaying the adoption of high-speed services for all. This paper is concerned with the process of configuring access to broadband services at the local level as enabled by public Wi-Fi. Inquiring local stakeholders about targeted users and intended applications is crucial in understanding the underlying the design and potential capabilities offered by Wi-Fi for universal broadband.

Open questions on the unlicensed spectrum

Although the Bush administration has identified Wi-Fi connectivity at restaurants, airports and other public spaces as one of the strategies to reach universal broadband service by the year 2007, there has been little discussion about the implications of public access through the Unlicensed National Information Infrastructure (UNII) for the process of universalization of high-speed services. Historically, telecommunication regulation has regarded public access as a strategic component of universal service policies, which seek to advance availability, accessibility and affordability of telecommunications services in high-cost, rural and remote areas (Muller, 1997). The same spirit informed early discussions about the National Information Infrastructure (NII) in the 1990s, which proposed to balance commercial market needs with public interest goals by fostering online access at public institutions (Keller, 1995). In this context, the Telecommunications Act of 1996 redefined universal service mandating the availability of advanced services in schools, libraries, and rural health centers across the nation. Attending to this policy directive, the federal, state, and local governments have invested resources for nearly a decade to ensure universal Internet access at the institutional level.

Over the same period, grassroots initiatives mobilized significant efforts and resources to enable citizens' access through "freenets," community networks, online groups, and similar venues targeting mainly underserved communities. All these interventions crafted a variety of public access models for advancing the adoption of the Internet nationwide. The expansion of wireless broadband in public spaces can contribute to raise awareness on high-speed services, provide means of connectivity for those who lack them at home, and enhance online interactions among current users. These promises have yet to be delivered.

In the realm of spectrum policy reform, the expansion of the unlicensed spectrum and its use in public spaces has also become a strong force advancing the case for the formalization of the notion of a *spectrum commons*. In the last decade spectrum commons has emerged as an

alternative regime to licensing and spectrum auctions allowing the dispersion of spectrum rights to larger segments of society beyond traditional licensees (Bauer, 2003).

Critics observe that problems of interference, conflicting uses and over-utilization of the spectrum are likely to lead us to the *tragedy of the commons* scenario. Addressing this concern, advocates of the commons stress that a common property system emerges from arrangements crafted by a set of individuals who share rights and responsibilities in the management and use of resources (Buck, 2002; Benkler, 2002). The *tragedy*, they contend, can be avoided through the application of a structured set of rules in both technological standards and institutional arrangements enabling the maximum number of multiple uses. Buck (2002) argues that this management regime should be based on a co-management system where users of the spectrum (from traditional incumbents to citizen groups) will form “local spectrum management groups” crafting local arrangements that meet their needs and satisfy their expectations. Issues such as technological standards, definition of violations, conflict resolution, or application of sanctions will still demand action from the federal authority. However, local spectrum management groups would become a primary source of authority and governance in the spectrum commons. Today, when hundreds of communities around the nation are making use of the unlicensed spectrum to gain access to high-speed services, the power of the locale has become crucial in materializing the opportunities offered by spectrum reform.

Our research informs the discussion of these topics by examining the directions, challenges, and institutional arrangements shaping the configuration of public Wi-Fi networks in an American city. By public Wi-Fi networks we mean the provisioning of broadband Internet services to the public through wireless fidelity platforms (IEEE 802.11x family) in spaces other than home or office, under non-discriminatory terms and conditions. This study is also one of the first in assessing how communities, local government, and businesses collaborate in promoting public wireless broadband, their reasons for doing it, and the implications of such decisions for larger issues of access.

We chose public Wi-Fi initiatives in Austin, Texas, as our case study. In Texas, broadband service has reached over 50% of computer users in urban areas, well above the national average (Straubhaar, Strover, Gustafson, Inagaki, & Fuentes-Bautista, 2005). By these accounts, Austin can be seen as the promised land of wireless innovations; a city where wireless is bridging the gaps between the availability of the high-speed service and its actual use. We examine the way in which wireless innovations are delivering the promise of access for all through the study of the configuration of emerging public Wi-Fi networks in Austin. Through this case study, we attempt to provide answers to the following questions:

1. What are the patterns characterizing the growth and configuration of public Wi-Fi infrastructure in Austin?
2. What are the factors shaping public Wi-Fi as perceived by the key organizations involved in the provision and support of these networks?
3. What are the implications of such decisions for larger issues of access?

METHODOLOGY

Case study methodology generates insights into social processes in real-life context through multifaceted, in-depth investigations (Yin, 1989; Orum, Feagin & Sjoberg, 1991). In order to characterize the landscape of public Wi-Fi provision in Austin, we employed a multi-method approach encompassing: 1) semi-structured interviews with stakeholders in conjunction with social network surveys; 2) a survey of public Wi-Fi venues; 3) a socio-geographic analysis of the distribution of public Wi-Fi venues in the city; and 4) a survey of Wi-Fi users at public sites.

First, review of the literature, including published lists of Wi-Fi access points, was used to produce a primary database for the locations and types of Wi-Fi access points, as well as to collect background information for our narrative. Wi-Fi facility data were collected and kept current between April and the end of September 2004. The dataset as of early July 2004 served as the sampling universe for our Wi-Fi facility survey sample. The full dataset was used for all other analyses.

Second, a survey of owners and managers of selected venues explores the reasons for adoption. A total of 62 Wi-Fi facilities were selected for this purpose from our primary database by using a method similar to quota sampling.⁴ We obtained 47 complete responses, and nine additional partial responses. The questionnaire was distributed in person in most cases and via fax in others. Respondents were asked about the reasons for adopting Wi-Fi service at their facilities, costs of provision, and their perceptions about Wi-Fi, Austin, and users.

Third, we explored the patterns of IT usage among users of public Wi-Fi. Data were gathered between July and September 2004 through a self-administered, online survey. The call to answer the questionnaire was made directly to users at 85 public Wi-Fi venues employing fliers, websites and email lists. An inherent limitation in studying Wi-Fi users through a convenience sample is our lack of knowledge of the Wi-Fi population in Austin, precluding a robust result and broader generalizability of the results. Nevertheless, the analysis presents initial insights into an emerging group of distinct Internet users in one of the most unwired cities of the country.

Finally, the structure of the network of organizations engaged in the deployment of public Internet connectivity in Austin, their visions, and the nature of their relational ties were explored through social network analysis and in-depth interviews. Social network analysis is a set of procedures that describe patterned relational ties through which groups or actors interact (Wasserman & Faust, 1994). Social network analysis considers two aspects of social interactions: the existence or absence of relational ties, and the nature and strength of the relationship associated to this tie (Granovetter, 1973).

Employing a snowball sampling technique we identify the universe of organizations involved in the deployment, provisioning or advocacy of public Wi-Fi in Austin (see Appendix). The snowball method can be particularly helpful to capture the elite network of organizations or actors of a given social network. However, nodes that are not well connected to a significant

⁴ Quota frames with varying weights were created based on the following three variables: type of facilities, type of providers, and the median household income of the zip code area in which Wi-Fi site is located. Target facilities were randomly selected within each quota frame according to sampling weights until the sample size reached 62.

number of other nodes in the network (“isolates”) tend to be disregarded (Hanneman, 2001). We began by asking representatives of Wi-Fi providers—as revealed by our primary access point database—to identify entities they consider central to the public Wi-Fi landscape in Austin, and to answer a social network survey. The questionnaire asked them to list organizations engaged in the support or deployment of public Wi-Fi in Austin. It also asked them to report the presence (1) or absence (0) of four types of relational ties between their particular organization and others in the list. These ties assessed *collaboration* in terms of: *a)* payment or reception of funds, *b)* technical cooperation, *c)* visions and strategic cooperation, and *d)* volunteer cooperation. The sum of the scores serves to construct a relational measure reflecting the proximity between organizations from 0 (no relationship) to 4 (all four types of relationships) (Diani, 2002). This method yielded a 14 x 14 asymmetric relational matrix of organizations engaged in the research, advocacy or provisioning of public Wi-Fi services in Austin.

We tested the patterns of association among organizations through two basic procedures: (1) Eigenvector⁵ centrality scores provide an assessment of the organization’s prominence in the network; and (2) cluster analysis⁶ was employed to observe grouping patterns among different organizations (Wasserman & Faust, 1994). Analyses were performed using the network analysis software UCINET 6.⁷ Semi-structured interviews further assessed the nature of organizational ties. Interviews with 18 representatives of 14 organizations engaged in the provisioning and advocacy of public Wi-Fi in Austin explore organizations’ visions of Wi-Fi technology, factors advancing or deterring the deployment of public Wi-Fi, the nature of their organizational ties, and reasons for collaboration. A particular set of questions was given to broadband and wireless service providers inquiring about characteristics of their services, the terms or conditions in which services are offered, perceptions about competition, and the general vision of the wireless broadband market in Austin.

RESULTS

AUSTIN’S PUBLIC WI-FI HISTORY AND ACTORS

Drawing on interviews with stakeholders and secondary data, this section reconstructs a brief history of public wireless connectivity in Austin tracing the trends that mark the transformation of Austin into one of the nation’s top unwired cities. Experiments in wireless Internet connectivity were already taking place in Austin’s public spaces a few years prior to Wi-Fi’s debut in the consumer market. One such experiment was carried out in 1997 by a few individuals

⁵ *Eigenvector centrality* provides an evaluation of organization’s prestige in the network. This measure is a function of the centrality of the institution to which others are connected, weighted by the strength of their relational ties. The index assesses actors’ prestige according to the importance of actors to which they are connected, taking into account the strength of the relationship between actors.

⁶ *Cluster analysis procedures* were employed to observe grouping patterns and strength of the links between organizations. Johnson’s Hierarchical Clustering enables the observation of emerging or fusing groups within a network of institutions. Setting the average distance or average link between pairs of actors as a criterion, the analysis finds in hierarchical order the collection of organizations that are structurally equivalent or similar to this value, and displays them in a dendrogram. The analysis used a non-parametric procedure testing for average similarities.

⁷ *Ucinet 6* is Available for download at <http://www.analytictech.com/downloaduc6.htm>

affiliated with the Austin Free-Net (AFN), Outernet, and the Austin Public Library, and the City of Austin government.⁸ AFN, in collaboration with local ISP—Outernet, the city government, and the Austin Public Library, succeeded in deploying a 3-Mbps wireless network connecting the Library's downtown location, city buildings, and the Outernet data center, enabling high-speed connection for public Internet access at the library. However, high prices of wireless broadband equipment in the late 1990s discouraged AFN and the Library from pursuing further experiments with the technology.

However, the first public Wi-Fi service in Austin was not an outcome of such public-private collaboration. Wayport, an Austin company pioneering *for-fee* wireless Internet service in public spaces, turned the Austin-Bergstrom International Airport into one of the first airports in the country with wireless Internet connectivity for travelers.⁹ Since 2000, Wayport and other commercial wireless Internet providers (most notably T-Mobile) have steadily built public fee-based Wi-Fi access points in Austin. This early public Wi-Fi expansion was concentrated in venues that were part of national hotel, coffee shop and restaurant chains and the airport. The configuration of public Wi-Fi in Austin in this period was still removed from the everyday experience of the majority of computer users in the city.

A new set of actors became visible in Austin's public Wi-Fi landscape in the 2000-2001 period. These were wireless enthusiasts and tinkerers who individually experimented with Wi-Fi (e.g., devising new antenna technologies to enhance signal coverage) in places such as coffee houses and restaurants they personally patronized. Their activities gradually become more collective. By the end of 2001, wireless enthusiasts in Austin had organized different Wi-Fi user groups. As these enthusiasts and groups set up more access points in their favorite venues, they engendered the vision of an *open* public wireless, *free-to-end-user* model, as an alternative to the then dominant *for-fee* model. Knowing that the practice of opening closed broadband networks could upset established broadband providers operating in the city, they made a public statement declaring they had no intentions of taking business away from these businesses:

“One of the key things the recent media coverage on wireless freenets has focused on is the concept that those of us putting up freenets are doing so to provide connections to the masses...the suggestion is that, in doing so, we're taking business from the broadband providers... but the thing is, most of the people who are using the networks are the same guys putting up the Access Points and antennas. And the reason we start these user groups is because the access points on our own homes don't quite span to the areas we might want to be able to connect from. Even the folks who use the wireless networks but don't put up amplified antennas still usually have wireless over broadband in their homes...So in most cases, freenets aren't taking business from the providers, we're just giving their existing subscribers more places from which to connect...”¹⁰

The organized and individual actions of Wi-Fi enthusiasts enabled a number of hotspots¹¹ in coffee houses and other venues but the deployment of these networks was still too haphazardly.¹²

⁸ Interview with an Austin Free Net representative, August 11, 2004.

⁹ Interview with a City of Austin Airport Authority representative, August 6, 2004.

¹⁰ AWCG website <http://www.austinwireless.net/cgi-bin/index.cgi>. Accessed April 3, 2004

¹¹ We use “hotspot” and “public Wi-Fi sites” interchangeably in this paper.

A strategic vision of network deployment emerged in 2003 with the creation of special purpose organizations for the provisioning and advocacy of the free-to-end user model of access. These initiatives sought to harness “the community-mindedness spirit” of volunteer and user groups with the drive of entrepreneurialism of technology startups.¹³ The Austin Wireless City Project (AWCP) rapidly became the flagship entity of the so-called “free Wi-Fi movement.” The organization, composed of members of numerous Wi-Fi groups coexisting in town (user groups, startups, nonprofits, and advocacy groups), was created “to self-provision and self-maintain vast community networks of free Wi-Fi hotspots and transform ourselves from consumers of corporate services to co-creators of a technology that better links us to what matters to us” (“Austin Wireless City Project Lights Up,” 2003). As explained by Richard MacKinnon, co-founder and president of AWCP, the group was organized replicating the structure of a network operator/service provider. The organization has a strategic planning committee (the Board), an executive team (the Core), a sales force (the Walkers or volunteers that offer the service to the venues), *hotspotters* or installers, and the Caretakers that monitor and maintain the network. Less Networks, a software company founded by MacKinnon, designed and provided the software used in the operation of AWCP’s network of hotspots throughout the city.

The “free” Wi-Fi services patronized by the AWCP immediately gained followers and popularity in the city. The AWCP’s strategy—Adopt-a-network—was modeled after the Austin Free-Net’s “Adopt-a-site” program, which invited companies and organizations as donors to support public access sites affiliated with the Austin Free-Net. The AWCP’s Adopt-a-network encourages commercial and public venues to become their own sponsors in lighting up public Wi-Fi networks. Within a year, the number of AWCP-supported public Wi-Fi venues outnumbered those of commercial, for-fee venues (Schwartz, 2004).

The AWCP’s model of public Wi-Fi was unique in the following respects. First, it offered free-to-end-user wireless Internet service supported by the venues. Second, AWCP’s activities were carried out entirely by volunteers occasionally in collaboration with startups and broadband providers. Third, the AWCP did not simply add wireless access devices to the wired broadband but did so in a manner that created managed Wi-Fi networks. This was made possible by networking all AWCP sites via open-source software specifically designed for this application by Less Networks. This allowed common user interfaces across different Wi-Fi venues, network monitoring for problems and usage statistics, user verification system for security purpose, and portal sites with contents created by AWCP and sponsoring venues.

The activities of the AWCP reached beyond commercial venues. The AWCP also formed a partnership with Austin city government and the Austin Free-Net, and began creating wireless access points in city parks, public buildings and nonprofit organization facilities. Through this partnership, the city government has deployed Wi-Fi networks at most of the public library branches, three parks and squares, three public buildings, and a multi-purpose building in an economic revitalization zone located in a predominantly minority population area. Public Wi-Fi connectivity operated by the city government is jointly managed by the city and the AWCP.

¹² Interview with an Austin Wireless Project representative, May 11, 2004

¹³ “Richard MacKinnon on building a community wireless organization. Muniwireless,” a blog entry by Richard MacKinnon. Available at: <http://muniwireless.com/community/guests/396>. Accessed August 3, 2004

Thanks to the AWCP software, the login method, types of content in the login screen, the duration of connection per login, and other aspects of connectivity are standardized. The interface follows the design used in commercial and nonprofit AWCP venues, linking city government's public facilities with other Wi-Fi venues in Austin. After the successful completion of a pilot wireless project by the newly formed partnership between the AWCP, the City of Austin formed the Wireless Board, an internal unit that would discuss the issues of standards and security as well as to coordinate efforts among different units of the city government for the deployment of wireless technologies at city facilities. According to city officials, the city government's involvement in public Wi-Fi provision is strictly a "public business" encompassing extended public access in city facilities (e.g., libraries), enhanced information services for the citizenry, and city services (e.g., policy and fire). The thinking behind these operations is that the city's public Wi-Fi network should not operate in competition with the private sector.

A different class of wireless Internet providers also emerged in Austin's public Wi-Fi market around 2003. These providers—mostly local startups—supported the free-to-end-user model as a means to promote their businesses. They experimented new business models that sought ways to generate revenues without charging end-user fees. As one of the informants put it, "from a startup perspective, how would you go against T-Mobile? Wayport got there, T-Mobile is there, but I can't think of anybody really making money in a paid model."¹⁴ As will be discussed in more detail later, some of these commercial Wi-Fi providers offer free public Wi-Fi to the end-users, while others offer the service for free for both end-users and Wi-Fi venues.

The AWCP, the city, and commercial wireless providers built their public Wi-Fi networks essentially as shared extension of existing wired broadband lines provided by cable TV operators and telephone companies. At one time, these companies developed concerns for security and profit perspectives regarding the use of broadband lines for shared public wireless application. However, such concerns were rapidly retracted, at least in practice, as the companies realized that profitable business models meeting the unique market condition in Austin could be structured. Instead of banning shared bandwidth use at Wi-Fi venues or seeking to become public Wi-Fi providers themselves, these telecommunications companies have positioned themselves primarily as the bandwidth providers, and adopted a light-handed approach with respect to the activities of local Wi-Fi players.¹⁵

The symbiotic relations formed between commercial bandwidth providers and the providers and supporters of public Wi-Fi services can be understood in light of the extensive contacts they have had with each other in the last few years. One of the primary venues for such contacts was a roundtable discussion on Austin and Central Texas' economic future hosted by the Innovation, Creativity & Capital Institute (IC²) of the University of Texas.

Historically, IC² has been the site for visioning and crafting economic development strategies for Austin and central Texas. The growth of a thriving high-tech cluster economy in Austin in the last three decades was harnessed under the conceptual framework of the "technopolis wheel"

¹⁴ Interview with an Austin Unleashed, Inc. executive, July 27, 2004.

¹⁵ Interview with a Time Warner Cable Austin executive, October 10, 2004; Interview with an SBC Lab executive, October 13, 2004.

(Smilor, Kozmetsky, & Gibson, 1988). This strategic vision designed by leading local entrepreneurs and founders of IC² emphasizes the cooperation between businesses, local and state government, and academic institutions in initiatives that promote technology diversification and economic development. Beyond physical infrastructure, the strategy demands the creation of “smart infrastructure” based on the interactions of intelligent organizations, and people sharing a common purpose and vision: building the *technopolis*.¹⁶ Building on this tradition, in late 2002, IC² invited community leaders and representatives of Austin’s ICT businesses, venture capital companies, and UT’s Wireless Networking & Communication Group to brainstorm ideas to design a new plan that would reproduce the successful experience that brought the semiconductor industry to Austin in the late 1980s.¹⁷

Throughout the course of the IC² roundtable discussion, participants brought attention to the blooming wireless businesses in Central Texas. The agglomeration of wireless businesses in Central Texas, and the presence of a premier wireless research institute (WNCG) suggested that Austin was ripe for a successful wireless milieu. The roundtable asked IC² to produce a report (*Austin’s Wireless Future*¹⁸) on the wireless businesses in the region, and to formulate strategic recommendations for the region’s economy. These meetings, and the process leading to the publication of the report, turned into an excellent opportunity for exchanging information among different kinds of organizations about key technologies, markets, and regulatory issues.¹⁹

An even more tangible venue for contacts among local stakeholders in wireless and Wi-Fi businesses came to being during the same period. Some of the participants from the IC² roundtable meetings and other leaders of the wireless industry in Austin formed the Austin Wireless Alliance.²⁰ The organization’s mission is “to develop, sustain, and promote Austin as a global leader in business activity, technical innovation, and community participation within the wireless industry.” The AWA quickly understood that carrying out this mission entailed even broader outreach and greater collaboration with other stakeholders. The organization saw the growth of public wireless networking in Austin as a marketing tool, and as an opportunity for wireless businesses to leverage resources.²¹ As a result, the AWA invited the chairman of the volunteer Wi-Fi organization Austin Wireless City Project to sit on its steering committee, crediting the work of the AWCP in expanding public Wi-Fi connectivity in the area.

A brief review of this history highlights the following dynamics underlying the growth of public Wi-Fi in Austin:

1. *Multiplicity of initiatives*: There are a number of initiatives encompassing commercial, nonprofit, and public activities in public Wi-Fi provisioning in Austin. The market is co-habited by diverse actors espousing differing visions of public wireless access.

¹⁶ Technopolis or technopole is one of the terms commonly used to refer to initiatives that foster technology-based economic development.

¹⁷ Interview with an IC² Institute representative, August 5, 2004.

¹⁸ Evans, E., Lebkowsky, J., Welter, L., Hung, G., Mayfield, D., and Gangadharbatla, H. (2004, January). *Austin’s Wireless Future*. Austin, TX. Accessed on 01/25/04 <http://www.ic2.org/publications/AustinsWirelessFuture.pdf>

¹⁹ Ibid

²⁰ Founding members included two University of Texas’ institutes (IC² and the WNCG), the Chamber of Commerce, and companies such as SBC, Tuanis Technologies, and Metrowerks.

²¹ Interview with an Austin Wireless Alliance representative, August 14, 2004.

2. *Free Wi-Fi movement*: Organized actions of grassroots groups—in part driven by free-market entrepreneurial spirit—cultivated the idea of “free” or venue-sponsored public Wi-Fi access, and presented the idea to the citizens, bandwidth providers, and local government as a viable alternative to a fee-based model of public access.
3. *Institutional collaboration*: The growth of public Wi-Fi has been facilitated by collaboration among diverse actors. The know-how for institutional partnerships—gained through the *technopolis* experiment in the 1980s—served as a backdrop in creating arrangements for mutual benefit.

FORCES BEHIND WI-FI

We explored the conditions fostering rapid growth of public Wi-Fi networks in Austin by asking our panel of 18 experts and providers to identify the main factors advancing wireless broadband in the city. We coded the answers given to this open-ended question to create a hierarchically ranked order of factors. The range of factors is presented and discussed below.

Presence of a Critical Mass of Early Adopters and Tech-Savvy Users

The presence of a sizeable number of tech savvy users that are *early adopters* of the technology was the factor cited most often as a driver of the public Wi-Fi boom in Austin. Our informants characterized users of public wireless Internet as Wi-Fi enthusiasts and hobbyists, technology and creative professionals, technologically savvy people, students and “geeks.” Experts and industry representatives remarked that Austin is more than a community of tech-savvy people. The majority thinks that the action of user groups setting up hotspots or demanding the service at different venues is a unique feature of Austin’s Wi-Fi landscape. Anecdotal information gathered through our survey of Wi-Fi venues seems to confirm this opinion. Managers of some Wi-Fi venues reported that users have become very vocal in recommending some providers, interfaces or type of service preferred.

Many also referred to Austin’s *creative class* as a catalytic force pushing for the expansion of Wi-Fi services throughout the city. Being a college town and a high-tech agglomeration economy, Austin has attracted a wide range of creative and technical workers that are the foundation the newly emerging *creative economy* (Florida, 2002). According to our interviewees, creative workers are very mobile people who tend to use connectivity everywhere. An industry representative emphasizes that these users are the first in incorporating the technology into their daily lives, encouraging the development of new applications.²² However, other informants cast some caution over an excessive faith in the natural diffusion of the technology, and in the role that early adopters may play in the rapid spread of the innovation to the overall population. Austin Free-Net sees early adopters of Wi-Fi as particular constituencies who do not mingle with users of traditional public Internet access sites such as libraries and community centers in low-income communities, even though these sites are Wi-Fi enabled.

²² Interview with an Austin Wireless Alliance representative, August 14, 2004.

Research and social networking work developed by the IC² and WNCG was cited as the second most important site for collaboration. These institutes at the University of Texas at Austin became a forum where actors exchange information, ideas and visions that have promoted the development of public Wi-Fi in the city.

Centrality scores confirm that the focal point of the network is composed by the AWCP, the Austin Wireless Alliance, a wireless business association, and research institutions, a pattern that suggests the existence of a core network organized around efforts of volunteerism, entrepreneurial initiatives and research (see Table 1).

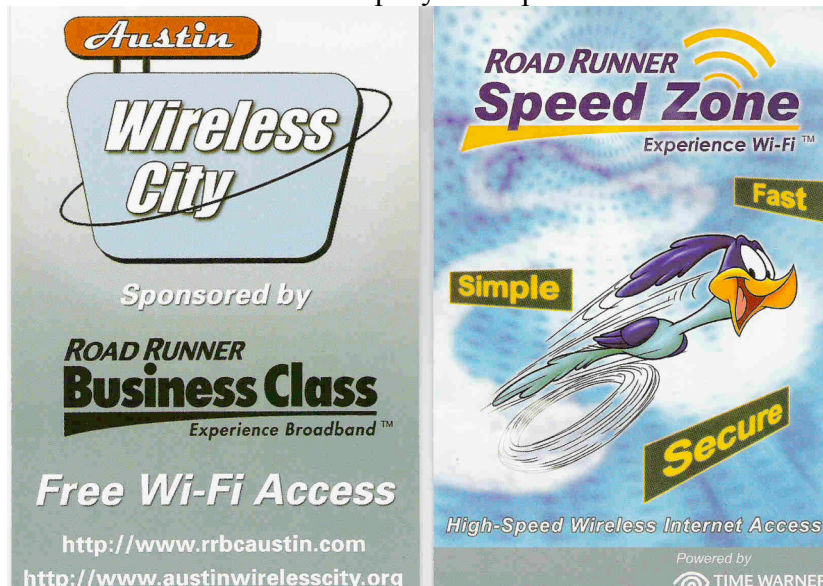
Table 1. Eigenventor centrality scores. Core Wi-Fi organizations

Organizations	nEigenvec.
AWCP	61.97
Austin Wireless Alliance	58.376
University of Texas Wireless Networking & Communications Group	47.916
IC ² Institute	46.683
City of Austin, Com & Tech Management Dept (City IT Group)	38.314
Austin Free-Net	38.29
Austin Unleashed	35.216
Electronic Frontier Foundation - Austin	31.291
City of Austin Public Libraries	28.578
City of Austin, Regulatory Affairs	28.325
Time Warner Cable Austin/Road Runner (TW/RR)	28.224
WIFI-TEXAS	19.113
SBC	14.599
Waveforward	11.372

Responses to our social network survey revealed that the main forms of collaboration among organizations are *visioning* and *volunteerism*. Interviewees praised the AWCP for its demonstrated ability to mobilize and organize volunteers funneling resources, ideas and visions from different stakeholders. Our informants found that the leadership of the AWCP is clearly expressed in the popularity of the venue-sponsored or free-to-the end-user model of access in the city. The majority of our panel credited the AWCP as the most vocal advocate of the idea of “*free Wi-Fi*”. This vision and the dynamic action of the AWCP actually persuaded Time Warner Cable Austin to allow commercial customers such as coffee shops and bars to open their wireless networks to the public. According to an executive of Time Warner Cable Austin the company markets a product (*Speed Zone*) to commercial customers interested in becoming hotspots, and initially the company “did not think that wireless access should just be open to the public.”²³ However the firm modified this policy over the last year working with the AWCP. Time Warner, which typically acts as a last-mile carrier for residential and business customers, play the role of network backhaul for many AWCP venues that did not subscribe the service before. AWCP volunteers and Time Warner personnel often work together in assessing the sites and installing the network. The company considers that this relationship is a kind of *technical collaboration*. In

²³ Interview with a Time Warner Cable Austin executive, October 10, 2004.

Figure 2. Road Runner ads at AWCP sites and company's hotspots



this way, TW provides broadband and promotes its broadband services at the AWCP sites as well as at Speed Zones (Figure 2).

Wireless startups also see partnership with AWCP as an effective vehicle to promote their services and to seize business opportunities. Some of these firms have sponsored the installation of wireless access points at venues, and catered to them with services such as web hosting, software design and website development.

The city government and the public libraries have also welcomed *technical collaboration* with the AWCP and startups. WiFi-Texas, a young wireless Internet service provider, donated the wireless access points that enabled Wi-Fi connectivity in the main public libraries of Austin.²⁴ Less Networks, the for-profit arm of the AWCP, made available the software that runs the public wireless interface at libraries and all other city facilities. The city benefits from the obvious reduction in the cost of deploying wireless access. Meanwhile, the startups and nonprofits consider that these efforts increase their visibility and credibility in the community, potentially opening new doors for their operations.

Spillover Effect of Austin's High-Tech Economy

Our interviewees consider that as a high-tech city, Austin offered a unique milieu that fostered the growth of public wireless Internet. Informants considered that the high broadband penetration throughout the city, and the availability of state of the art equipment at relatively low cost have facilitated the rapid, *ad hoc* deployment of hotspots and Wi-Fi zones in Austin.

A diverse corporate environment that mixes venture capital, chipmakers, equipment manufacturers, broadband providers, and pioneering wireless firms was also cited as a factor stimulating the growth of public wireless networks. Startup firms reported that this is a particular advantage because the operation costs in the Austin area still remain relatively low in comparison with other high-tech cities.

The presence of the University of Texas (UT) was also a factor highly praised by our informants. Some remarked that UT has acted as an agent of change promoting wireless access among members of its community, and by making its campus a wireless zone. A standing tradition of policies fostering innovation and promoting collaboration was valued by the majority of our

²⁴ Interview with an Austin Public Library representative, July 28, 2004.

interviewees. In their view, this has been a factor stimulating volunteerism and well as entrepreneurial spirit surrounding public Wi-Fi initiatives in the city.

Austin's Culture

Austin has branded itself as “the city of ideas”; a cutting edge, hip place in which both technological innovations and live music thrive. As Richard Florida explains it, the mix of technology, talent and a tolerant culture has proved to be an effective economic development strategy placing Austin at the top of the fastest growing economies in the nation (Florida, 2002).

Users groups and startups have been successful at crafting the link between Austin’s culture and wireless Internet. They were the first in transforming the *motto* of the town –“*Keep Austin Weird*”- in slogans such as “*Keep Austin Wi-Fi*” and “*Keep Wi-Fi Free*” promoting their services and building a natural connection with Austin’s hip culture.

Some informants underscored that Austin’s ethos is very open to innovations. Over the last 20 years, service businesses in Austin have expanded, catering to the needs of the high-tech industry. This close relationship has made owners of coffee houses, restaurants and bars very sensitive of the needs of computer and creative workers, increasing awareness and opening the doors of venues to Wi-Fi services.

City officials sees the public Wi-Fi access at city facilities as a natural development of long standing policies to provide online government services and public Internet access to Austin’s citizens. For these goals, the city government sought an aggregated network effect by adding access points to the network maintained by the AWCP. The choice of wireless made sense for the city government because wireless allowed the city to expand broadband access by leverage on the existing wired Internet access points (e.g., public libraries).

Geographical layout of Austin

Experts and providers believe that Austin’s geography makes it a suitable place to develop wireless broadband projects. Different from other Texan cities such as Houston and Dallas, the Austin metroplex is fairly compact and concentrated in the central corridor of the city. Although only Verizon has announced a citywide plan for their customers, providers agreed that Austin’s layout would allow a rapid development of wireless broadband networks. The business district, the Capitol, government buildings and the main academic institutions in town constitute a natural hub of connectivity for adjacent locations.

TYOLOGY OF ACCESS MODELS²⁵

In order to identify the access models prevalent in our case study sites, we inventoried three key dimensions of the public Wi-Fi services available in Austin: access business models, providers, and types of public Wi-Fi venues. An important backdrop to our discussion is the urban social geography of Austin, which is characterized by the economic, ethnic, racial, psychological, and

²⁵ We identified a total of 220 public Wi-Fi access points within Austin’s city limits as of the end of September 2004. We base our analyses in this section on these venues.

physical boundaries formed by Interstate Highway 35. The neighborhoods east of I-35 are primarily composed of racial and ethnic minority communities with disadvantaged socioeconomic statistics. The western half of the city is composed of predominantly ethnic Anglo neighborhoods. An economic divide mirrors this residential segregation.²⁶

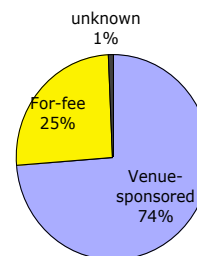
Business Models

The access business models of Austin’s public Wi-Fi can be broadly divided into two groups according to the methods by which the costs of service provision are borne and by whom. The first model is based on the *venue-sponsored* provision of Wi-Fi service, in which property owners of Wi-Fi facilities pay for the cost of service provision sponsoring its use. Because there are no direct access fees paid by the end-users, we can also call this model a *free-to-end-user* model. In contrast, the *for-fee* model relies on the revenues from access usage fees collected from the end-users; the end-users are thereby responsible for the bulk of service cost.

The dominance of the venue-sponsored model of access in Austin’s public Wi-Fi market is clear (Figure 3). In a typical public Wi-Fi venue adopting the venue-sponsored model, any costs incurred in the provision of public Wi-Fi are borne initially by the venue owner but are subsequently recovered through the revenues generated from the sales of merchandise and service to Wi-Fi users.²⁷ In contrast, the for-fee model operates on a premise that Wi-Fi users are willing to pay extra fees for wireless Internet service in addition to the expenditures they make for buying the core services and merchandise offered by facilities (except at publicly-owned Wi-Fi venues).

The geographical distributions of the two models exhibit contrasting patterns. Figure 4 compares the locations of public Wi-Fi venues by two major cost models—venue-sponsored model and for-fee model. Public Wi-Fi venues offering service free of charge to end-users are fairly evenly distributed across Austin’s geography. In contrast, for-fee venues are only found in areas west of I-35, an area with average or above average socioeconomic statistics. For-fee Wi-Fi services are most popular in the city’s business districts and upscale commercial areas, but are virtually absent in minority and low-income areas (i.e., East of I-35).²⁸ This pattern seems to indicate that economic motivations are fundamentally influencing the operation of for-fee Wi-Fi services.

Figure 3. Public Wi-Fi venues in Austin by cost models

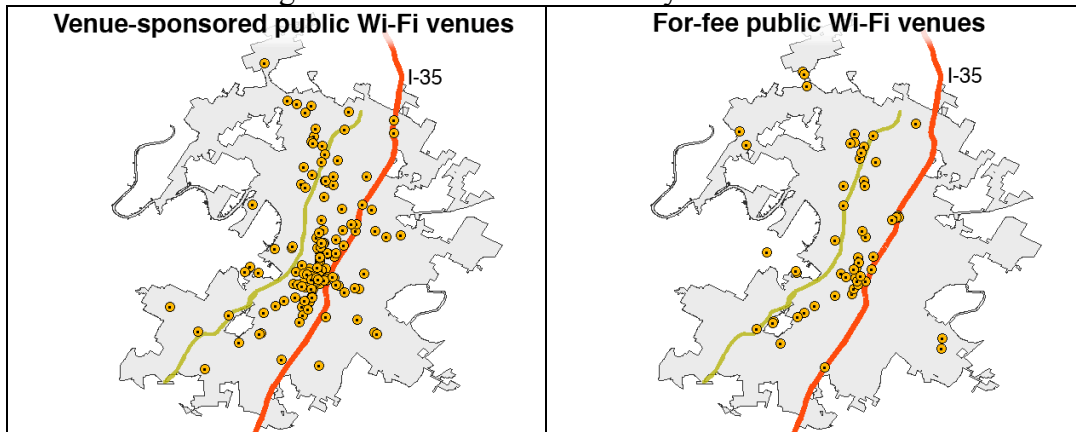


²⁶ For example, the 78702 zip code area, which corresponds to a historically disadvantaged area called East Austin that lies just east of the downtown, and separated by the interstate, has the city’s highest rate of households under poverty—25.5%. The figure is vastly worse than Austin’s average—9.2%. 36% of the population in East side of the city is non-Hispanic White, well below the city average (53%).

²⁷ This does not apply to public Wi-Fi services at noncommercial venues (e.g., public libraries, public parks).

²⁸ The few access points visible on the map in east and southeast Austin are special cases; they are located at the Austin-Bergstrom International Airport and some of the hotels adjacent catering to airport users.

Figure 4. Public Wi-Fi venues by cost models



Providers

Three types of Wi-Fi providers dominate Austin’s public Wi-Fi venues. The Austin Wireless City Project/Less Networks Inc. is the single largest wireless Internet provider, followed by commercial WISPs (wireless Internet service providers), and “independent” providers (Table 2). The AWCP and its technological underpinning, the software developed by Less Networks Inc., offers login-based but free-to-end-user Wi-Fi services in 83 locations. The AWCP/LessNet-supported Wi-Fi facilities include both commercial establishments (57 sites, or 25.9% of all public Wi-Fi venues in Austin) and non-commercial spaces (26 sites, or 11.8%).

Table 2. Public Wi-Fi venues in Austin by types of providers

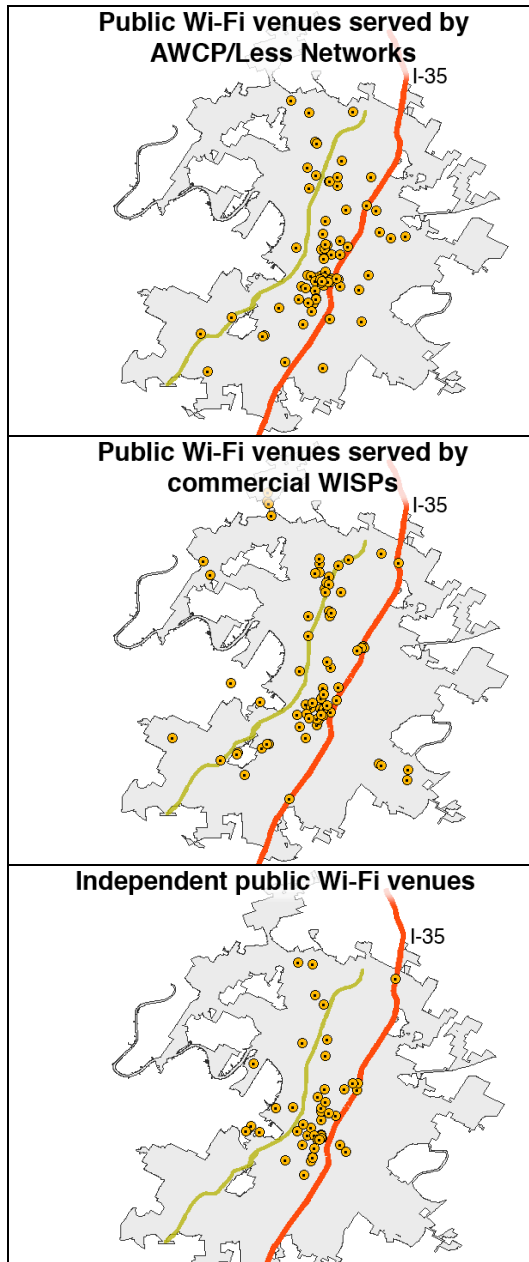
Provider	Number of venues	Share in public Wi-Fi market
Austin Wireless City/Less Networks	83	37.7%
Commercial WISPs	74	33.6%
Independent venues (self-started)	50	22.7%
Telco/Cable Wi-Fi services	7	3.2%
Austin Free-Net	1	0.5%
Unknown providers	5	2.3%
Total	220	100%

As of September 2004

Commercial WISPs encompass not only well-known national players such as T-Mobile and Wayport but also local wireless ISPs that operate in the local and regional markets. It should be noted that “commercial” does not intrinsically imply “for-fee” public Wi-Fi. A third of the commercial WISPs operating in Austin offer venue-sponsored services (n=23). Those commercial WISPs offering venue-sponsored service can be further divided into two groups: (1) those that form formal contractual relationships with venues and charge service fees; (2) those that do not charge fees to venues but use “free” service (free to venues, free to end-users) as a promotional tool for other revenue-making businesses such as maintenance, network security, and content development.

More than one-fifth of public Wi-Fi sites in Austin are independently run by retail and service outlets that have self-installed Wi-Fi access points. All independent public Wi-Fi venues provide their wireless service free of charge to end-users. They constitute 22.7% of all public Wi-Fi venues in Austin, and about 30% of venue-sponsored Wi-Fi venues.

Figure 6. Public Wi-Fi venues by providers



Austin is a surprisingly small market for Wi-Fi services for large telephone and cable companies. As of September 2004, there are only seven public Wi-Fi venues served by the local exchange carriers and cable franchises combined. The low market penetration among this class of providers seems to be primarily influenced by the abundance of free public Wi-Fi sites in Austin, which significantly reduces incentive among venues to choose a for-fee service.²⁹ However, these telephone and cable companies primarily play the role of bandwidth providers in Austin's public Wi-Fi market. For their bandwidth needs for public Wi-Fi service, 43% of the public Wi-Fi venues in our venue survey sample (n=53) buy DSL service from SBC, and 38% use Time Warner Cable's cable Internet service.

Figure 6 compares the geographical extent of the three most popular types of public Wi-Fi providers in Austin. All three types of providers serve venues that tend to cluster in the downtown area (i.e., the middle of the maps just west of I-35). Beyond this, each group of public Wi-Fi venues has the following distinctive characteristics.

Despite the concentration in the downtown area, the geographical extent of the AWCP-supported sites is fairly large and evenly distributed. The venues in this group spread from the north end of the city to the south end, and have some presence in the east side of I-35. The section of the city that has the least penetration of AWCP-supported venues is the area west of Mopac Express (the north-south highway on the left). This area is comprised primarily of affluent residential areas sprinkled with a few upscale shopping centers.

²⁹ Interview with an SBC Lab executive, October 13, 2004.

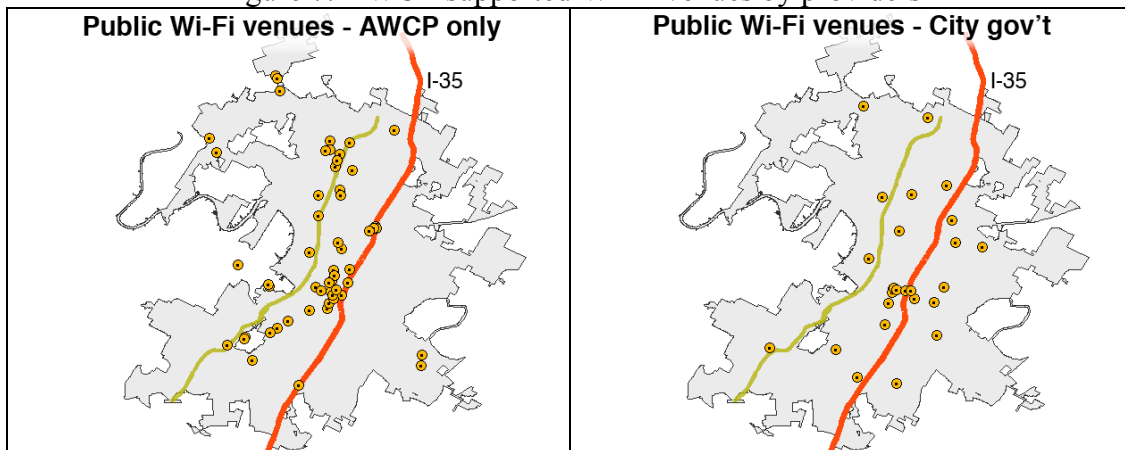
Compared to AWCP-supported venues, public Wi-Fi venues served by commercial WISPs have higher penetration in the more affluent areas west of Mopac Express. Also, the hotspots in this group seem to have a greater presence in north and northwest Austin. However, venues served by commercial WISPs are virtually lacking in the area east of I-35, an area with a high concentration of racial and ethnic minorities and poor households.

Independent public venues seem to have the smallest geographical coverage among the three major types of providers. Like commercial WISPs venues, independent Wi-Fi venues are mostly absent in east Austin.

The geographical pattern we saw for the public Wi-Fi venues served by the AWCP/Less Networks needs clarification. The venues in this group include those operated jointly with the City of Austin government. A different picture emerges when we distinguish AWCP venues from the municipally operated venues.

Figure 7 breaks down the first map in Figure 6 (“Public Wi-Fi venues served by AWCP/Less Networks”) into two subgroups. The first group is comprised of Wi-Fi venues located at “non-City” facilities; the AWCP undertakes the entire network operation at these sites. The second group consists of Wi-Fi venues located at City facilities and jointly operated by units within the city government and the AWCP. The access sites at City facilities, though few in numbers, spread evenly across the entire city. The geographical pattern of AWCP-only venues, on the other hand, appears very similar to those of independent venues and commercial WISP venues. This is not surprising because most of the “AWCP only” venues are commercial establishments, a characteristic shared by both independent and commercial WISP venues. Local government sites are much more widely spread, covering all areas of the city including poorer areas east of Interstate 35. Thus, public wireless sites in disadvantaged communities are mostly sponsored by the local government.

Figure 7. AWCP-supported Wi-Fi venues by providers



Public Wi-Fi Venues and their Spatial Characteristics

Access to public Wi-Fi networks in Austin is bundled with other types of activities, such as visiting a library, sitting in a coffee house, or staying in a hotel. There is no evidence of the presence of “Wi-Fi only” access sites in Austin. This is a unique *spatial* feature because it means that one must enter a space originally designed for other purposes. This *a priori* access requirement—encompassing physical, social, cultural, and economic access—may privilege or prejudice segments of the existing and future users if the types of venues available are biased.

Indeed, there is a strong commercial bias in Austin’s public Wi-Fi venues, with 86% of the city’s public Wi-Fi venues located at sites of goods and service consumption (Table 3). Those truly *public* sites that do not require additional consumption such as public libraries constitute only the small minority of Austin’s hotspots. While no concrete evidence is available, public Wi-Fi venues in Austin also seem to be biased culturally; Wi-Fi venues tend to be patronized by middle and upper-middle class people, creative workers, high-tech employees, intellectuals, or people with professional occupations.³⁰ Anecdotal evidence also suggests spatial-cultural barriers in the diffusion of public Wi-Fi service. The owners of restaurants and other retail establishments in the underserved areas often express disinterest in the service are hesitant to explore potential benefit, and cite the lack of demand from customers.³¹ Combined with the geographical unevenness of the availability of public Wi-Fi venues, these spatial biases of public Wi-Fi venues seem to reduce, not enhance, public access opportunities for the poor, less educated, or minority populations.

Table 3. Public Wi-Fi venues in Austin by types of venues

	Number	Percent
Restaurant & bar*	77	35.0%
Coffee house*	60	27.3%
Lodging*	26	11.8%
Other retail*	25	11.4%
Library	21	9.5%
Park & square	5	2.3%
Public building	3	1.4%
Nonprofit group facility	2	0.9%
Airport*	1	0.5%

As of September 2004

*Sites of goods and service consumption

As expected, public Wi-Fi venues are predominantly located in commercial zones. We observed a positive correlation between public Wi-Fi availability and the density of commercial activities; a higher percentage of commercial zones in a given ZIP code area is associated with a greater number of public Wi-Fi venues in the area.³² An even stronger predictor of public Wi-Fi

³⁰ Based on authors’ casual observation during numerous visits to public Wi-Fi sites during research.

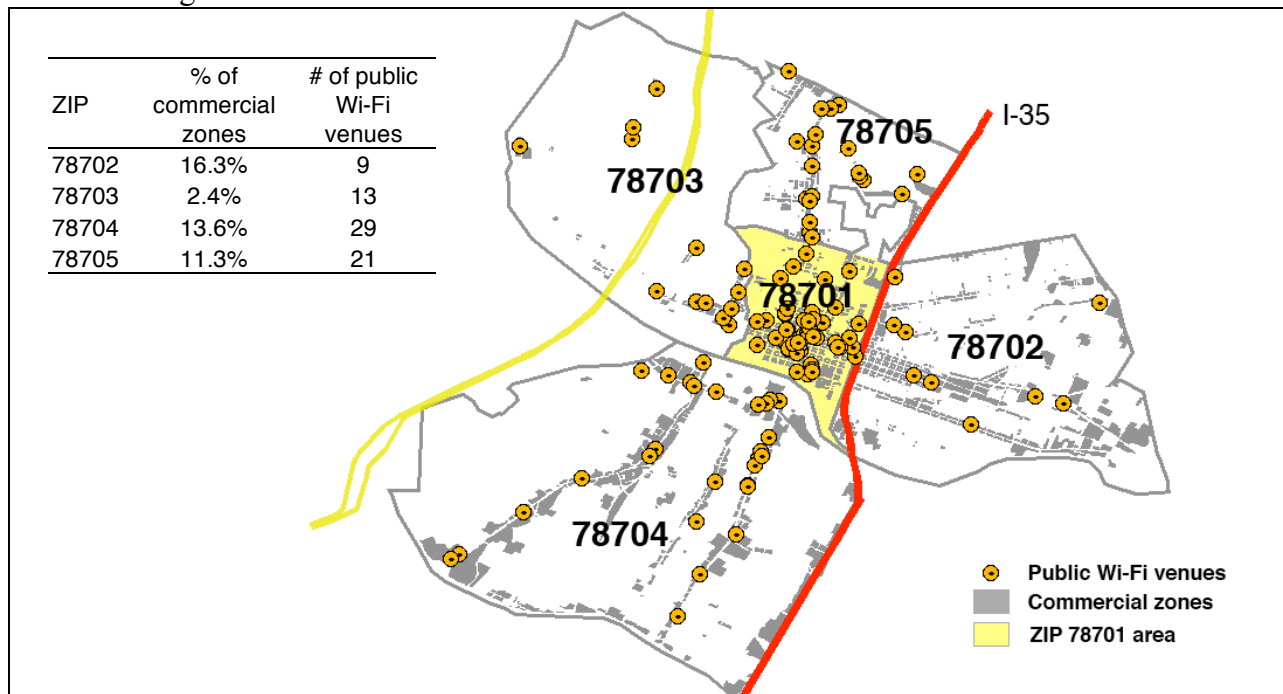
³¹ Various interviews cited throughout this paper.

³² A Pearson correlation for the number of public Wi-Fi venues and the percentage of commercial zones in each Zip code area indicates that these two variables are significantly related ($r = .509$, $N = 34$, $p < .01$, two tails). To account for outliers in the data, the test excluded those Zip code areas in which there is no presence of public Wi-Fi venues. In this paper we define *commercial zones* as the areas that have the following designations in the City of Austin’s

availability is the distance of a given area from the geographical center point of Austin’s Central Business District (CBD). We found that the closer an area to the CBD center point, the greater the number of public Wi-Fi venues in the area.³³

However, access to public Wi-Fi in the poorest section of the city defies these statistics. The ZIP code area 78702, located just east of the downtown across I-35, is an area with the city’s least educated and poorest populations, and has the second smallest population of ethnic Anglos. Nevertheless, the 78702 area is not an urban ghetto found in other large cities, and has numerous restaurants, coffee shops, and other small retails—the types of establishments that seem conducive to public Wi-Fi. In the 78702 area, however, its proximity to the CBD and the large presence of commercial zones do not translate into more public Wi-Fi venues. In comparison to three other ZIP code areas adjoining 78701 (CBD is located inside 78701), public Wi-Fi hotspots are visibly sparse in 78702 (Figure 8). The 78702 area also displays a much weaker locational correspondence between commercial zones and public Wi-Fi.

Figure 8. Public Wi-Fi venues and commercial zones in Austin’s central area



zoning code: CBD (central business district), CS (commercial services), CH (commercial highway), LR (neighborhood commercial), and GR (community commercial).

³³ The area within Austin’s jurisdictional boundary was divided into 46 co-centric bands of circles with a 0.5km increment. $r = -.730$, $N = 46$, $p < .01$, two tails.

WHO IS BEING SERVED? A SNAPSHOT OF USERS AT VENUES

The unevenness of public Wi-Fi in Austin is also evident from our findings on public Wi-Fi users. Our survey of Wi-Fi users at Austin’s public spaces shows them as a select group of the population placed among the youngest, more educated, and more affluent Internet users in the state of Texas. The characteristics of this group arguably reflect particular features of Austin as both a college town and a technology center (Table 4). In terms of race and ethnicity, respondents reveal themselves as a fairly homogenous group not representing the diversity that characterizes Texas and Austin’s population.³⁴ More than three-fourths of Wi-Fi users in our sample were Anglo (78%), 5.8% reported to be of Hispanic origins, 5.3% Asians, and only 4% African Americans.

Table 4. Characteristics of current Internet Users

Age	% Austin's Wi-Fi Users*	% Urban Texans **
18 to 29	24.5	21.4
30 to 39	42.4	23.1
40 to 49	23	24.4
50 to 65	10	23.1
65 or older	0	8
Income		
< \$20,000	11.2	11.3
\$20,000-\$39,999	19.4	24.7
\$40,000-\$60,000	21.6	22
> \$60,000	47.8	42
Education		
Some high school or less	0	4.1
High school diploma	21	55.3
College graduate	79	40.7
Occupation		
Working full-time	67.9	63.2
Working part-time	12.4	9
Going to school	8	5.3
House keeping	0.7	9.4
Retired	1.5	8.6
Unemployed, laid off	9.5	4.5

* n= 151, ** n=615

Notes: Data on Internet users on urban areas in Texas correspond to a statewide, random telephone survey of 1,002 adults (18 years or older) for a project contracted to the Telecommunication and Information Policy Institute of the University of Texas at Austin by the Department of Information Resources of Texas. The data were gathered between February and March 2004. (Strover, S., Straubhaar, J., Inagaki, N., Gustafson, K., & Boa-Ventura, A., 2004, July).

Users of public Wi-Fi appear as a group of experienced and heavy Internet users that go online from diverse platforms, and are fully engaged in the age of mobile communications. Internet penetration at home has reached almost universal levels among participants in our survey, and a

³⁴ According to Census data for 2000, 52.9% of Austin’s population is non-Hispanic white, 30.5% Hispanic, and 10.7% African American.

sizable percentage (79%) goes online from home using high-speed connections (Table 5). Considering that about two-thirds of the U.S. population use the Internet, and only one-third enjoy broadband access at home, respondents of our survey appear to belong to a special category of heavy Internet users in the country.³⁵ High scores of ownership across technologies and devices show Wi-Fi users as a highly connected group of people employing a variety of means to gain access to telecommunications services.

Table 5. Technology ownership

Technology	% of ownership
Own cell phone	94.6
Have Internet at home	90.6
Own laptop	88.5
Have Internet at school or work	87.2
Have broadband at school or work	84.5
Have broadband at home	79.1
Own desktop	70.5
Own telephone at home	65.8
Own PDA	45.6

n= 151

Patterns of ownership across devices clearly reveal respondents' preferences for wireless technologies. Penetration of cellular phones in this group has attained universal levels, while only two-thirds of the respondents report to have landlines at home. Likewise, laptop computer ownership prevails over that of desktop computers. Asked about the frequency of use of certain devices, respondents reported to use laptops more frequently than desktops when going online. The possession of desktop and landlines appears to be sensitive to income. As respondents' income increases, so do their reported ownerships of both wired (e.g. desktop PC and landlines) and unwired devices (e.g. cell phones, laptops). The results suggest that lower income users tend to use wireless devices only.

Another important trait of our sample is the extensive use of broadband technologies reported by participants. Respondents use high-speed services most frequently at work or school (84.5%). The domestic adoption of the technology appears remarkably high among this group (79.1%), in particular when compared to urban Internet users in Texas (39%). However, our analysis found no significant relationships between the adoption of high-speed connection at home and participants' income, age, or education.

Email is by far the most frequent activity performed by users in hotspots (95.2%), followed by reading news (73.3%). Telecommuting is an activity commonly associated with broadband use and many Wi-Fi users are teleworkers on the road. Fifty-seven percent of our sample uses hotspots around the city for work assignments and 14.5% reported doing school-related work in public spaces. Testimonies of participants underscored the importance of free public Wi-Fi in their daily work routines. These Austinites highly appreciate the ability to do work outside the office for different reasons. Working at a public space translates into the possibility of "getting

³⁵ Studies estimate current Internet penetration between 64% and 75% of the U.S. adult population (Madden et al., 2003; The Digital Future Report, 2004). According to a recent assessment, 78% of the Texan population currently uses computers, and 97.3% of them have gone online (Strover et al., 2004)

the job done” while reading news, surfing the net or doing other online activities. Public wireless Internet also allows users to combat feelings of isolation by working and using their laptops at public spaces surrounded by other people. This style of working is associated with “higher quality of life” and a “better work environment”.

“I enjoy getting out of the house and being with other folks. I'm self employed. This way I get to work around people. I don't have to be isolated”

“Free public wireless access is a fantastic quality-of-life increaser in Austin and really sets Austin apart from many cities in the US (or world). I have largely restructured my working life due to free wireless--I now spend many weekday mornings at a local coffee shop that offers free wireless where I can work quietly and effectively away from distractions. I support the coffee shop extensively (buying coffee & food) so that this remains profitable for them...”

“A wireless connection would be of great value to me. I sell real estate as a sideline to my primary job. I have a well-equipped laptop that allows me to do almost all real estate functions from where this service is available. I would be very excited about unlimited access to a wireless network that could be accessed from any point in the greater Austin area and would likely sign up for such a service if the price were reasonable.”

Although Wi-Fi is increasing the quality of life of mobile Internet users, and reinvigorating the function of public spaces in the local economy, these benefits remain confined to privilege areas and can further reinforce historical divides in the city.

FACTORS RESTRICTING EXPANSION IN UNDERSERVED AREAS

Municipal Telecom and Politics

As previously discussed, the public Wi-Fi sites operated by the City of Austin government (jointly with the AWCP) have helped reduce gaps in public Wi-Fi opportunities between disadvantaged neighborhoods and the rest of the city, and between commercial and non-commercial access sites. However, the city government has deployed public Wi-Fi in a rather restricted way.

During the 1990s the City of Austin had attempted to build a citywide advanced telecommunications network serving the citizens, businesses, and institutions using installed capabilities and the fiber rings surrounding the city (Berquist & Grant, 1999). However, the passage of a state bill prohibiting the provision of telecommunications services by municipal entities in 1995, and the opposition from incumbent telecommunications providers effectively derailed the initiative.

This early experience has influenced and shaped the understanding of the City of Austin government about possible opportunities to operate public Wi-Fi networks. As the city government lighted Wi-Fi access points at different locations, it imposed restrictions on itself in order to avoid friction with private telecommunications companies. This essentially meant that

the city would not deploy public Wi-Fi networks in competition with private broadband services.³⁶ The city defines the restriction on public-private competition in terms of types of facilities: any residential units and commercial establishments fall outside the scope of the city's public Wi-Fi offering. As a result, the city has eliminated the possibility of leveraging wireless Internet to expand broadband using it for last mile connectivity in underserved areas beyond city facilities.

Dominance of Commercial Access Model

The second factor restricting the expansion of public Wi-Fi to the underserved communities and population is the commercial model of access driving the deployment of Austin's public Wi-Fi. Here we can define commercial public Wi-Fi as a service through which public Wi-Fi users engage in economic exchanges with the venues or providers. Most of the "free" public Wi-Fi services in Austin are commercial in this regard. As we saw earlier, the majority of public Wi-Fi sites (74%) do not implement access charges for their Internet-using customers. However, the majority of these "free" venues have built-in economic exchanges between the users and venues—i.e., the price tags for coffee, car wash, and hotel room. Such economic exchanges are exclusionary against population segments in lower socioeconomic strata. Obviously, the problem is compounded by the relatively high cost of ownership of mobile computing devices.³⁷ Thus, the "free" Wi-Fi model by itself does not diminish the economic barriers against technology have-nots.

There is also a supply-side issue. The example of the 78702 ZIP code we saw earlier raises questions about the ability of the commercial model of access to make broadband access more equitable. In theory the 78702 area's proximity to the downtown area and the substantial presence of commercial zones within the area are factors conducive to prolific public Wi-Fi connectivity. In reality the area is severely underserved, symbolizing the social barriers preventing it from being considered as potential market of public Wi-Fi services. We found anecdotal evidence pointing to the relative lack of interest in public Wi-Fi among businesses at the east of I-35. The commercial model, which has facilitated the proliferation of public Wi-Fi service in many parts of Austin, appears to be an ineffective framework in socio-economically challenged communities.

The dominance of the commercial rationale in public Wi-Fi is also evident in the views expressed by those who host public Wi-Fi connectivity. Our survey asked the owners and managers of public Wi-Fi venues to identify the main reasons for adopting Wi-Fi at their facilities. As shown in Figure 9, most of the reasons pertained to some form of business and commercial motivations. Only 10.6% of the respondents (n=5) considered *providing access to the people* a reason for adopting Wi-Fi.³⁸ Not only were the reasons in this category mentioned infrequently, but the owners and managers of the venues that espoused the notion of public

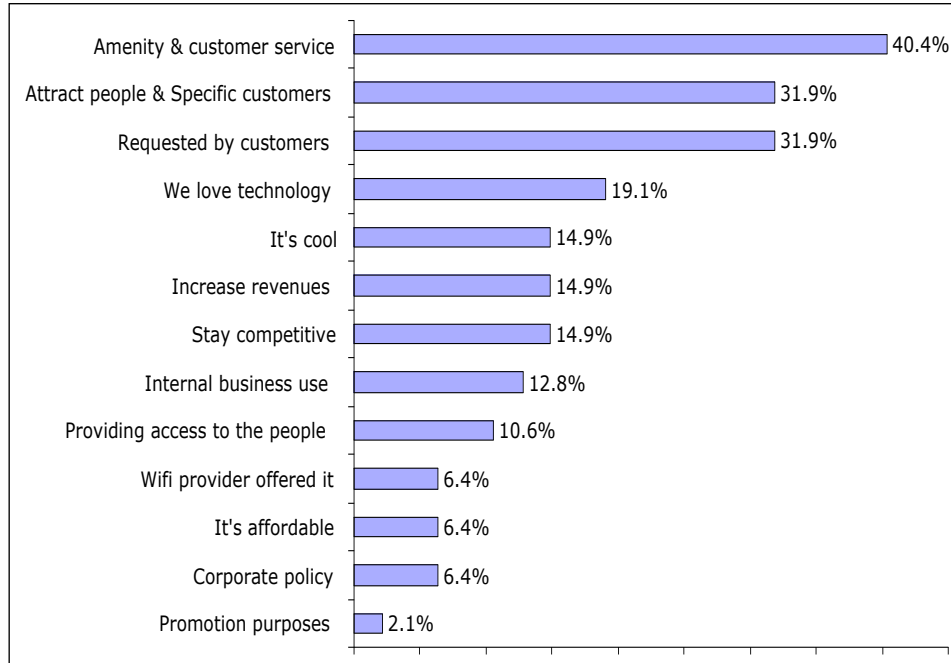
³⁶ Interview with a senior administrator of the City of Austin, Communications and Technology Management Department representative, August 9, 2004.

³⁷ Some public Wi-Fi venues in Austin offer computer terminals for customers only. We found that close 11 sites of the 47 surveyed had desktop or laptop computers available for their customers: 3 restaurants or fast food, 3 coffee places, 2 lodging, 1 non-profit facility, and 2 other retail.

³⁸ The raw responses recoded into this category included: bridging digital divide, community service, providing access to the community, have people of color use the Internet, etc.

access were of a particular nature: They include two city-owned sites, a nonprofit community meeting facility, a nonprofit bookstore, and a coffee house that provides service in a low income neighborhood of the city.

Figure 9. What were the reasons for adopting Wi-Fi?



n = 47

Lack of Social Vision

Perhaps the most formidable challenge for more socially balanced expansion of public Wi-Fi service in Austin is the relative lack of social visions among the main actors in Austin’s public Wi-Fi initiatives. Our interviews with the key stakeholders revealed that their visions of wireless service and users generally lacked strategies for making public Wi-Fi beneficial to all, including the groups of Austin populations that do not have access to high-speed Internet.

Two characteristic, but very intuitive, patterns are observed in the perceptions of primary customers and users among the key stakeholders (Table 7). First, the majority agrees that the primary customers of public Wi-Fi services are owners of Wi-Fi enabled devices who already enjoyed some form of connectivity. However, only two entities (a city government unit and AFN) recognized public Wi-Fi as a resource for all citizens. Second, many providers identify commercial venues as main customers of their services, indicating contractual relationships between providers and venues. Beyond these intuitive perceptions, however, the stakeholders did not express visions of future users of public Wi-Fi. Specifically, the stakeholders have not envisioned broadening the user base to include lower socio-economic strata. The lack of a solid social vision about the benefits of the technology for all is illustrated by the responses of stakeholders to our question regarding their plans for deploying or facilitating public Wi-Fi in East Austin. Some responses included in Table 8 express the uncertainty felt by stakeholders about the viability of extending public Wi-Fi services to disadvantaged communities.

Table 7. Who are your primary Wi-Fi customers?

Organizations*	Wi-Fi venues	Business people	Owners of wireless devices	Citizens in general
AWCP	x		x	
Austin Free-Net			x	x
Commercial WISP 1	x			
Commercial WISP 2	x			
Bandwidth provider 1	x			
Bandwidth provider 2	x			
City government unit 1		x	x	x
City government unit 2			x	
Public Library			x	
IC ² Institute			x	

* The table lists only those organizations whose representatives answered the interview question pertaining to the perceived Wi-Fi users.

Table 8. Do you envision a way of cultivating more hotspots in East Austin?

-There are a lot of middle class assumptions built onto many [Wi-Fi] programs. There are little thought put into [bringing public Wi-Fi to East Austin] so far.
-The growth of hotspots in Austin is associated to how the Austin corridor is divided.
-Usage will not be high [at a planned Wi-Fi site in East Austin].
-It's just demographics [that there are not many Wi-Fi users in East Austin].
-We think it's important, but we are not sure how to use it in East Austin.
-Financially, there are all sorts of priorities in our operation.

* Table includes quotations from interviews with the City of Austin government, the Austin Wireless City Project, the Electronic Frontier Foundation-Austin, the IC² Institute, commercial Wi-Fi providers; we avoid citing quotations to specific individuals to ensure anonymity these comments.

Issues of sustainability of public Wi-Fi networks, perceived lack of familiarity with the technology, and socio-economic factors were cited as main reasons for not attempting deployment of public Wi-Fi in these areas. However, these views among the stakeholders do not necessarily suggest a lack of awareness about the new inequalities created around Wi-Fi connectivity. Indeed, the deployment of a few public Wi-Fi access sites by the city government (i.e., libraries and parks) in East Austin was a conscious decision to close the Wi-Fi access gap. Yet, other institutions and organizations—individually or collectively—have so far failed to formulate a clear strategy for making public Wi-Fi beneficial for all.

DISCUSSION

Our assessment of Austin’s public Wi-Fi landscape reveals that the opportunities opened by the unlicensed spectrum are materializing in two different directions. On the one hand, we found evidence of proliferation of new spaces for high-speed connectivity in the city, leading to more commercial activities and innovations benefiting the local economy. On the other hand, public

Wi-Fi networks are growing in an uneven fashion, further enhancing connectivity in commercial areas and more affluent areas while leaving behind the underserved population living in less affluent neighborhoods of the city. In this section we discuss these contradictory outcomes and their implications for larger issues of access.

Swift growth and multiplicity of public Wi-Fi initiatives in Austin have primarily been supported by the existence of a *strong demand* for wireless broadband services. Workers of the creative economy in Central Texas served as a well-established market for these services. But these users have not acted as mere consumers of innovations. Employing their technical expertise and entrepreneurial interest, Wi-Fi user groups and startups organized multiple-purpose organizations that promoted, installed and maintained open Wi-Fi networks throughout the city. In reality, the organized actions of these groups have promoted the adoption of the technology most heavily in commercial venues. Austin Wireless City Project (AWCP), principal institutional body behind the so-called ‘free-Wi-Fi’ movement in town, has transformed into the single largest provider of public Wi-Fi service in the city.

The multiplicity of initiatives has also been facilitated by a strong network of collaboration and partnerships among stakeholders. Relying on the technical expertise among members, and acting as demand aggregator of Wi-Fi services, AWCP has played the role of intermediary between broadband providers and Wi-Fi venues. AWCP has also formed a partnership with the local government, providing support to open Wi-Fi networks in city facilities. These examples show how private-nonprofit or private-public partnerships actually facilitate the provisioning of a new public Internet access service.

Institutional arrangements have contributed to shape the access models available in the city. Our survey of venues found that the *venue-sponsored* or *free-to-end-user* access is the prevailing model of public Wi-Fi access in the city. Under this model, venue bears the cost of bandwidth and, in many cases, the cost of the wireless access point equipment needed for the delivery of Wi-Fi service to their customers. Users perceive this model as “free” service, but it is in fact a *venue-sponsored* model that embodies commercial relationships between venues and user-customers. The popularity of this model is the byproduct of the articulation of diverse interests among providers, user groups, commercial establishments, research institutions, nonprofits, and the local government. The motives for embracing this model are diverse and reflect the unique visions of individual actors.

It is undeniable that the venue-sponsored model has become the hallmark of AWCP, promoter of the “free” Wi-Fi movement in Austin. Through the formation and the activities of the AWCP, the visions of the user groups evolved from the original, self-serving idea of wireless enthusiasts seeking the convenience of connectivity into a wider conception of public Wi-Fi as a service for everyone.

The city government has sponsored free hotspots to fulfill three different goals. First, it extends and enhances broadband access at existing city facilities where the city already offers public Internet access (e.g., libraries). Second, it enhances access to e-government services for the citizens and for groups who use city facilities for gatherings and conferences (e.g., convention

center events). Third, the city has installed Wi-Fi for its own operations and use (e.g., health services).

From the perspective of local Wi-Fi startups, the venue-sponsored model is a marketing tool used as opportunity to build business models that differentiate them from established Wi-Fi providers. Startups feel that replicating the *for-fee* access model of large incumbent providers does not add any competitive advantage to their businesses. These small firms are seeking strategies that allow them to offer, directly or indirectly, *free-to-end-user* service at one layer of public Wi-Fi provision while securing revenue-generating activities in other lines of the business (e.g., network security and maintenance, content development, etc.).

Austin Free-Net espouses free-to-end-user connectivity in some of its public Internet access sites as a cost-effective solution to enhance connectivity at these locations. However, the inherent limitation of existing nonprofit Wi-Fi initiatives is the lack of access to the necessary equipment (i.e., laptops and other wireless devices) among the very segments of the citizens they intend to serve. Groups working for enhancing access and use of high-speed services identified the relative cost of the equipment and issues of mobility as factors preventing them from developing a more effective strategy to bring benefits to all.

Despite the presence of talents, local technological expertise, and a dense network of collaboration among the public and private institutions, we observed an uneven growth of public Wi-Fi infrastructure. Wi-Fi initiatives are mostly serving the best-connected and technologically savvy users of the Internet population in the city. Public access of high-speed wireless services is virtually absent in the city's ethnic minority and low-income areas. Why local initiatives have not ensured that larger societal goals are met? We identified three main factors deterring a more aggressive employment of Wi-Fi networks for furthering access to high-speed services in low-income communities.

First, although the geographical unevenness has been remedied to a certain extent by the deployment of public Wi-Fi in city facilities (public libraries, public parks), the local government currently expresses no intention of entering the provision of public Wi-Fi service beyond its facilities. Neither does it have plans to circumvent the barrier of access imposed by the high cost of wireless devices. One informant described these decisions as a "common sense" choice based on the understanding that public and private sectors have clearly demarcated territories for their services. In reality, the course of action taken by the city government with respect to public Wi-Fi deployment can be interpreted as the legacy of anti-munitelecom legislation passed in the mid 1990s restricting municipal telecommunications provision in the state of Texas. This historical lesson has prevented the city from developing local expertise or different types of local interventions to promote digital inclusion of underserved populations.

Second, we found that the proliferation of public Wi-Fi sites is mostly confined to commercial, more affluent areas of the city, and that the majority of hotspots (for-fee or venue-sponsored) are strongly associated with sites of consumption. Arguably, the implicit commercial transaction between these Wi-Fi venues and their customers may restrict access for those with less financial means.

Third, although stakeholders manifested awareness about the new inequalities created around Wi-Fi connectivity in the city, the majority of them have not formulated clear solutions to extend connectivity for the underserved population. Furthermore, most of the key stakeholders do not see themselves as having a role in fulfilling this task. The situation begs for a more proactive framework—whether in a form of specific regulations or a new political discourse—to guide and inform local initiatives about ways in which technology can be distributed and used in more equitable ways.

Austin’s public Wi-Fi landscape is the result of a unique combination of technical expertise in wireless, commercial providers (small and large), and a broad user community base. Collaboration among organizations supported multiplicity of initiatives. Dutton et al. (2004) praise the potential of such private-public partnerships to create multi-layered initiatives for broadband deployment that tap different layers of user demands. The organized action of the nonprofit group AWCP effectively shaped the demand for broadband services in Austin in two main ways: (1) by convincing owners and managers of venues to subscribe the service and open their networks to the public; and (2) by using its power as intermediary to negotiate with broadband providers who finally allowed broadband sharing. However, such efforts have primarily contributed to create a network of wireless LAN enclaves enhancing access to the Internet for the ‘better-connected’ segments of the population. As Bar & Galperin (2004) have pointed out, transforming “cordless archipelagos” to integrated wireless grids will require more than just investment. Issues of standardization, system management, and regulation will demand more attention. Furthermore, to move beyond these exclusive cordless archipelagos, actors will need to develop a vision that is more all-encompassing and aiming at a variety of social goals.

CONCLUSION

Wireless platforms have become a strategic component of local-level initiatives for fostering universal broadband access, innovation, and economic development. The case of public Wi-Fi in Austin illustrates how unlicensed spectrum can be transformed into a valuable resource for new businesses, public services, civic interactions, and local economic development. Austin’s experience also shows that unlicensed spectrum as a resource bears different meanings for stakeholders. Unlicensed spectrum has been transformed into services for citizens, means of communication for nonprofit groups, a valuable commodity for trade, or simply an amenity in commercial venues. The coexistence of this multiplicity of uses has been enabled through institutional arrangements between stakeholders. Such arrangements can take the form of commercial relations, volunteer actions, information sharing, or visioning. It is precisely these shared visions and institutional collaborations that prevented the tragedy of the commons from materializing in Austin. The active involvement of local stakeholders in the co-management of the resource has been a crucial factor creating an environment in which multiple users are sustained.

However, an entrepreneurial drive and local management do not ensure that broader societal needs will be met. The uneven growth of public Wi-Fi in Austin poses questions about the ability of local actors to address these problems. More thinking and efforts are required to deliver the promise of universal broadband access through the unlicensed spectrum. We contend that

enhanced access through public wireless broadband networks will become a crucial component in these efforts.

For almost a decade, telecommunications policy scholars have called attention to the need to expand traditional definitions of universal service to account for different layers of access, including devices that support connectivity to advanced services, as well as software and content requiring specialized skills. Wireless Internet brings new arguments to the table, calling for reconsideration of old notions of access, as well as new solutions that use the sum total of networks' capabilities to extend connectivity to all. Wireless broadband has created new possibilities to turn the old problem of building the last-mile connection into users' first-mile access to the online world. As Dutton et al. (2004) assert, the potential of this technology lies in its uses, and its promise will not be fulfilled until stakeholders make a political decision to work on more balanced forms of public access. This effort will require intervention in underserved areas, higher level of coordination, and strategic thinking to renew concerns for activities that promote digital inclusion.

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APPENDIX

Organizations involved in the deployment, promotion and advocacy of public Wi-Fi in Austin

Nonprofits	5
AUSTIN WIRELESS CITY PROJECT	
AUSTIN FREE-NET	
ELECTRONIC FRONTIER FOUNDATION	
CAPITAL AREA TRAINING FOUNDATION	
DEWITTY JOB TRAINING CENTER	
Users groups	1
AUSTIN WIRELESS GROUP	
Local government agencies	3
CITY OF AUSTIN- IT GROUP	
CITY OF AUSTIN- REGULATORY AFFAIRS	
CITY LIBRARIES	
Educational institutions	4
AUSTIN COMMUNITY COLLEGE	
HUSTON TILLOTSON COLL.	
AUSTIN INDEPENDENT SCHOOL DISTRICT	
UNIVERSITY OF TEXAS	
Research institutes	3
UT IC ² INSTITUTE	
UT WIRELESS NETWORKING & COMMUNICATIONS GROUP	
UT LBJ SCHOOL	
Business associations	3
AUSTIN WIRELESS ALLIANCE	
CHAMBER OF COMMERCE	
WIRELESS ALLIANCE	
Commercial providers	10
SOUTHWESTERN BELL CO.	
GRANDE COMMUNICATIONS	
TIME WARNER/ ROAD RUNNER	
WAYPORT	
WIFI-TEXAS	
TENGO INTERNET	
AUSTIN UNLEASHED	
IMAGEMICRO	
WAVEFORWARD	
REALLINX	
Total	29