Wireless Feasibility Study

Prepared for the City of Tucson

Tucson, Arizona

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Abstract

The City of Tucson, Arizona, ranks third in the United States on the 2006 Digital Cities Survey,[1] which examines how city governments are using digital technologies to better serve their citizens and streamline operations. This notable achievement highlights the emphasis the City of Tucson places on using emerging technologies to communicate with the residents and businesses of Tucson. To build upon this achievement, the City is researching methodologies to increase the affordability and availability of connectivity services for residences and small businesses.

High-speed Internet access is a basic necessity because it provides the means for access to information anywhere, anytime. Unfortunately, many Tucson residents and business owners find themselves without access to this vital service either because of high monthly access costs or broadband service deployment policies that leave their area without service. Just as water and electricity are critical public services, high-speed Internet access is rapidly emerging as a new type of basic public service

This report evaluates the opportunities to encourage a private sector provider to implement a City-wide WiFi network to deliver low-cost high-speed Internet access to residents and business. In addition, this report details the current use of Internet by residences and business, outlines the existing Internet providers and services, reviews strategies to leverage community assets, details a conceptual WiFi design, and describes key business model elements.

[1] Conducted by the National League of Cities (NLC) and the Center for Digital Government. See http://www.centerdigitalgov.com/surveys.php?survey=cities

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1. Executive Summary

The City of Tucson seeks to fill gaps in coverage, encourage new uses of technology, leverage the mobility of WiFi and enhance the availability of a cost-efficient Internet access solution for residents and small businesses. To that end, the City of Tucson engaged Columbia Telecommunications Corporation (CTC) to assist with evaluating whether to issue a Request for Proposal (RFP) to encourage the private sector to build and operate a Citywide WiFi network to deliver an affordable high-speed Internet offering. This report was prepared by CTC in early 2007 to evaluate the potential for Citywide WiFi.

This project is designed to help realize the City's vision for its technical future in which:

1. Tucson is a connected community, where all people have an equal opportunity to participate in civic affairs through all means possible, at all times possible, in all places possible.
2. Tucson is a place where community connections and the quality of life are enhanced by access to high-speed Internet access anywhere, at any time, by anyone.
3. Tucson is a community-wide Internet hot spot where all thrive civically and economically for a lifetime.

1.1 Study Methodology

To adequately conduct this analysis, CTC's staff of engineers and analysts undertook the following tasks:

- Conducted telephone surveys of randomly selected businesses and residents. The surveys were constructed to evaluate consumer use of Internet access, what services are used, and interest in a low-cost wireless offering.
- Conducted in-person interviews with the City, school districts, and other agencies including:
    - Community Services Department – City of Tucson
    - Pima County Community College
    - Pima County – Information Technologies
    - Tucson Convention Center - City of Tucson
    - Tucson Regional Economic Opportunities
    - Tucson Unified School District
    - Tucson Wi-Fi Alliance
    - University of Arizona – Information Technologies
    - Vail School District
    - Visitors and Convention Bureau

- Conducted a public forum to discuss the potential uses and benefits of WiFi access.
- Meet with City Council members, staff, and the Mayor to better understand goals and objectives.
- Reviewed various business models and their fit to the City's goals and objectives.
- Reviewed potential digital inclusion strategies that leverage the proposed WiFi network and coordinate with other community inclusion efforts.
- Conducted research regarding the existing Internet providers in the region to determine the existing availability of services; to assess the factors that prevent or delay further private sector investment; and to determine how existing and planned service offerings may compete with or complement a WiFi offering.
- Prepared a conceptual WiFi design to better understand the potential investment requirement to deploy a City-wide WiFi network.
- Examined the potential financial viability of a low-cost Internet offering in the community.
- Outlined a series of considerations for inclusion in a Request-for-Proposal (RFP) to encourage a private provider to deploy a WiFi network in Tucson.

1.2 Study Goals

In summary, CTC and the City have identified the following goals and considerations for reaching the City's objectives:

Encourage the private sector to provide affordable access options. The market research conducted during this project showed a high-demand for a high-speed alternative priced to compete with dial-up services – under $25 per month for residences and under $30 per month for businesses.

Leverage community assets to help ensure that the private sector investment can realize a reasonable return on investment. Deployment of a City-wide WiFi network will exceed $15 million plus the consumer installation costs. Getting a commitment to build a WiFi network will take innovative approaches to improve the WiFi business case.

Increase awareness of the benefits of high-speed access. Many dial-up and other Internet users are unaware of or do not take advantage of on-line services beyond email.

Encourage new applications, such as telemedicine and distance learning. The area school districts have initiated new learning activities in which high-speed on-line services is essential.

Explore and encourage digital inclusion programs and offerings to enhance learning and employment opportunities. Although the use of high-speed access in Tucson is higher than the national average, there is a gap between users and non-users based upon income level.

Maintain a separation between public safety applications and the proposed WiFi network. The City of Tucson has begun deployment of a WiFi network for support of public safety and other uses. The public safety network is designed to support critical outdoor traffic – not indoor retail services.

Minimize the City of Tucson's required investment to obtain commitments from a provider to deploy a City-wide WiFi network. The City intends to attract a private sector company to build a WiFi network without direct City investment (or indirect investment through an anchor tenancy that would guarantee substantial annual payments to the provider from the City). This investment goal is quite different from other municipal WiFi efforts. The majority of municipalities that have obtained a commitment from a private provider to build a city-wide WiFi network have done so by agreeing to be an anchor tenant. Given that this model does not fit the City's goals and objectives, alternative approaches are required. The Request for Proposal (RFP) should highlight the areas that City is willing to assist in to encourage providers to develop creative responses.

Understand the City of Tucson's costs to support a private provider deployment of a City-wide WiFi network. Even without a direct investment, the City of Tucson will see expenses related to the network deployment and operation. The anticipated expenses are dependant upon the model negotiated with the private provider and how aggressively the City wishes to monitor the installation and on-going operations.

1.3 Potential Benefits of a City-Wide WiFi Network

CTC and the City have identified a wide variety of benefits that are likely to flow from a public wireless network. The following are a few illustrative examples:

Connection to the Community: The Tucson Community Services Department sees Internet as a basic tool to survive in society. From checking children's grades and progress at school to filing job applications, Internet access is no longer a luxury. Staff does not find it usual to see people without furniture yet they have a computer. Parents need to connect with their children's schools through the Internet. Job seekers need access to online employment ads. Seniors and disabled residents unable to directly participate in services need online access opportunities. Residents need access to City information after business hours. Increased access to the Internet through a City-wide WiFi initiative opens up the opportunity for the Department to provide online services and programs.

Education: Instructional needs drive school initiatives. There is a movement in the educational arena to utilize video (streaming and on-demand) and other technology-based programs to enhance learning. Remote learning crosses school boundaries and brings learning into homes. Learning anywhere anytime is the future. The reluctance to fully embrace remote technology comes down to an equity issue. Not all students have computers, not all students have access to the Internet. A City-wide WiFi initiative provides a platform of consistent connectivity and overcomes a giant hurdle because equitable access is achieved. If ubiquitous Internet coverage is available it opens new doors for teaching. The opportunities for students and their parents are many. Access to school databases, software programs, online learning initiatives expands the school day into the at home hours and permits parents to become more involved in their children's instruction.

Tourism: Tourism accounts for one of every 10 jobs in Tucson and adds over $1.8 billion per year to the local economy. Travel and tourism produce 40,000 jobs and is one of the most rapidly growing industries in Tucson. City-wide WiFi access raises the "attractability index" of the City which in turn increases tourism. Outside WiFi coverage is an assumed amenity in a town with Tucson's climate. Visitors should be able to eat lunch and check email while in the Downtown area. "Stay with you connectivity" is important as visitors move from place to place.

1.4 Anticipated Costs

Encouraging a private investor to build a City-wide WiFi network is not without costs for the City of Tucson. The anticipated implementation costs and annual expenses are dependant upon the private offering made and the degree of participation the City of Tucson desires or is required by the selected provider. The anticipated range of expenses for implementation support is $89,000 to $314,000. Assuming the City of Tucson covers power expenses for fifty percent of the Wireless Access Points (WAP), the annual expenses are estimated at $297,000 to $574,000. Without the power and attachment expenses the estimated annual expense ranges drops to $58,000 to $131,000.

A City-wide WiFi deployment will cost at least $15 million plus consumer installation expenses. The cost estimate is dependant upon the deployment strategy and vendor selection. CTC estimates the implementation cost from $15.2 million to $29.4 million plus consumer costs. Assuming that 20 percent of households acquire a WiFi service, the estimated investment ranges from $25.6 million to $35.4 million.

As an option, the City of Tucson may consider encouraging a targeted deployment in downtown or selected neighborhoods. For example the cost estimate, not including consumer costs, for a downtown deployment ranges from $476,000 to $654,000. The cost estimate for a deployment covering downtown and the Rio Nuevo neighborhoods ranges from $1.3 million to $2.0 million.

1.5 Summary of Study Recommendations

As a result of the activities summarized above, CTC prepared the analysis, recommendations, and considerations provided in this report. These recommendations and considerations offer a variety of perspectives on how to encourage private investment and develop digital inclusion strategies.

Most importantly, CTC recommends that the City release a RFP for a City-wide WiFi deployment. We further recommend that the structure of RFP allows for implementation options such as a downtown or other targeted deployments and independent proposals to address the digital inclusion elements. Our assessment is that the potential market is such that the City will attract bids from the private sector. In preparing the RFP, we suggest the following strategies:

First, we recommend a work session with selected Tucson staff and decision makers. The purpose of the work session is to refine and tailor the recommendations and considerations presented in this report. The work session will help Tucson staff and decision makers view the recommendations in context of the identified goals and objectives.

Key Issues

We recommend consideration of the following issues during the work session and drafting of the RFP:

1. The assets that the City of Tucson has to offer and is able to leverage. The breadth of assets include; mounting facilities such as lamp posts and traffic lights, support from economic development, promotion of services to local residences or businesses, and others assets that will improve the profitability of the WiFi business.
   - Leverage of the City assets may reduce operating costs and the required investment for a City-wide deployment.
   - Leverage of the City brand name may help reduce customer acquisition costs.

2. The level of control or influence does the City of Tucson requires. Attributes to define include: availability of service (percent of all households, percent of outdoor, etc), price and service levels, requirements for installation at consumers, and other factors that influence the consumer experience.
   - Private investors will tend to pursue the "easy to reach consumers first, a city sponsored deployment needs to ensure all citizens have an opportunity to acquire service.
   - The market for WiFi is for a high-speed low-cost (under $25 per month) alternative to dial-up.

3. The level of political risk the City of Tucson is willing to absorb in order to attract a successful WiFi proposal.
   - Municipal WiFi is in an early development status and most business models are untested. A City-wide deployment either City or privately-owned face many challenges – technologically and financially.

4. The roles the City of Tucson will support in promoting the WiFi network including assistance with sales and marketing support of advertising in existing publications, and seeking anchor tenant commitments from area businesses.
   - Leverage of existing communication channels may reduce costs to obtain customers and increase awareness of the WiFi offering.
   - The success of the WiFi business hinges on the market share gained.

5. The digital inclusion goals and objectives, including coordination with other agencies in Tucson.

- Digital inclusion is not just available and affordable of access. Digital inclusion efforts require coordination with user training, hardware access, and other elements.

These issues are addressed in the specific recommendations below:

1.5.1 Leverage Marketing Assets and Resources to Attract the Investment for a Citywide WiFi Network

Attracting an investment for a City-wide WiFi deployment, although not trivial, appears possible, without having to commit to a capital investment and/or tenant payments. In order to attract the investment, the City of Tucson needs to leverage marketing assets and resources that will:

1. Reduce operating costs such as pole attachment fees, energy fees, customer acquisition and maintenance. As is discussed in detail below, reducing or eliminating pole attachment and energy fees may make or break the business case. The annual estimated pole attachments and energy fees approach $1,000,000, the second highest expense (staffing is the number one expense for the provider). The City of Tucson may reduce this fee by allowing attachments to the street lights[2,3] or providing Rights-of-Way access for solar-based solutions.

2. Reduce the required investment to deploy the City-wide WiFi network. Careful attention is required when specifying the geographic requirements. Removing requirements to serve parks, golf course, and other open areas will reduce the deployment costs—without subverting the objective of ensuring all households have the opportunity to participate.

3. Increase the number of anticipated consumers without lowering per customer contribution margins. The City of Tucson has an opportunity to leverage existing communication channels to educate residences and business regarding the benefits of high-speed access. Conducting education workshops is one example of a potential low-cost high-impact marketing effort that is relatively easy for the City of Tucson, but expensive for a new private provider.

1.5.2 Select the Appropriate Balance of Risk and Control Which Meets the Identified Objectives

Given the requirement of not making a direct or indirect investment, the City of Tucson must consider a range of other alternatives- which may take a political or other risk. The Tucson model must seek to reduce customer acquisition costs, increase potential market share, reduce implementation costs, and reduce operational expenses. For example, the

[2] The City of Tucson owns approximately 50 percent of the lampposts (ones located on major streets) and TEP owns the remaining lampposts (primarily in the neighborhoods).
[3] Lampposts owned by the City of Tucson are metered which should enable the City to allow the WiFi provider to obtain energy at an incremental cost, rather than paying the minimum service connection fee ($10 plus per month) at each location.

City of Tucson may consider offering assistance in encouraging residents and businesses to subscribe at the political risks of appearing to favor a new entrant in the market over providers that have previously invested in the community.

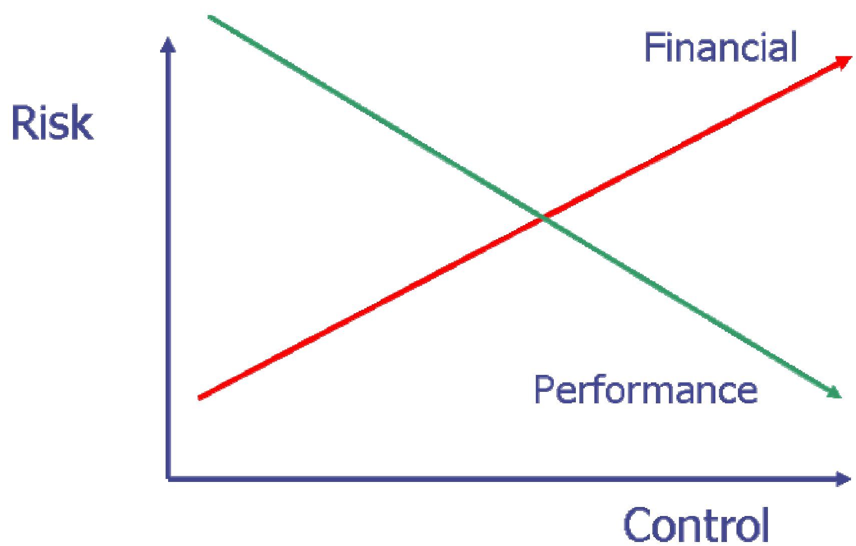
When refining the requirements and obligations for the City of Tucson and the RFP respondents, it is critical to select an appropriate level of risk, degree of control, and the share of potential rewards. All too often we see RFPs distributed to the WiFi provider community asking for financial commitments, free service, and other obligations with little or nothing in return. For example, a recent RFP developed and distributed by a municipality asked potential providers to build a city-wide network. In the RFP, the city asked for and required the responses to:

- Offer a free service for a digital inclusion program.
- Provide funding for the digital inclusion program.
- Provide 100 percent geographic coverage in the community.
- Offer a $20 per month 1 Mbps Internet service to all residences and businesses.
- Provide free access for police, fire, and other public uses.
- Provide the city a percentage of subscription revenues received.

In return, the city offered to grant access to lamp posts and other assets for a monthly fee. Not surprisingly, no responses were received.

When developing the RFP, it is important to remember the balance of risk and control. This relationship is illustrated in Figure 1-1.

Figure 1-1: Balance of Risk and Control



The concept shown in Figure 1-1 is simple. The more control a municipality requires with respect to performance, coverage, pricing, and other attributes, the higher a financial (or other) risk the municipality must be willing to take.

It is also important to understand that Municipal WiFi is early in development from a vendor and business model perspective. Many vendors that are offering WiFi products today may not survive in the long term. In addition, many of the business models are untested or proven. Further, the promises of great financial municipal rewards are greatly overstated. If high-rates of return were guaranteed, the private sector would already have systems in place. As the City considers releasing an RFP and as it evaluates responses, it is critical not only to look at what the City of Tucson gets – but an examination of the potential for the provider to succeed.

1.5.3 Use the Market Research Findings to Demonstrate the Extent of the Potential Market

CTC's market needs analysis will be an important element of the future RFP because it demonstrates the demand and need for a low-cost high-speed service. Our research indicates that 35 percent of all households and 40 percent of business are willing to consider switching to a high-speed low-cost Internet service. This should serve as a powerful incentive to potential bidders who may respond to the City's RFP.

Pricing will play a key role in the development of a public or private venture into broadband Internet service provision. The success of a WiFi business hinges on the market share gained. We foresee there being little problem encouraging some residential high-speed subscribers to switch to this service; they will essentially receive the same (or better) service at a lower price.

The key demographic in this business is that of dial-up users, who are perhaps less likely to be concerned with, or value, a faster speed. Their service provider decisions are largely based on price, and their perception of ease of use. By employing an overall cost leadership position strategy, a WiFi provider's chances for success improve greatly. This involves slightly undercutting the monthly prices of national dial-up providers and marketing the product as a both lower cost and better quality service. The survey results indicate that the ideal price point is between $20 and $25 per month.

Because the low-end pricing of this service is so crucial, the WiFi provider will be wary of attempting to "do too much." The revenue per customer will be such that there will be little room for large expenses, and the provision of unnecessary or extravagant services will quickly erode net income and cash flow. The market positioning of this service is designed to provide essential high-speed Internet to residential and small business users.

In negotiation with a potential provider, it is important to understand that the private and public sectors have conflicting objectives. The private sector will try to maximize revenues (for example, they will seek to keep capital investment to a minimum, do not serve hard-to-reach consumers, shift expenses to consumers, deploy a lower density of wireless access points, and charge consumers for installations). A public sector objective is to maximize participation (ensure all households have an opportunity to participate, make an extra effort to ensure consumers are connected).

1.5.4 Release and Publicize the RFP Widely

As a starting point for the RFP distribution, we recommend submittal to the WiFi vendors. Many of the WiFi vendors are courting providers that are interested in building municipal networks and are likely to distribute to potential regional and other providers that we are not aware of.

The WiFi vendors include:

- BelAir
- Cisco Systems
- DigitalPath
- Firetide
- Motorola
- Nortel
- Proxim
- RoamAD
- Sky Pilot
- Strix
- Trango Systems
- Tropos

In addition to distributing the RFP to the identified WiFi vendors, we recommend distribution to the following providers:

- 20/20 Communications
- Arinc
- At&t
- Azulstar
- CenturyTel
- Cellnet
- Clearwire
- Communication Bridge Global
- EarthLink
- Frontier
- Kiva Networks
- GTS
- MetroFi
- MobilePro (NeoReach)
- Moving Target
- NextWLAN
- Northrup Grumman
- Onvoy
- Red Moon
- Redzone Wireless

- Razortooth Communications LLP (d/b/a RedTAP)
- SeaKay, Cisco, IBM (partnered in San Francisco)
- Softcom
- Unplugged Cities
- U.S. Internet
- U.S. Wireless
- Veraloft
- Others

1.5.5 Require a Robust Digital Inclusion Program Focused on Scalable Service

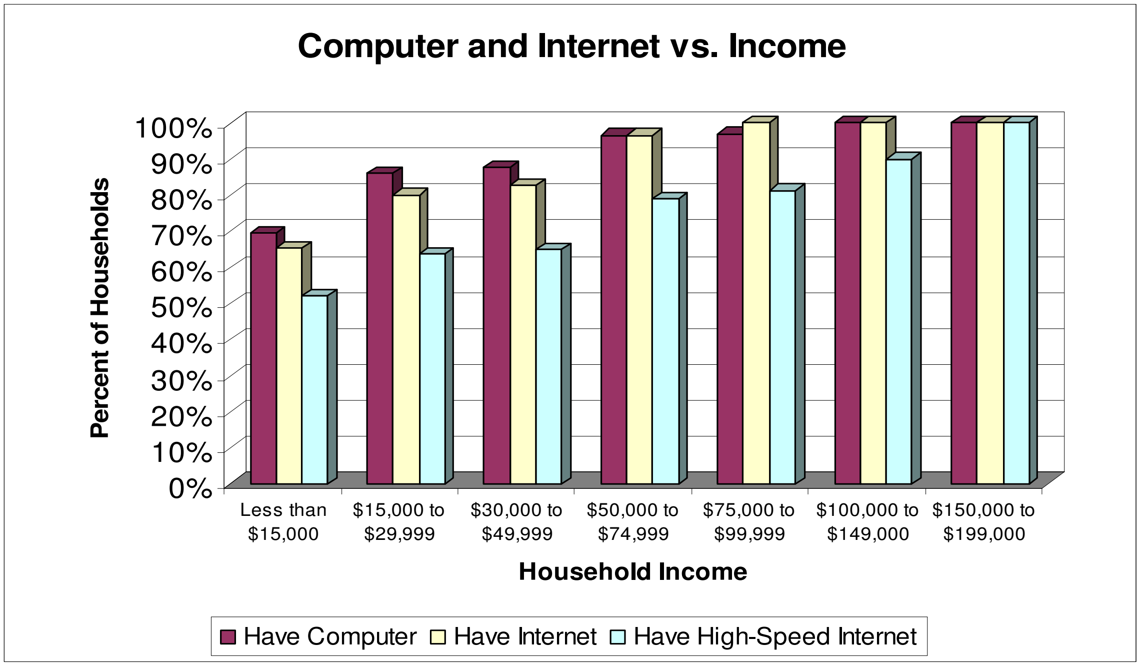
CTC recommends the City of Tucson include in its RFP the following elements for a digital inclusion program.

- Require the provider to provide ubiquitous coverage – allowing all residents the opportunity to participate.
- Require a free service with at least 300 Kbps access as the starting point for digital inclusion. Do not accept a "walled garden" that only allows access to selected web-sites.
- Negotiate for speed of access of the free service over time (perhaps scaling with paid products).
- Avoid means-based inclusion approaches because they may add a barrier to participation.
- Require the provider to conduct education sessions as part of their core marketing efforts. The education sessions are to feature how high-speed access can reduce monthly household expenditures on telecommunication services.
- Concentrate WiFi provider efforts on low-cost or free access – not the other elements of the digital divide.
- Coordinate digital inclusion access efforts with other agencies such as the area schools.

CTC recommends these components of a digital inclusion program based on our experience, our observations of the public wireless movement nationally, and the results of our market research—which suggests that although residential Internet access in Tucson is far above the national average, there is still a digital divide among Tucson residents.

Approximately 90 percent of all households in Tucson have a computer, and approximately 87 percent of all households have Internet access (80 percent with high-speed, 20 percent with dial-up). These percentages, however, vary greatly with household income. Of the households with annual incomes of less than $15,000, only 70 percent own a computer and 52 percent have high-speed Internet access. On the other end of the spectrum, 100 percent of households with income greater than $100,000 have a computer and nearly all have high-speed Internet access. This correlation is illustrated in Figure 1-2.

Figure 1-2: Correlation of Computer and Internet vs. Income



The digital divide has real consequences for the Tucson community. A portion of the population may be unable to take advantage of educational opportunities; may be unable to participate in programs and services offered through web-based applications; and have no access to quality jobs because of inability to search the web for employment information or apply for jobs online. Tucson schools use computer-based curricula as a complementary educational tool. Administrators and teachers recognize web-based, at-home learning as expanding the boundaries of school and providing a longer school-day, but they are cognizant that not all students have access to the Internet. The interviews indicated that as computers become more affordable, the digital inclusion challenge that needs to be addressed is not as much equipment-based but rather how to overcome the monthly Internet access charge.

Many municipal WiFi agreements include a requirement for the provider to fund digital inclusion programs. These requirements however, are conditioned to profitability benchmarks that might be difficult to reach if at all. Given this, it is quite optimistic to expect that the WiFi provider will provide the access and fund the other elements of digital inclusion.

It is unrealistic to expect the private sector to voluntarily switch for profit business models and offer free Internet access. To address this reality, many municipalities, libraries, school districts, and park districts are providing WiFi hotspots for public use. While this is an important first step, to serve the critical need for "information anywhere, anytime," these shared-use public facilities need to complement private access. A City-wide WiFi network in Tucson takes public shared-use to the next level. It permits every Tucson home and business to have Internet access.

Bridging the digital divide brings benefits to all. Access to web-based services and programs is cost-efficient for the providers (schools, governments, private-sector, etc.) and brings the users not only convenience but fair and equal access. By considering a City-wide WiFi Program, Tucson is poised to provide a model for mitigation of the digital divide in the community.

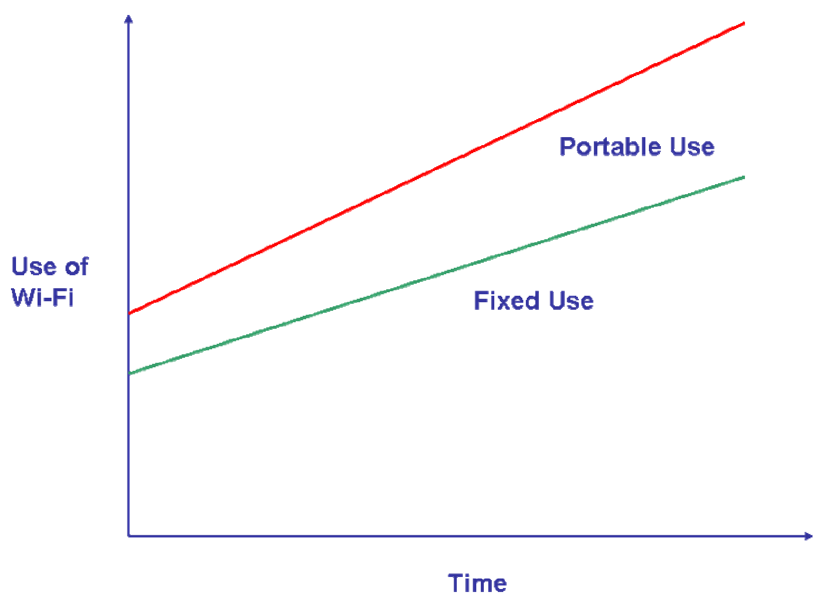
1.5.6 Plan for Incremental Fiber Deployment to Meet Long-Term Broadband Goals

A combination of wireless, fiber, and other connectivity technologies are required to meet the entire breadth of private and public connectivity needs. Obtaining a City-wide WiFi network is just a start -- not the ending. We strongly recommend that the City of Tucson view the WiFi effort as a necessary first step, then look at ways to embrace and encourage incremental steps toward fiber deployment to large business and institutions, then smaller business, and eventually to all households.

Although wireless technologies will continue to evolve at a rapid pace, wireless will not replace fiber for delivering high-capacity circuits to fixed locations. In addition, fiber will always be a necessary component of any wireless network because it boosts capacity and speed.

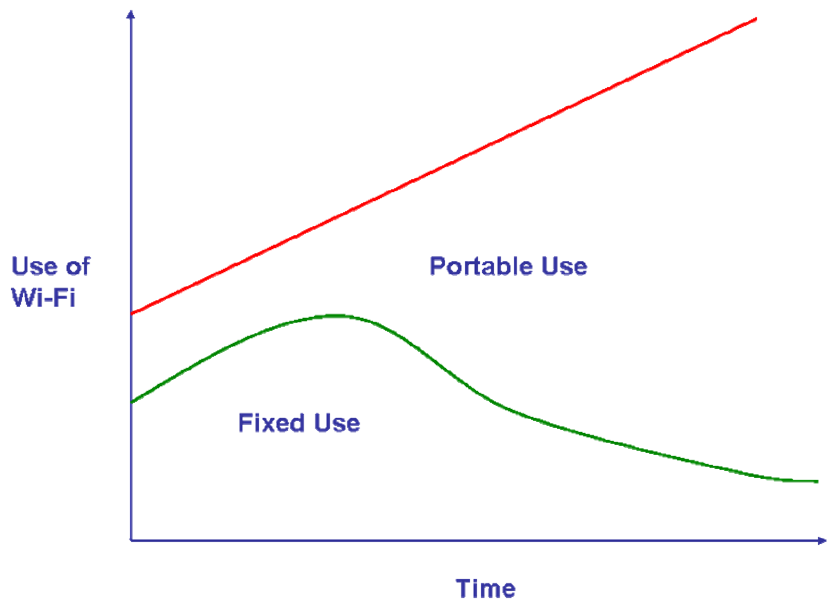
The industry observers and experts that propose wireless Internet access solutions will reduce the need for fiber - predict a shift to wireless for fixed access. Figure 1-3 illustrates both fixed use and portable use of wireless increasing over time. This scenario requires that wireless technologies capabilities increase substantially, meeting expanding capacity and speed needs.

Figure 1-3: Wireless Access-Prediction 1



Another scenario is that while portable use continues to grow, fixed use will flatten and possibly decline. In this scenario, shown in Figure 1-4, alternative fixed based technologies such as FTTP become more prevalent.

Figure 1-4: Wireless Access-Prediction 2



CTC believes the second scenario is most likely in the long-term. Fiber offers the greatest future proofing and long-term growth potential. However, mobile wireless use will continued to grow since fiber solutions do not deliver mobility.

The United States does not currently have a national broadband policy that encourages fiber-to-the-premises development (unlike, for example, many European countries). As a result, fiber-to-the-premises solutions are unlikely unless the City or other public entity explore ways to encourage investment and explore other business models.

2. Market Assessment

This section provides a detailed summary of the survey[4] conducted with randomly selected residences and businesses located within Tucson. The survey results projects a variety of consumer behaviors including computer and Internet use, sensitivity to switch Internet service providers based on attributes such as speed and price, and perceptions regarding the role of the City of Tucson in ensuring high-speed access is available.

Market Insights

Residential Internet Use

Approximately 70 percent of Tucson homes have high-speed Internet access, which is higher than national averages. The latest report from the Pew Internet and American Life Project[1] indicates that the national average is 42 percent of all households having high-speed access.

DSL Availability

In Tucson cable modem service dominates high-speed access with a 65 percent market share, while DSL accounted for 26 percent. Based upon national based survey findings[5] and our experience in other communities, this is a potential indication that DSL coverage in Tucson is limited or has spotty coverage in residential areas.

The report from the Pew Internet and American Life Project[1] indicates that DSL overtook cable modem service as the most widely used residential high-speed access in 2006. The Pew Report indicated that DSL accounted 50 percent of the residential high-speed market, while cable modem accounted for 41 percent. The Pew Report indicated that substantial prices cuts accounted for the gains seen by the DSL providers. The Pew Report is not without controversy. Another research firm, Leichtman Research Group Inc., disputes the data. The latest findings from Leichtman Research Group claim that cable modem use still leads high-speed with a 52 percent share, compared with DSL's 46 percent.

Regardless of which survey provides the most accurate snapshot, the gains made by DSL providers are impressive. As indicated in the Pew Report, the gains have been initiated by aggressive pricing and tiered service offerings which give consumers more choices. However, The Pew Report appears not to consider another key factor – whether DSL is available at a given consumer location. Our survey findings and competitive analysis in other communities have shown that when DSL market share is low, DSL availability is limited or has spotty coverage. We are not surprised with different findings since DSL

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[4] The telephone survey was contracted with Advanced Data-Comm (ADC), Dubuque Iowa and the initial survey analysis was contracted with Clearspring Energy Advisors, Madison Wisconsin.

[5] Home Broadband Adoption 2006, Pew Internet & American Life Project, May 2006

availability in a community is not a consumer behavior attribute and DSL availability varies widely from community-to-community. In other words if the two surveys did not factor in the variations in DSL availability, differences in the survey findings are expected.

Consumer Expectations

For residential consumers, we observed significant differences between importance and satisfaction for price and connection speed of their Internet service. This may indicate a potential market opportunity for a low-cost high-speed service. It is however important to understand that perceptions a connection speed will vary from consumer-to-consumer. For example, from experience with other communities that have deployed City-wide WiFi, consumers that switch from dial-up to a 1 Mbps WiFi service are ecstatic about the performance, while previous cable modem users are generally dissatisfied with the download speeds. Given that in Tucson over 50 percent of residential Internet users have cable modem service(vs. 20 percent dial-up), offering a higher tier connection speed (2.5 Mbps or greater) will be important.

The gaps between importance and satisfaction are greater for business users. We observed significant gaps for speed, price, reliability, and security. In addition to the speed perception indicated above, marketing efforts for business users will need to specifically address the reliability and security attributes of WiFi.

Tucson Brand Image

We did not observe any significant consumer interest between a WiFi service that is endorsed by the City of Tucson versus a service not endorsed. This indicates that Tucson brand image may not have a significant value for a WiFi offering from a marketing perspective.

Factors Impacting Residential Internet Use

We observed the key factors impacting computer ownership and acquisition of high-speed Internet service.

1. Income: There is a 2 to 1 difference (50 percent vs. 100 percent) in having high-speed Internet at home between low-income and high-income households. Computer access has a similar pattern, but a reduced ratio (70 percent vs. 100 percent).

2. Age of the person responsible for paying household bills: Households having a computer at home dropped considerably for respondents over 65. Having high-speed Internet at home declined as age increased.

3. Having school aged children at home: We observed a slight increase of computer ownership and having high-speed Internet access for households with school age children to those households without school age children.

Residential Results

The key findings of the residential market research study include:

- Approximately 90 percent of Tucson homes have a computer, 87 percent have Internet access, and 70 percent have high-speed Internet access.
- The mean price paid for residential Internet service is approximately $39 per month (national average is $32 per month for DSL service and $41 per month for cable modem service).
- Low income homes and homes with older adults are less likely to have Internet access. Homes with preschool or school-aged children are more likely to have Internet access.
- Connection speed is the most important aspect of Internet service, followed by the ability to use telephone and Internet simultaneously and price of service.
- More than 50 percent of residential respondents are willing to switch to high-speed Internet service for a price of less than $20 per month, while less than 10 percent are willing to switch for a price greater than $41 per month.
- When asked about the role the City should play in development of wireless Internet service, 41 percent indicated that the City should promote the competitive market while 23 percent said the City should have no role. Only 10 percent indicated that the City should install a wireless network.

Business Results

The key findings of the business market research study include:

- Approximately 93 percent of Tucson businesses have Internet access, and 80 percent have high-speed service. Of those with Internet service, 42 percent have DSL, 30 percent use a cable modem, and 14 percent have dial-up service.
- The mean price paid for business Internet service is approximately $60 per month, excluding the very large users with monthly prices greater than $300.
- Reliability is the most important aspect of Internet service for businesses, followed by on-line security and connection speed.
- More than 50 percent of business respondents are willing to switch to high-speed Internet service for a price of less than $20 per month, while less than 15 percent are willing to switch for a price greater than $41 per month.
- When asked about the role the City should play in development of wireless Internet service, 41 percent indicated that the City should promote the competitive market while 22 percent said the City should have no role. Only 14 percent indicated that the City should install a wireless network.

The remainder of this section summarizes the findings from the residential and business Internet use surveys.

2.4 Residential Survey Results

We conducted telephone interviews of 401 randomly-selected residences in the City of Tucson between December 15, 2006 and January 5, 2007. Given approximately 195,000 households in Tucson, 401 responses provide results at the 95 percent probability level with a confidence interval of ±4.9 percent at the aggregate level.

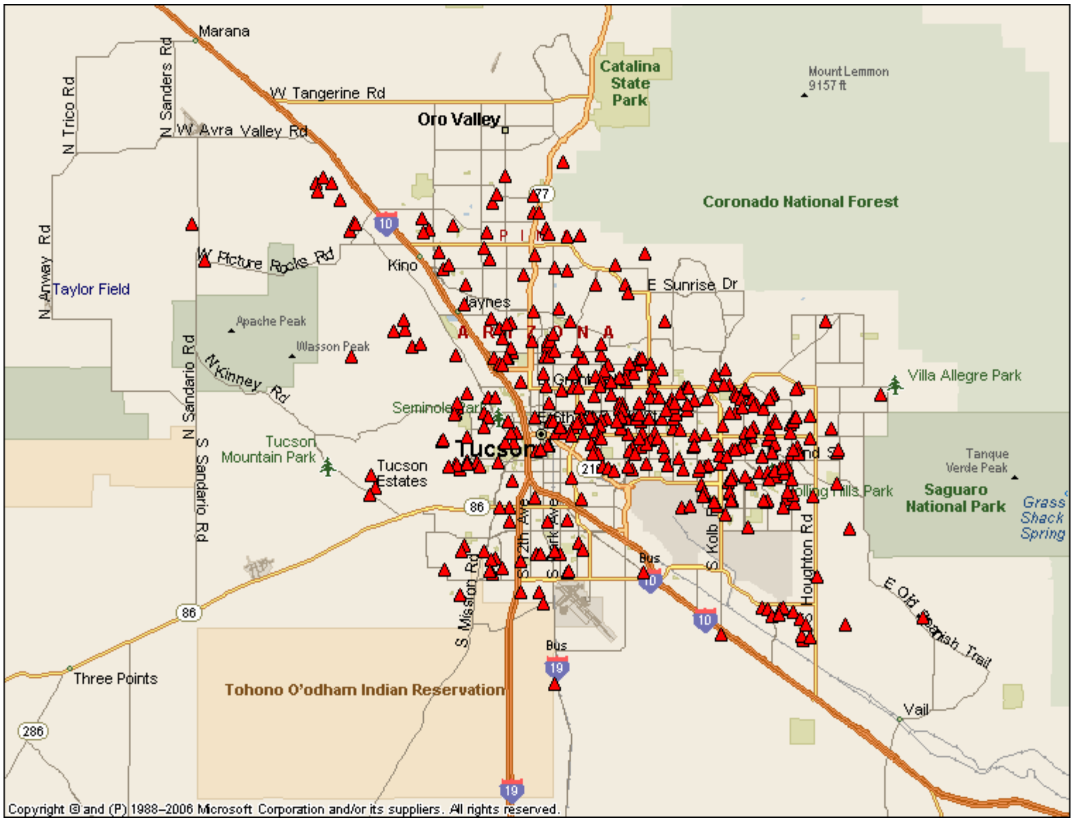
The residential survey results presented in this report are weighted by the age of the respondent to reconcile the differences between the ages of survey respondents and the Tucson population as a whole. The 2000 Census is used as the benchmark for the population distribution by age cohort (for all persons age 18 and older). The weighting calculations are shown in Table 2-1.

Table 2-1: Residential Weighting Calculations

Survey Response Weighting by Age			
Age Cohort	**Survey %**	**Census %**	**Weight**
18 to 24 years	2.8%	17.3%	6.23
25 to 34 years	11.6%	21.1%	1.81
35 to 44 years	17.2%	19.9%	1.16
45 to 54 years	19.2%	15.9%	0.83
55 to 64 years	25.0%	9.8%	0.39
65 years and older	24.2%	16.0%	0.66

The households responding to the survey were dispersed geographically across the City of Tucson. A map showing the locations of the respondents is shown in Figure 2-1.

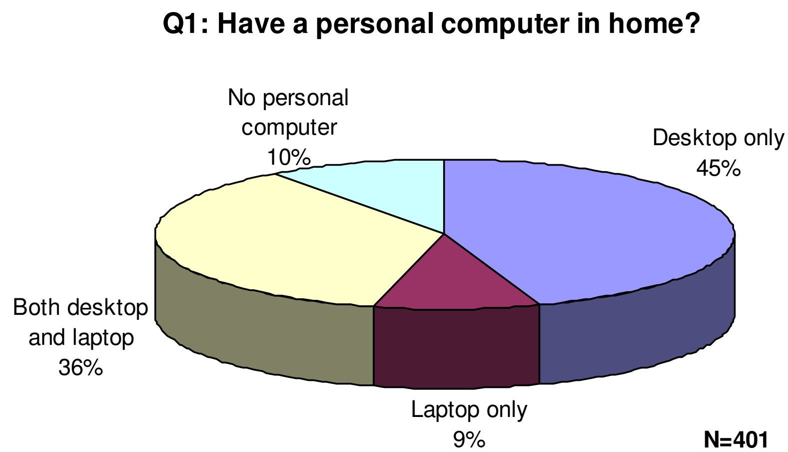
Figure 2-5: Residential Survey Respondents



2.4.1 Residential Computer and Internet Characteristics

As shown in Figure 2-2, approximately 90 percent of Tucson residents have a computer in their house. 81 percent of homes have a desktop and 45 percent have a laptop (36 percent have both).

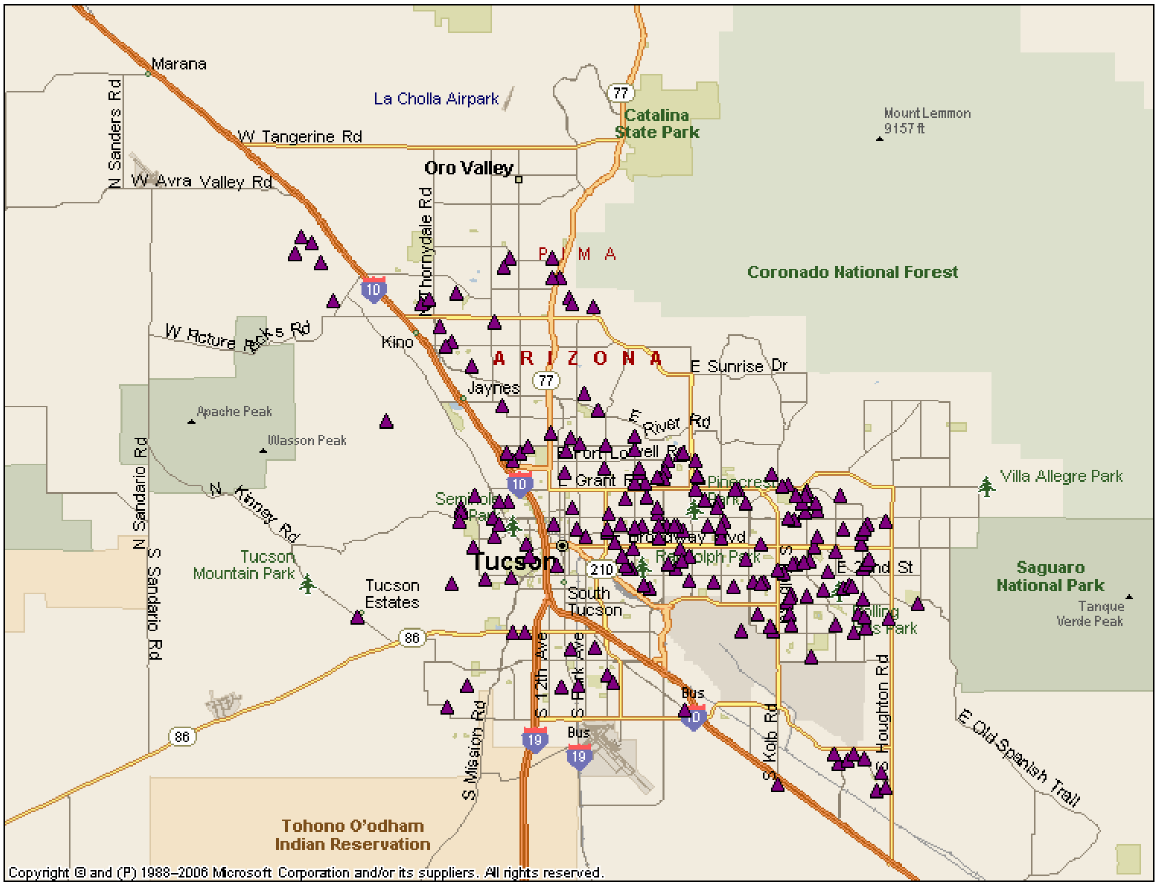
Figure 2-6: Households with a Computer



Of the 10 percent that do not have a computer, the reasons cited were: No need (63 percent); Can access elsewhere (43 percent); Do not know how to use (38 percent); and Expense (33 percent).

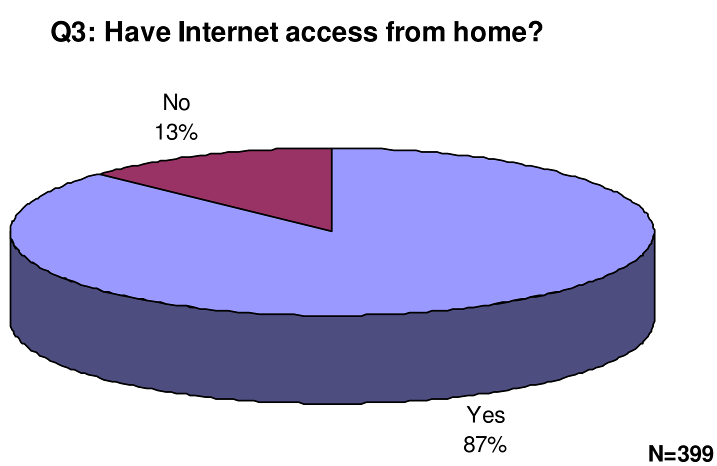
The locations of the respondents with a computer at home are shown is Figure 2-3. Comparing Figure 2-2 and Figure 2-3, the computer access at home appears lowest in the South side of Tucson. Throughout this section we present analysis and observations regarding what demographic attributes may account for variations in computer availability and Internet access for area residences.

Figure 2-7: Residential Survey Respondents with a Computer at Home



Approximately 87 percent of Tucson residents (Figure 2-4) have Internet access in their home, and another 1.8 percent plan to obtain Internet access within the next year.

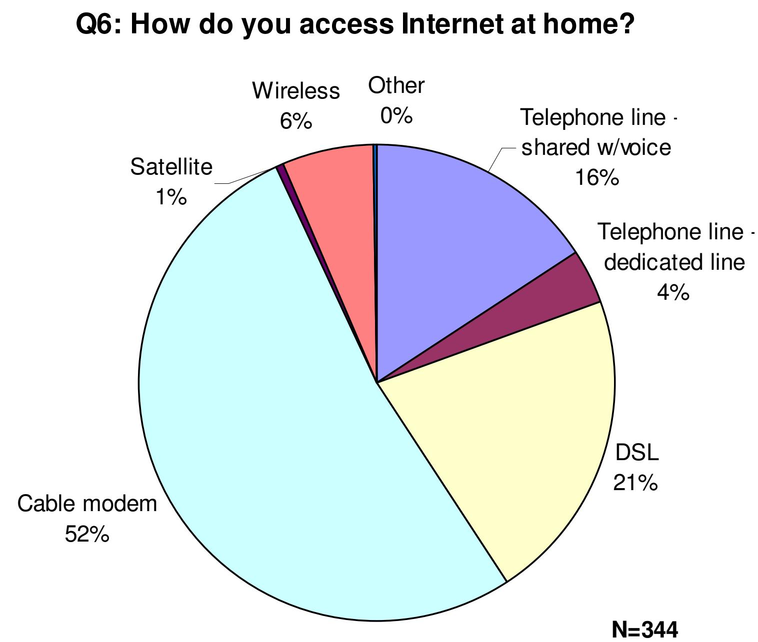
Figure 2-8: Households with Internet Access



Of the 13 percent who do not have Internet access, the main reasons cited were: Do not have a computer (64 percent); Too expensive (15 percent); No need for Internet (9 percent); and Can access the Internet elsewhere (6 percent).

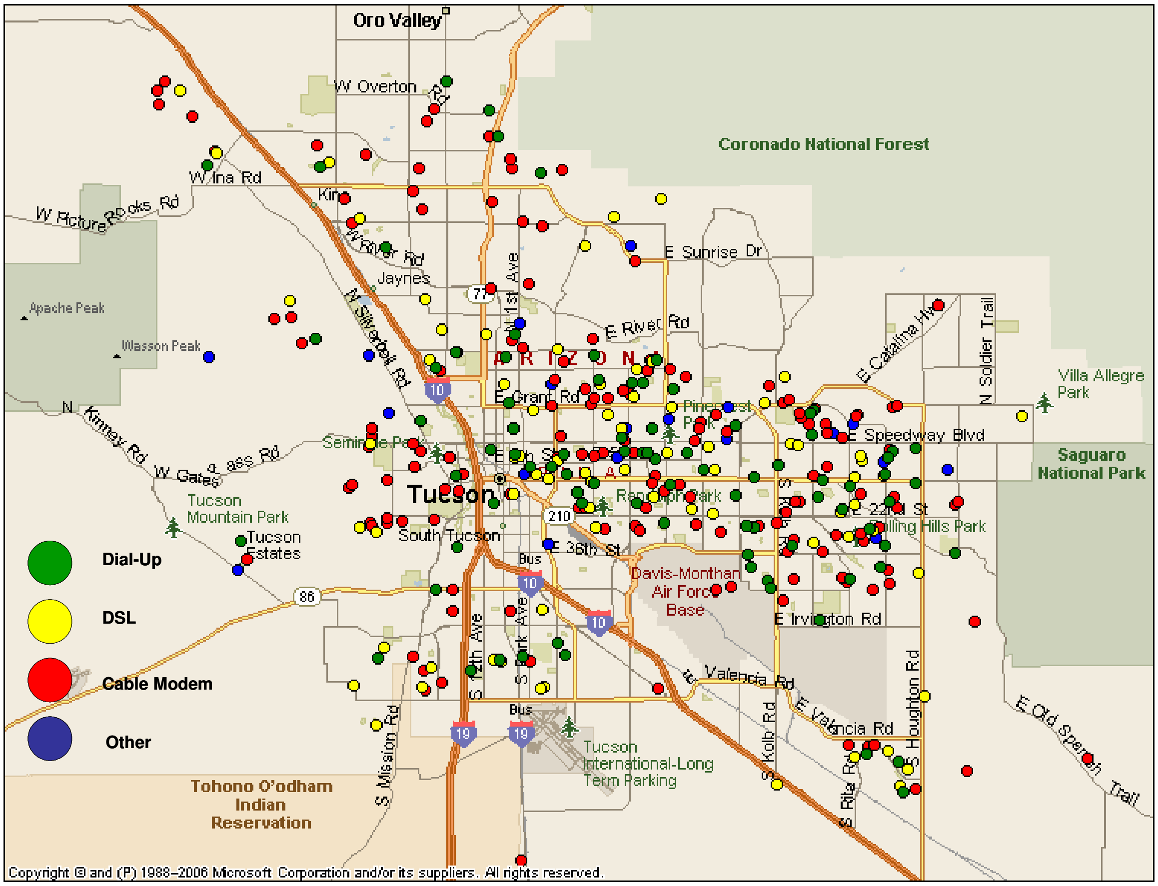
Of those with Internet access, more than one-half connect with a cable modem while 20 percent have telephone dial-up access. The type of Internet access is shown in Figure 2-5.

Figure 2-9: Type of Internet Access in Households



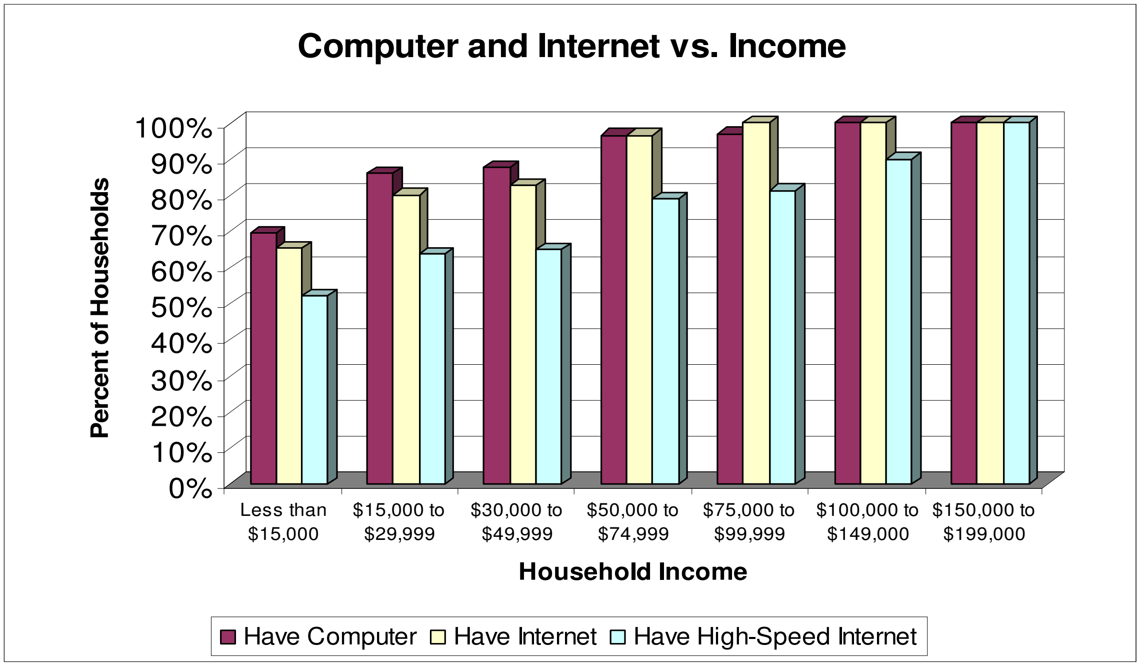
The locations of the type of Internet access used by the respondents are shown in Figure 2-6. As seen in Figure 2-6, the distribution of the type of service used is not uniform. For example, there appears to be some neighborhoods (for example North of W. Ina Road and West of Interstate 10) that DSL is not used. This may indicate gaps of DSL availability. Potential service availability gaps are explored further in Section 3.

Figure 2-10: Residential Survey Respondents - Type of Internet Access at Home



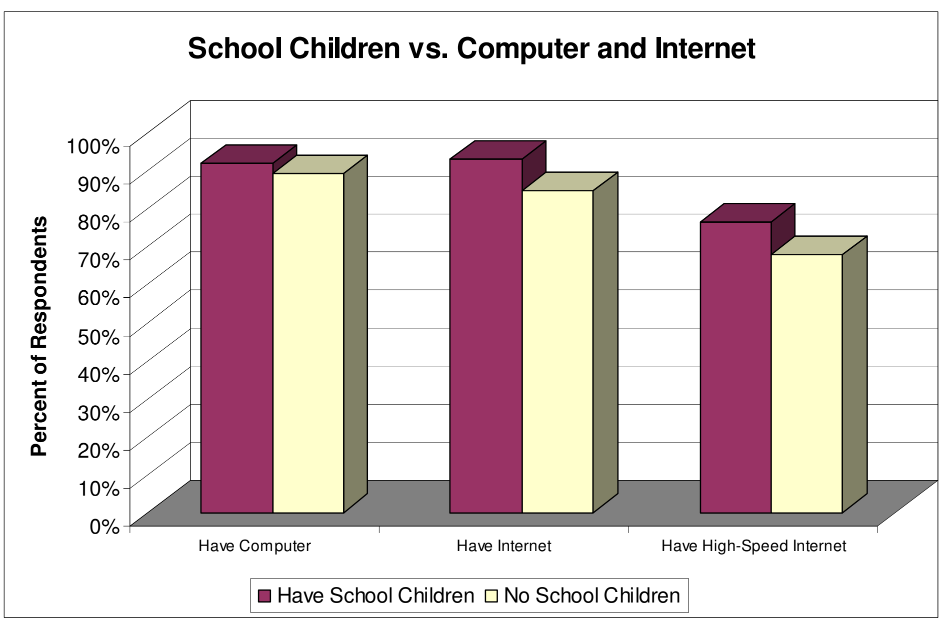
There is a correlation between household income and both computer ownership and Internet access. Of the households with annual income less than $15,000, only 70 percent own a computer and 52 percent have high-speed Internet access. On the other end of the spectrum, 100 percent of households with income greater than $100,000 have a computer and nearly all have high-speed Internet access. This correlation is shown in Figure 2-7.

Figure 2-11: Correlation of Computer and Internet vs. Income



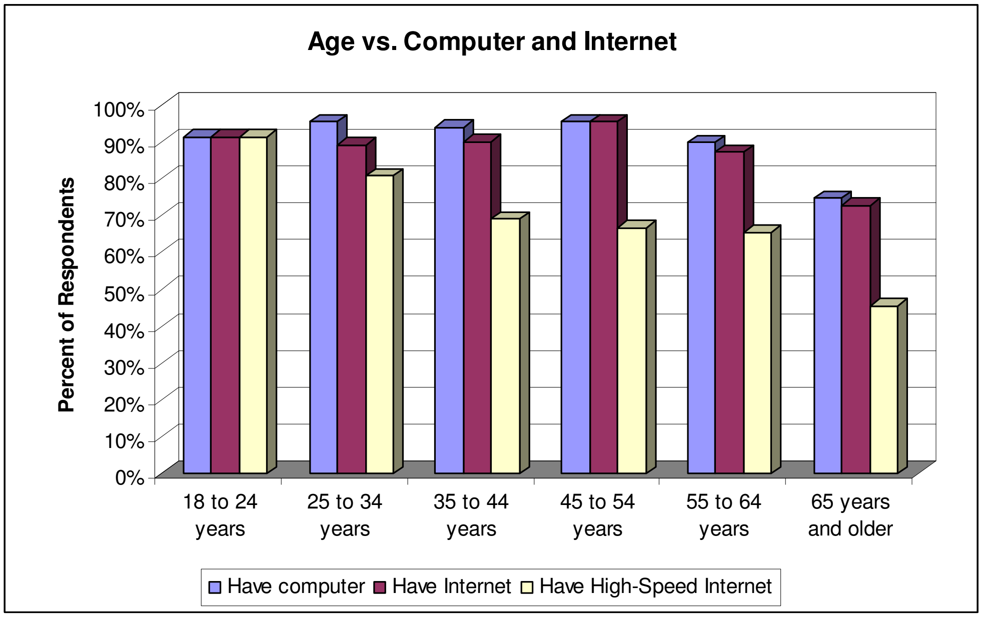
There is also a statistically-significant correlation between the presences of preschool or school-aged children in the home and Internet access (see Figure 2-8). Approximately 93 percent of homes with children have some form of Internet access, and 77 percent or homes with children have high-speed Internet access. Although a greater share of homes with children have a computer, the difference is not statistically significant.

Figure 2-12: Correlation of School Aged Children in Home vs. Computer and Internet



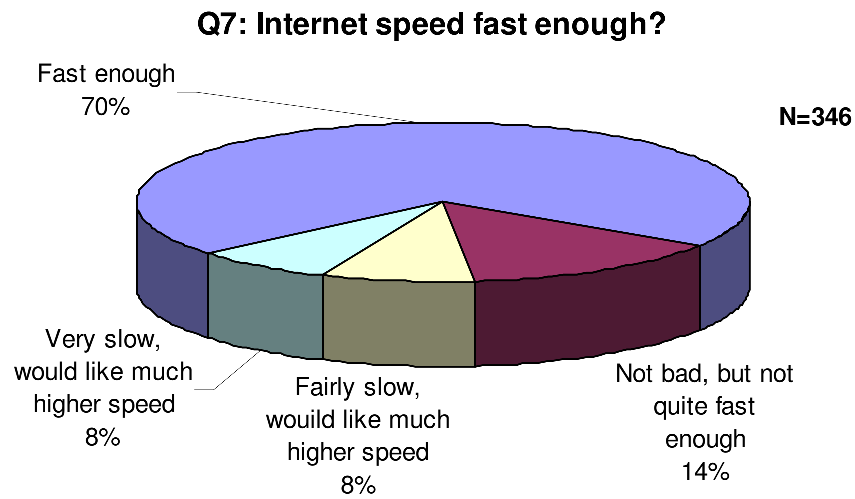
There is a correlation between the age of the respondent (person primarily responsible for paying telephone bills) and computer ownership and Internet access. Approximately 90 to 95 percent of respondents under age 65 had a computer, while only 75 percent of respondents 65 and older had a computer. The percent of respondents with high-speed Internet access drops from 90 percent for respondents under age 25 to 46 percent for respondents aged 65 and older.

Figure 2-13: Correlation of Age vs. Computer and Internet



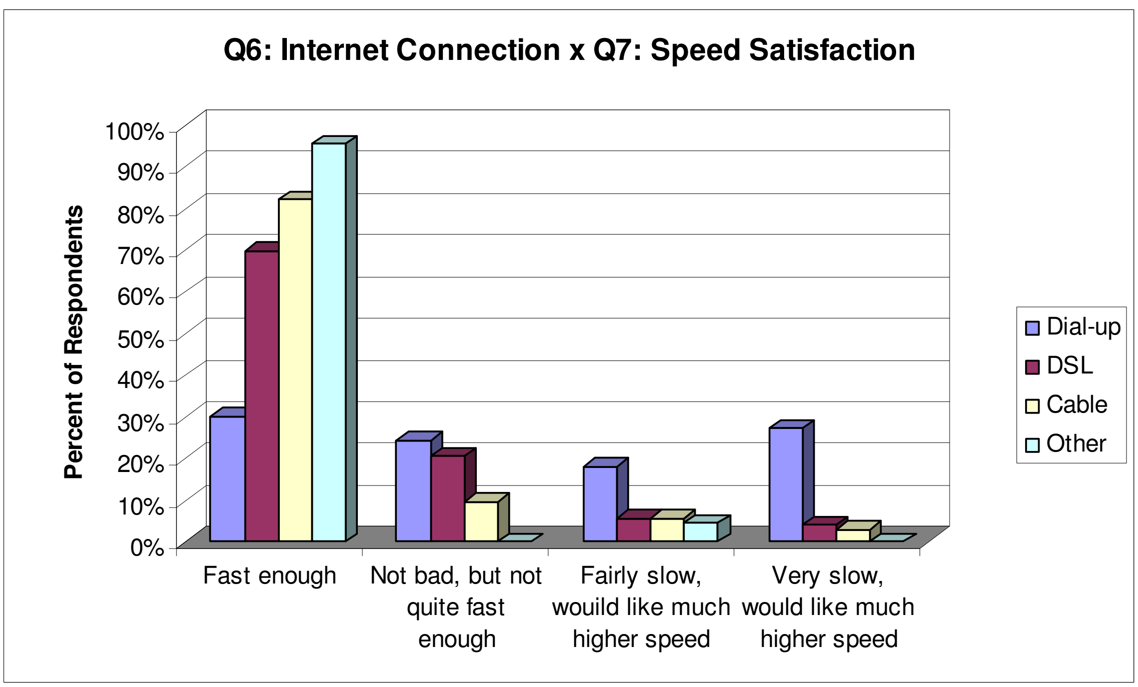
More than two-thirds of Tucson Internet users indicate that their current connection speed is fast enough for their needs. This varies considerably based upon the type of connection currently in use. These relationships are shown in Figure 2-10 and Figure 2-11.

Figure 2-14: Internet Speed Perception



Less than one-third of dial-up Internet users indicate that their connection speed is fast enough for their needs. This compares to 70 percent of DSL users and more than 80 percent of cable modem users.

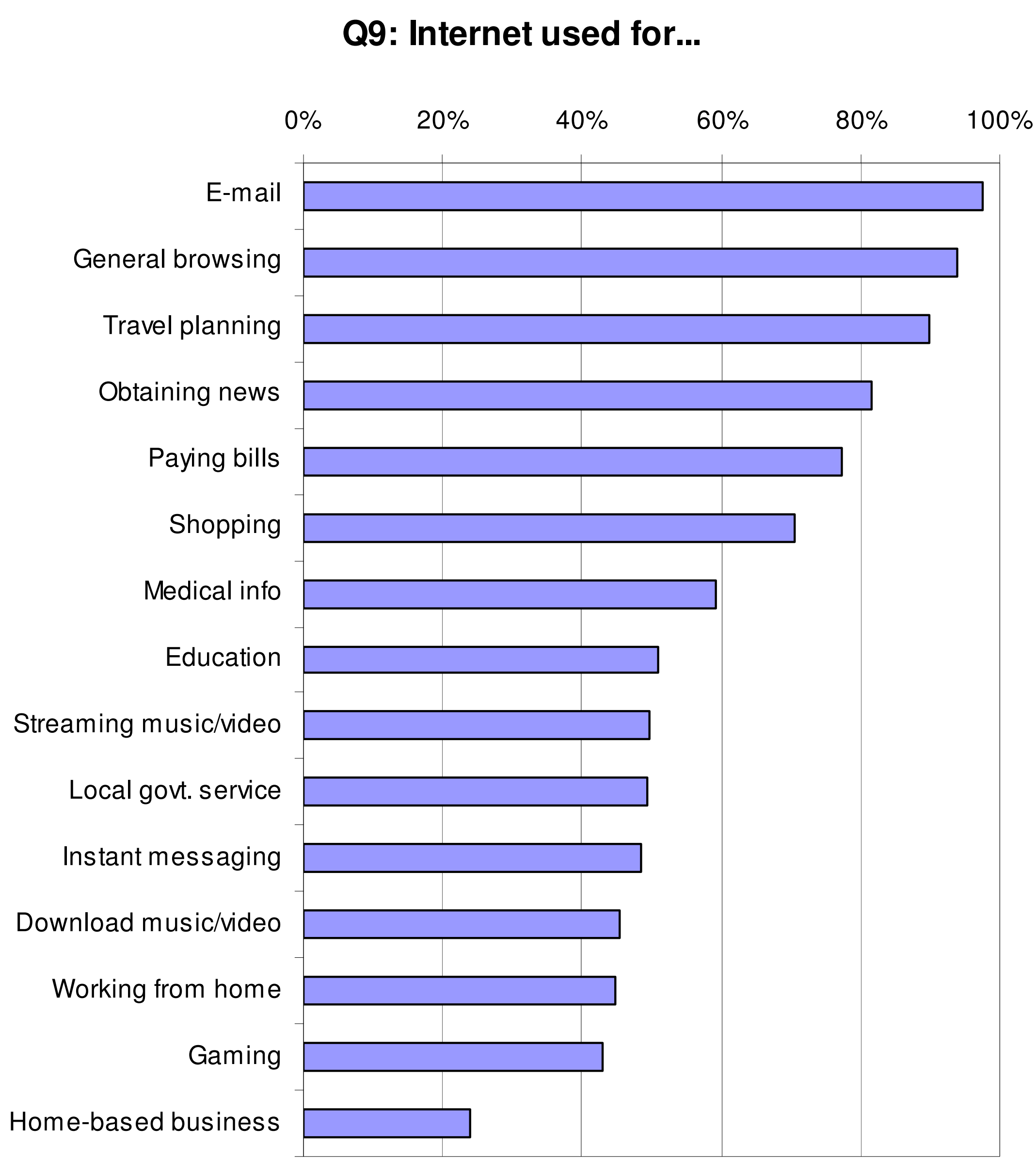
Figure 2-15: Internet Connection Type vs. Speed Satisfaction



2.4.2 Residential Internet Uses

Figure 2-12 shows how the residents use the Internet. More than 80 percent of respondents use the Internet for e-mail, general browsing, travel planning, or obtaining news. Between 60 and 80 percent use the Internet for paying bills or shopping.

Figure 2-16: Residential Internet Use



2.4.3 Residential Internet Providers and Price

The top Internet providers in Tucson are Cox Communications, Qwest, America Online, and Comcast. There are also a large number of other providers with less than five percent of the market each, including EarthLink, MSN, Juno, NetZero, and AT&T. Tucson market shares are show in Figure 2-13.

Figure 2-17: Residential Internet Market Shares

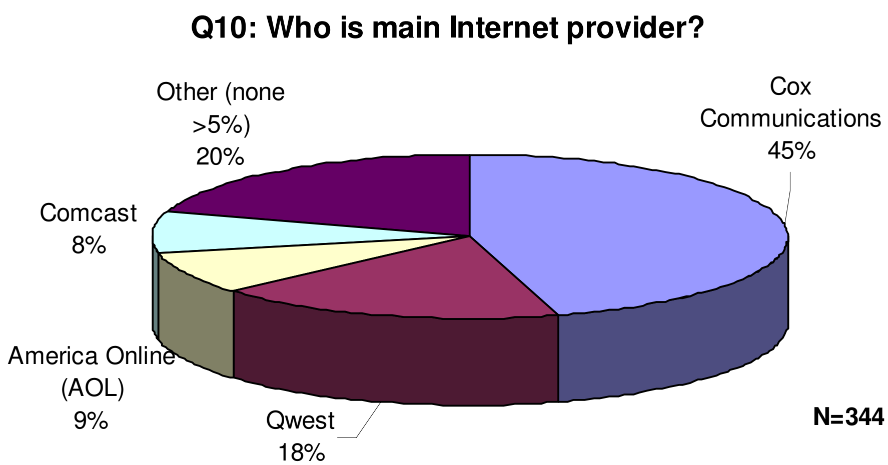
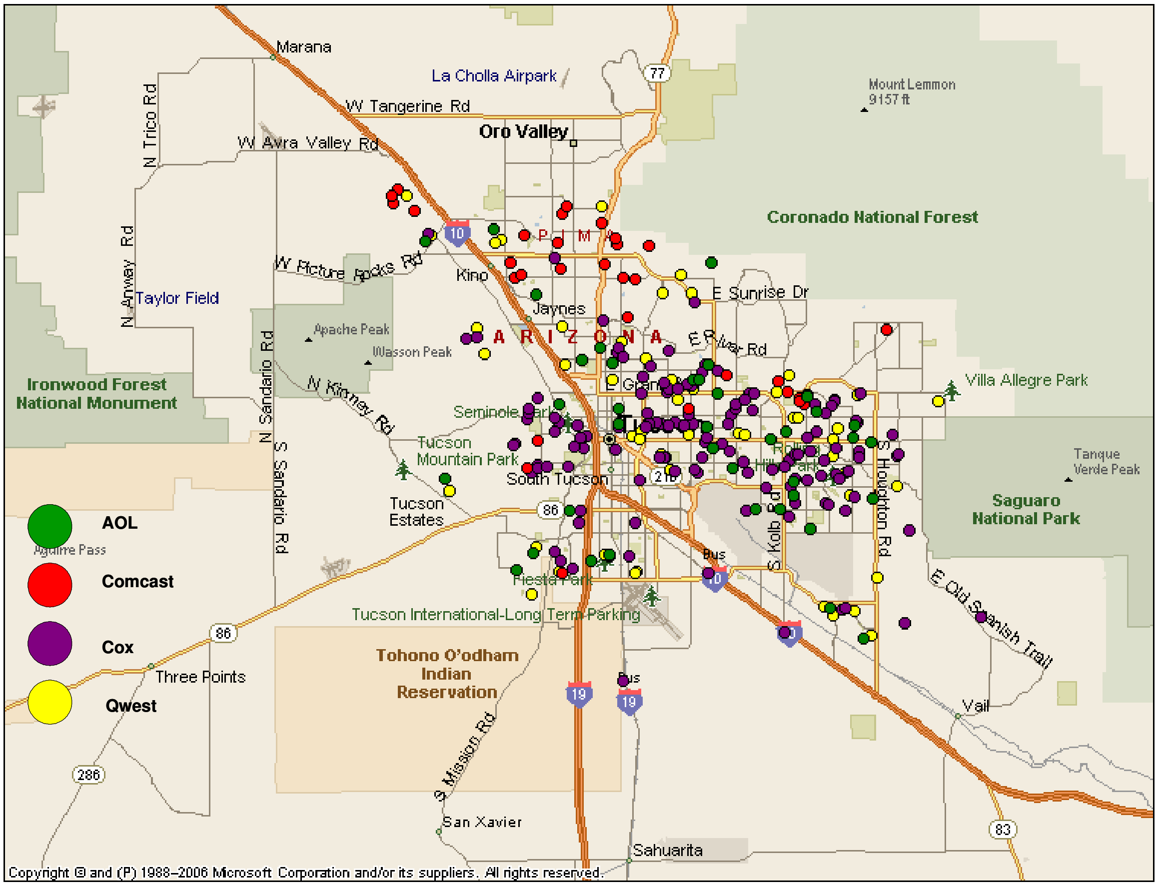


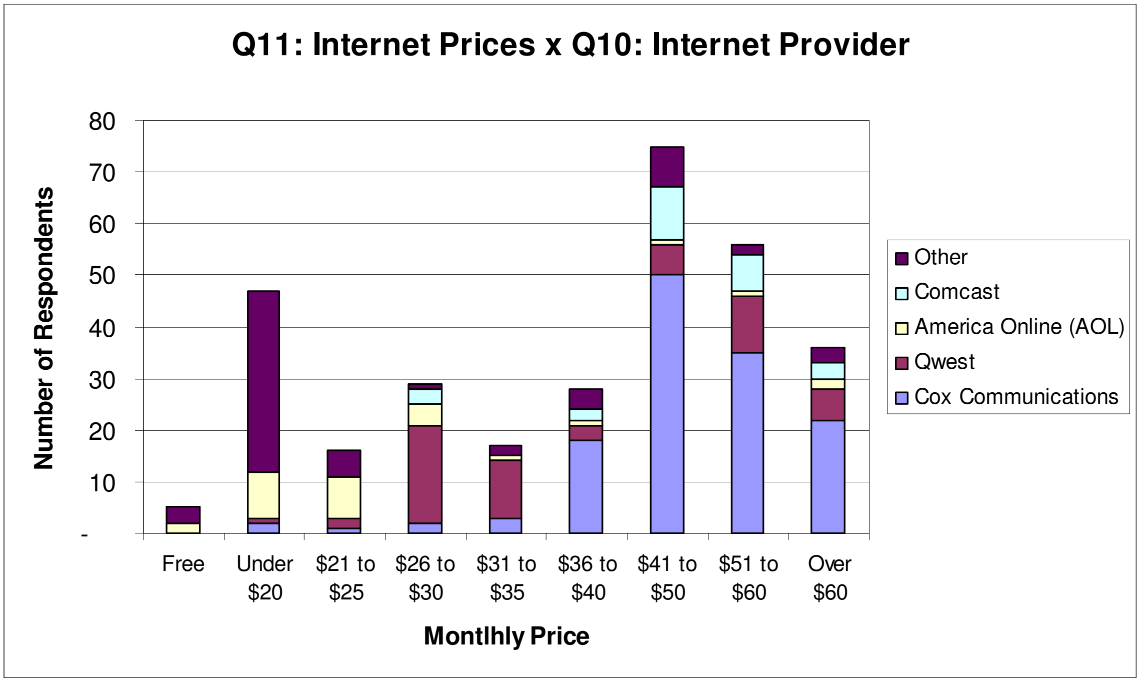
Figure 2-14 shows the geographic distribution of where the providers are delivering service. As expected, Comcast and Cox have a service footprint defined by the cable television franchise and little cross-over is seen.

Figure 2-18: Residential Internet Provider Customers



The average monthly price paid for Internet service is $39. Most Cox Communications and Comcast customers pay $36 or more for their Internet services. Qwest customers dominate the $26 to $35 price range, while AOL and other providers dominate the $25 or less price range. The relationship between the price paid for service and the providers is shown in Figure 2-15.

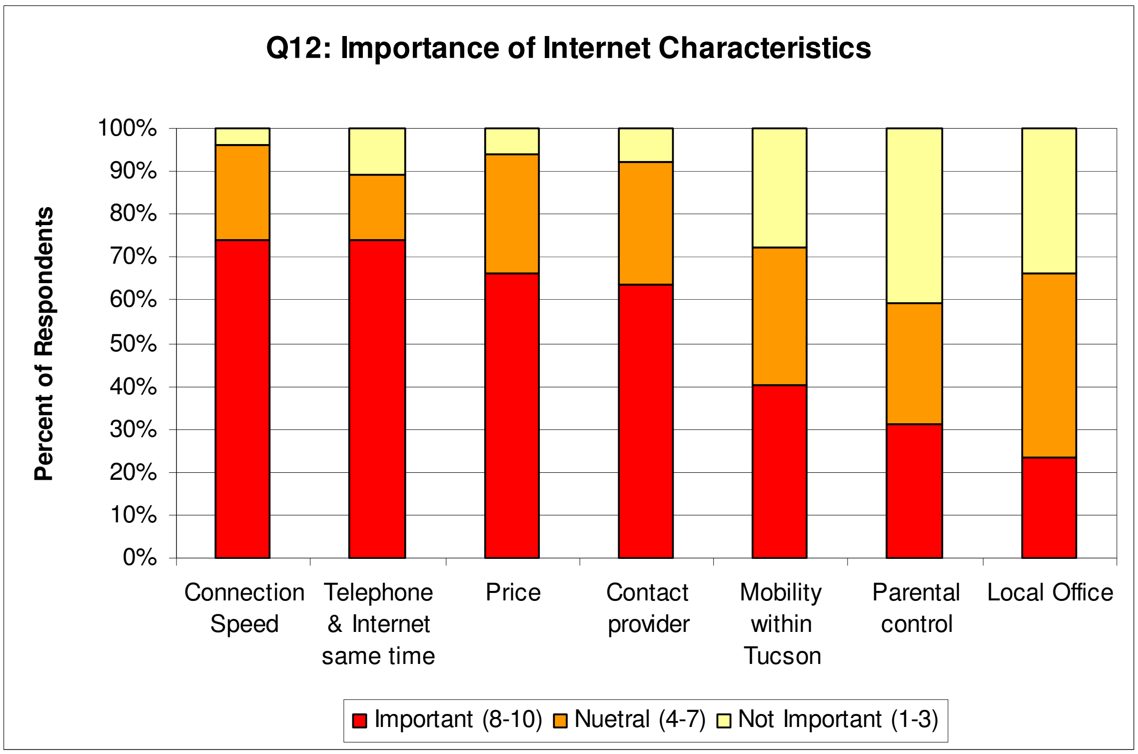
Figure 2-19: Internet Prices vs. Internet Provider



2.4.4 Residential Internet Aspects

When asked about the most important aspect of Internet service, connection speed ranks as the single most important item. The ability to use the telephone line and Internet simultaneously also ranks high, but is only applicable to the 20 percent of current Internet users that connect by telephone line[6]. Connection speed ranks above the price paid and the ability to contact the provider in terms of importance to users. Parental control and the existence of a local office are of lower importance.

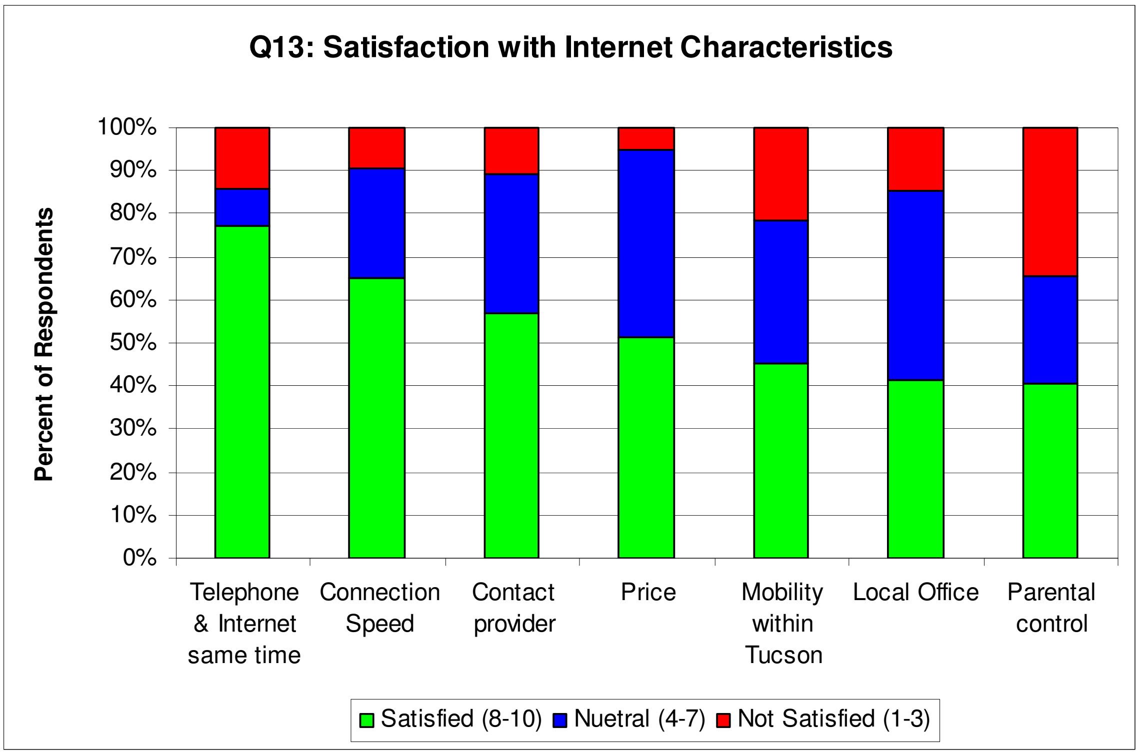
Figure 2-20: Importance of Internet Characteristics



[6] See Figure 2-5 (Question 6).

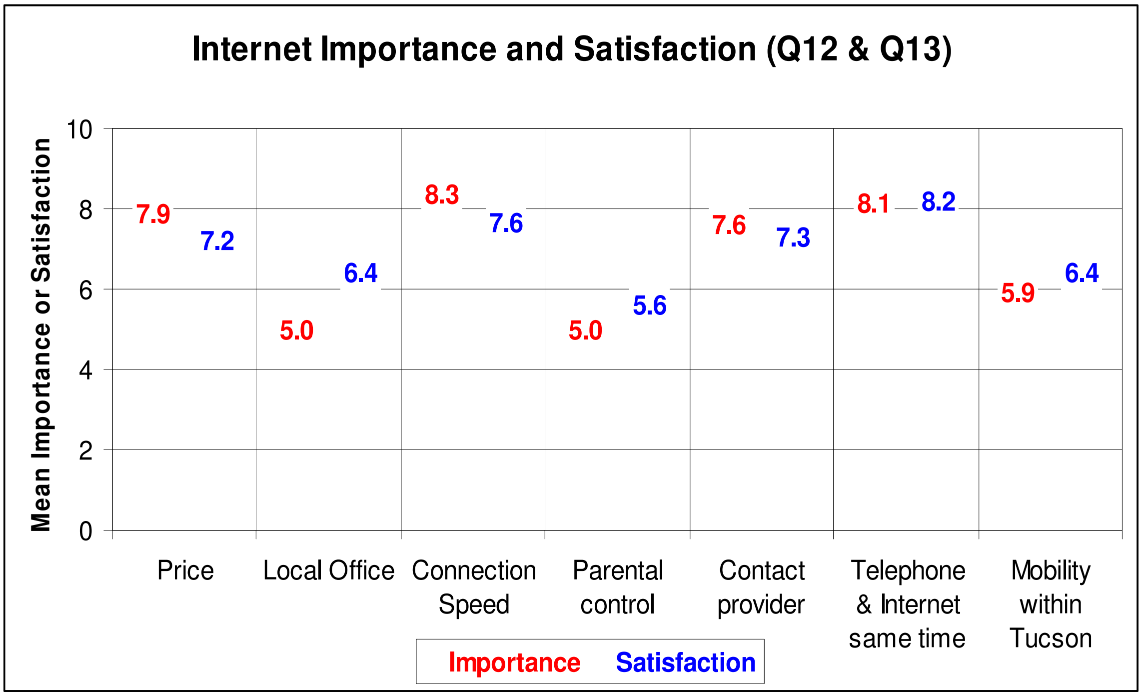
As illustrated in Figure 2-17, most people are satisfied with the ability to use the telephone and Internet at the same time, as would be expected since only 16 percent of respondents currently have a shared line. Approximately two-thirds are satisfied with their connection speed, but only one-half are satisfied with the price they are paying. More than one-third of respondents are *dissatisfied* with the level of parental control currently available.

Figure 2-21: Satisfaction of Internet Characteristics



A comparison of the mean importance and satisfaction with different aspects of current Internet service provides insight into the areas where expectations are not being met, are being met adequately, or are being exceeded. These results are shown in Figure 2-18.

Figure 2-22: Comparison of Importance and Satisfaction of Internet Characteristics



In the comparison, price and connection speed have significant differences between importance and satisfaction. Addressing theses gaps is important in a new service offering. The significance of these and other attributes are shown in Table 2-2.

Table 2-2: Significance of Importance and Satisfaction Gaps of Internet Characteristics

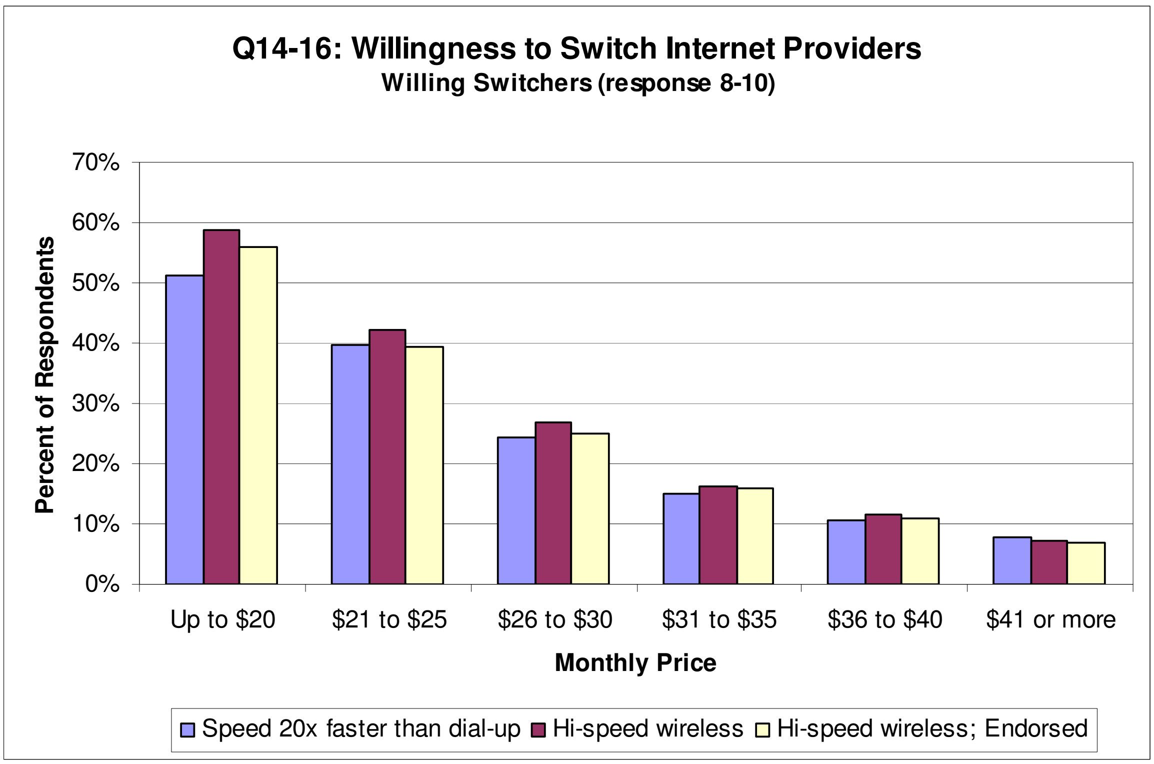
	Mean Importance	Mean Satisfaction	GAP* < -- >	Significance?
Price (n=345)	7.9	7.2	-0.7	Expectations not met
Local office (n=322)	5.0	6.4	1.4	Expectations exceeded
Connection speed (n=343)	8.3	7.6	-0.7	Expectations not met
Parental control (n=308)	5.0	5.6	0.6	Expectations exceeded
Ability to contact provider (n=337)	7.6	7.3	-0.3	Not significant
Use telephone & Internet at same time (n=340)	8.1	8.2	0.1	Not significant
Mobility within Tucson (n=296)	5.9	6.4	0.5	Expectations exceeded

*Difference is statistically significant: $p<.05$

2.4.5 Residential Willingness to Switch Internet Providers

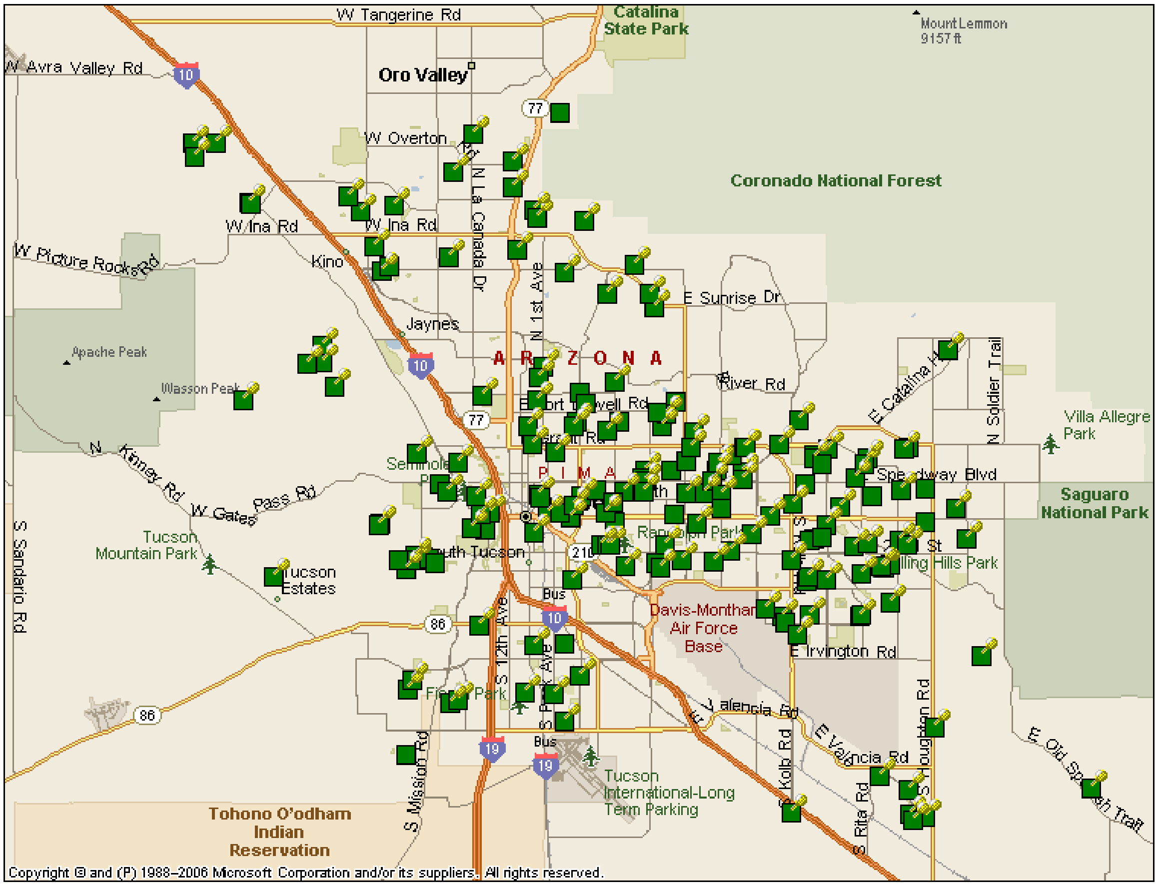
Respondents were asked about their willingness to switch Internet providers for high-speed service, high-speed wireless service, or high-speed wireless access endorsed by the City of Tucson at a variety of price levels. Over one-half of respondents indicated that they are willing to switch to high-speed Internet service at a price of $20 per month or less, while less than 10 percent are willing to switch for a price of $41 or more. The percent of respondents willing to switch for various price and service options are illustrated in Figure 2-19.

Figure 2-23: Willingness to Switch Internet Providers



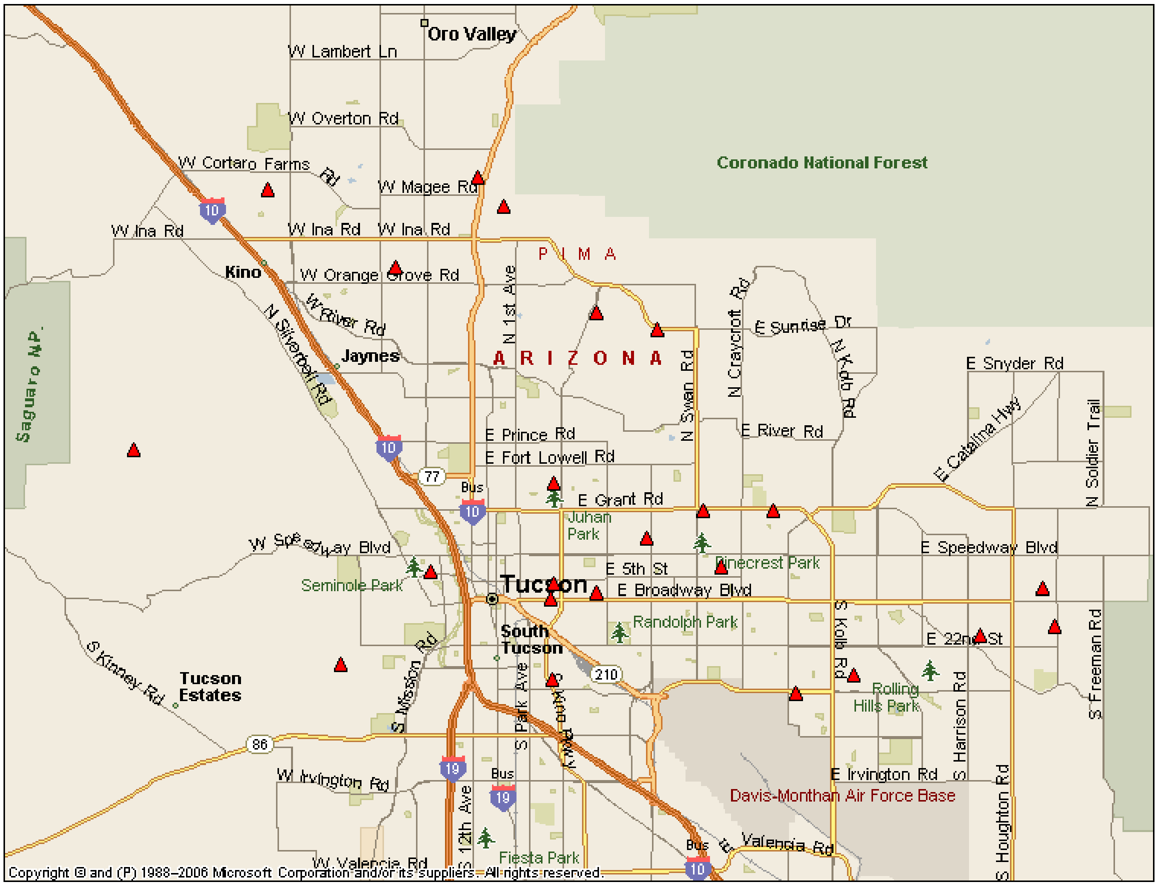
There are no observed patterns or differences of willingness to switch to a high-speed service under $25 per month between neighborhoods. These findings are shown in Figure 2-20. Please note in Figure 2-20 the "Green Square" indicates respondents willing to switch service for under $20 per month, will the "Yellow Pin" represents respondents willing to switch service for $21 to $25 per month.

Figure 2-24: Willingness to Switch Internet Providers for Under $25 per Month



As seen in Figure 2-21, as we increase the proposed price of the Internet offering, we do see a reduction of the respondents willing to switch providers, and appears some differences in neighborhood might exist.

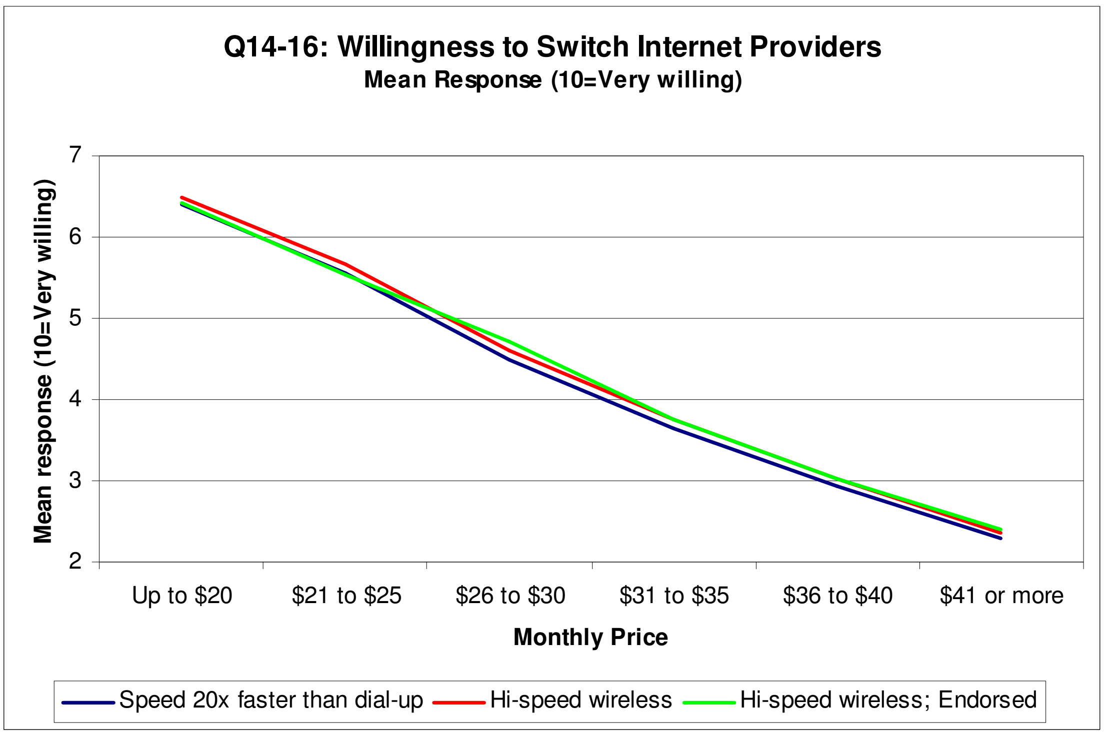
Figure 2-25: Willingness to Switch Internet Providers for Over $41 per Month



The mean willingness-to-switch response ranged from 6.4 for a price of $20 or less to 2.4 for a price of $41 or more. There was no statistical significance between the mean response to the type of high-speed access offered (wired, wireless, or Tucson endorsed wireless). This finding, in conjunction with the relatively low importance of mobility within Tucson (see Figure 2-16) indicates a minimal competitive advantage from offering wireless Internet access over the existing options (mostly wired) currently offered by the private market. Further for residential users, the City of Tucson does not have a strong enough brand image to change willingness to switch providers via an endorsement.

The mean willingness to switch at different price levels and service options are illustrated in Figure 2-22.

Figure 2-26: Willingness to Switch Internet Providers



Those respondents with dial-up services were less willing to switch at most price levels compared to those that already had high-speed Internet service. This indicates that current dial-up users can not afford, do not need, or choose not to spend for high-speed Internet service. Current connection and willingness to switch for high-speed service or high-speed wireless service are illustrated in the Figure 2-23 and Figure 2-24.

Figure 2-27: Willingness to Switch (20x) vs. Current Internet Connection

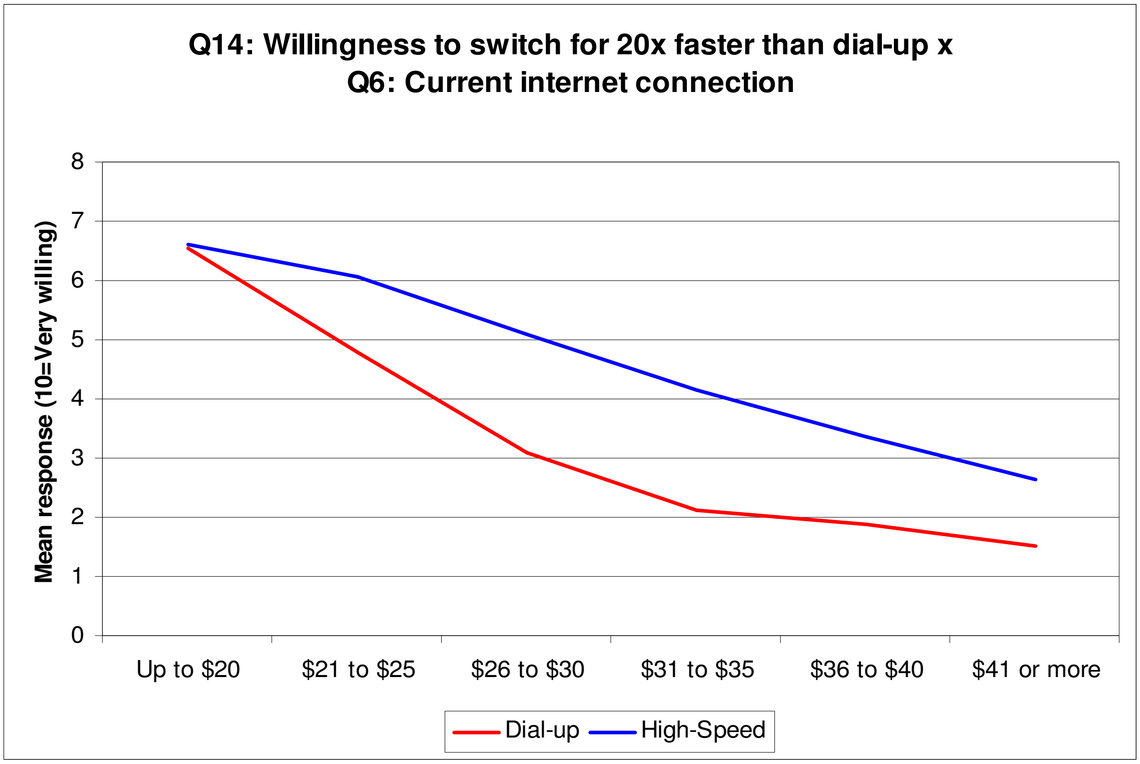
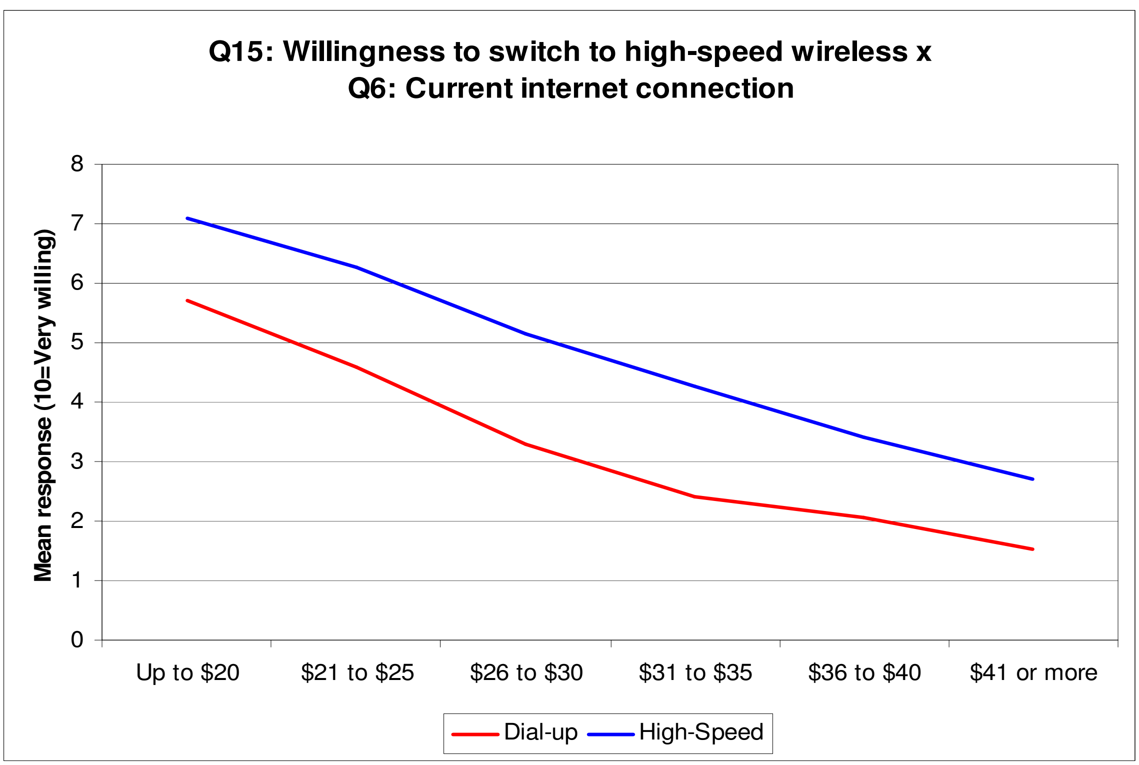
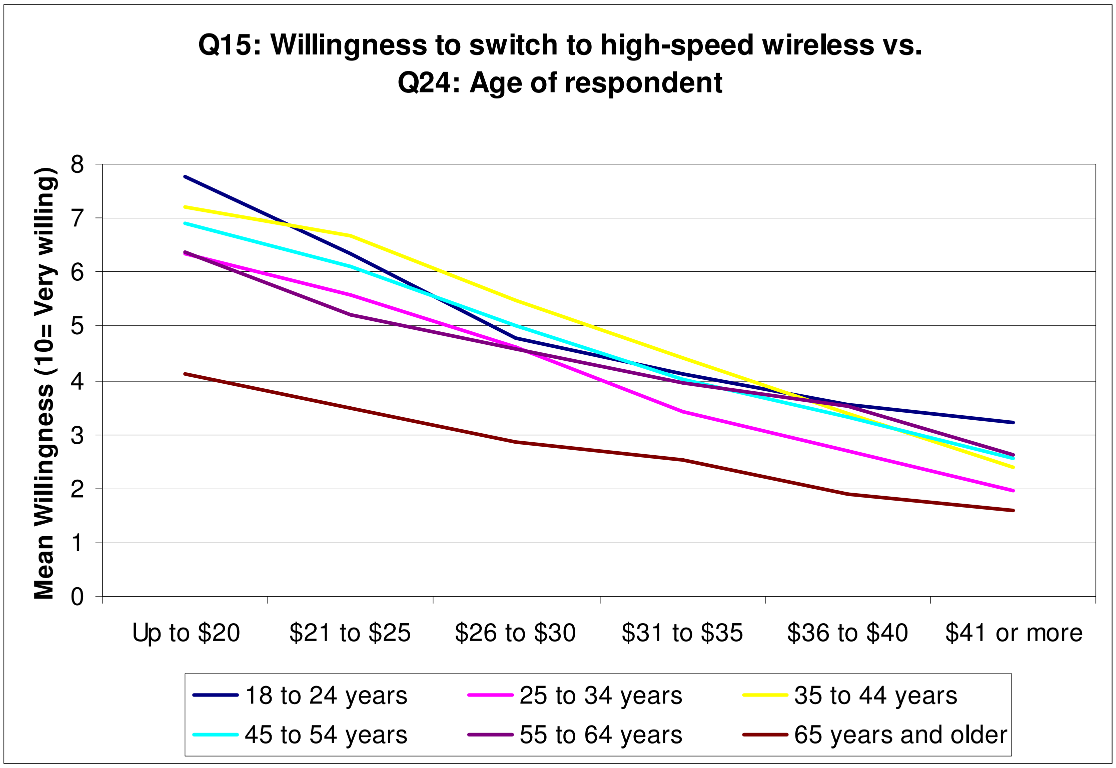


Figure 2-28: Willingness to Switch (Wireless) vs. Current Internet Connection



Respondents aged 65 and older were much less likely to switch at any price or at any service level. The likelihood to switch for other age brackets was not substantially different across most price or service levels, as illustrated in Figure 2-25.

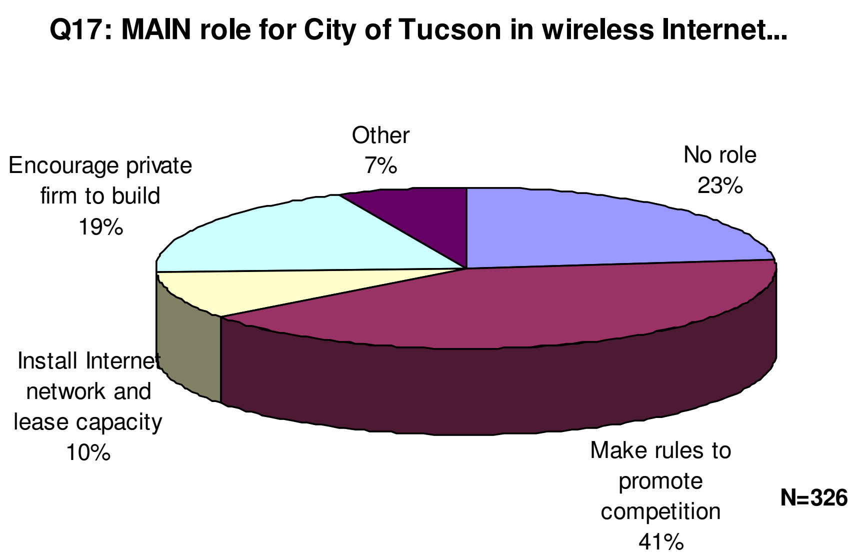
Figure 2-29: Willingness to Switch (Wireless) vs. Age



2.4.6 Residential Perceptions

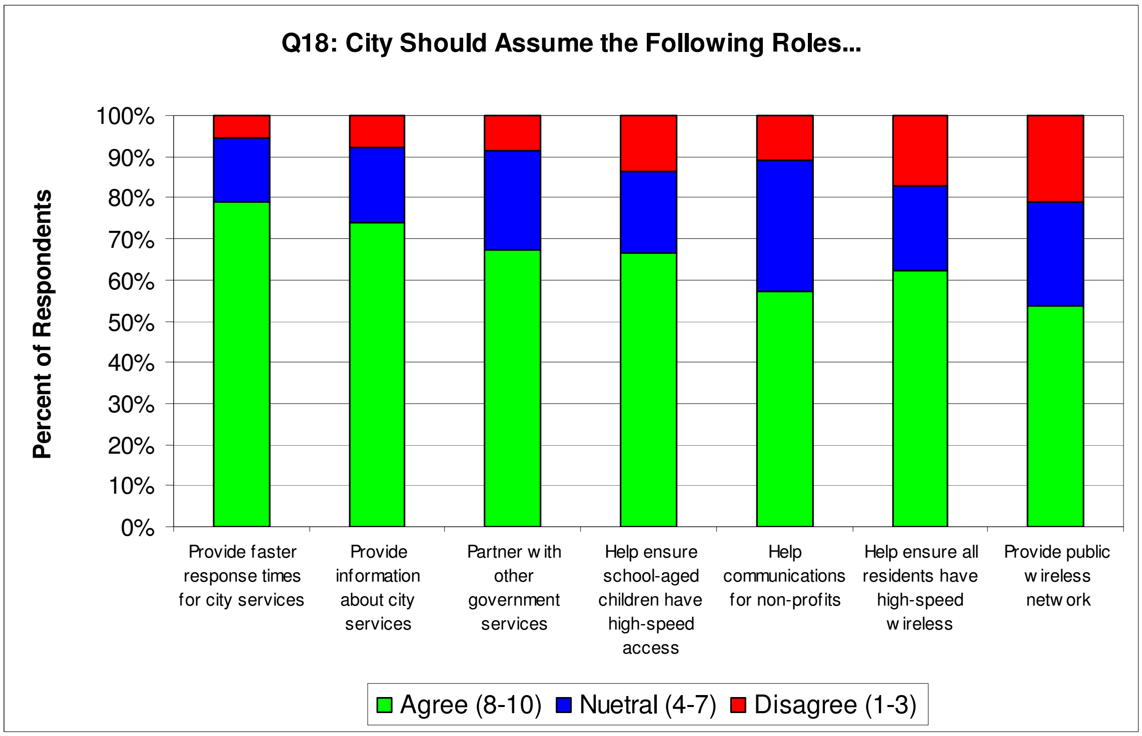
Respondents were asked to identify the **main role** that the City of Tucson should play to ensure wireless Internet connectivity, availability, and pricing. The responses are shown in Figure 2-26. Approximately 41 percent of respondents indicated that the City should make rules to promote competition, while an additional 19 percent indicated that a private firm should be encouraged to build a network. Approximately one-fourth of respondents indicated that the City should take no role in the development of wireless Internet access.

Figure 2-30: Main Tucson Role in Wireless Internet



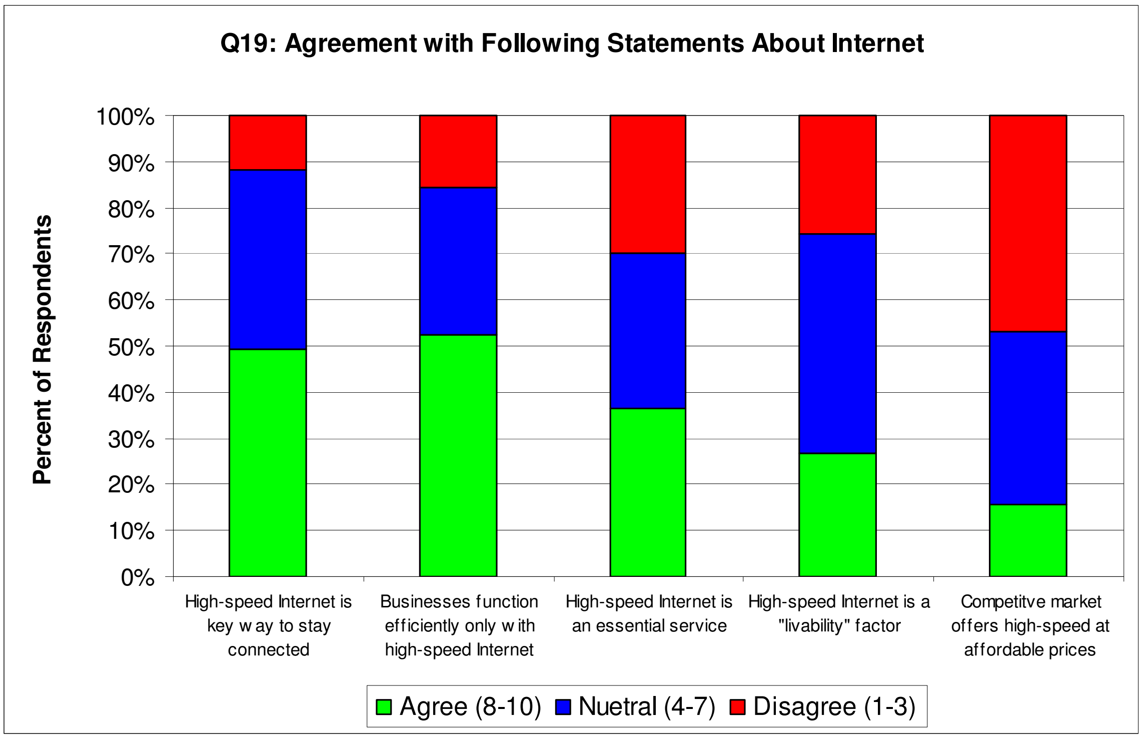
When asked about the role(s) that the City of Tucson should play to facilitate access to electronic information and services, nearly 80 percent of respondents agreed that the City should provide faster response times and information about city services. As indicated in Figure 2-27, approximately one-half agreed that the City should provide a public wireless network (although that may not be the ***main*** role taken, as indicated previously in Figure 2-26).

Figure 2-31: Tucson Roles in Wireless Internet



Approximately one-half of respondents agreed that high-speed Internet is a key to businesses operating efficiently and is a key way to keep connected with the community. Approximately one-third agreed that wireless high-speed Internet access is an essential service or that it is a "livability" factor. Only 16 percent of respondents agreed that the competitive market currently offers high-speed Internet access at prices that low income households can afford, while nearly one half disagreed with this statement. These perceptions are shown in Figure 2-28.

Figure 2-32: Role of the Internet



2.4.7 Residential Demographics

Consistent with the U.S. Census data, 28 percent of respondents had children living in their homes. Cross-tabulations of select responses compared to the presence of children were provided previously in this section.

Figure 2-33: Respondents with Children under 18 Attending School

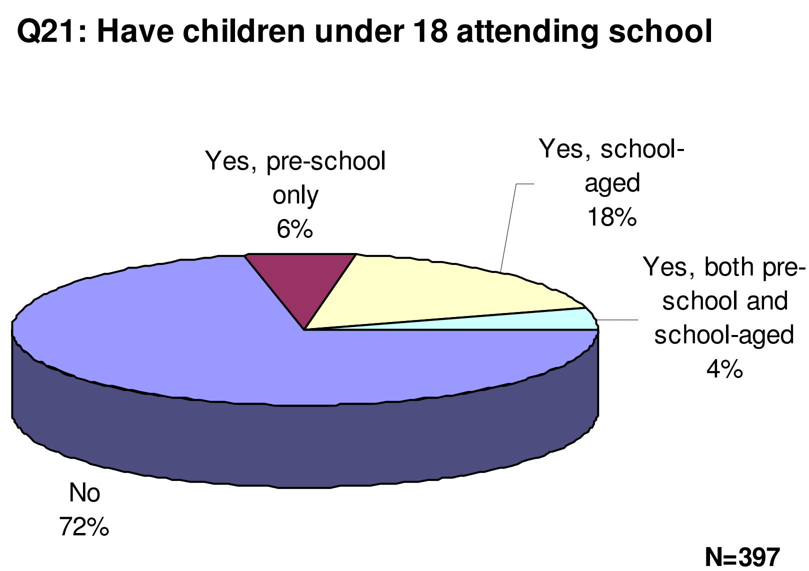


Figure 2-29: Number of Adults in Household

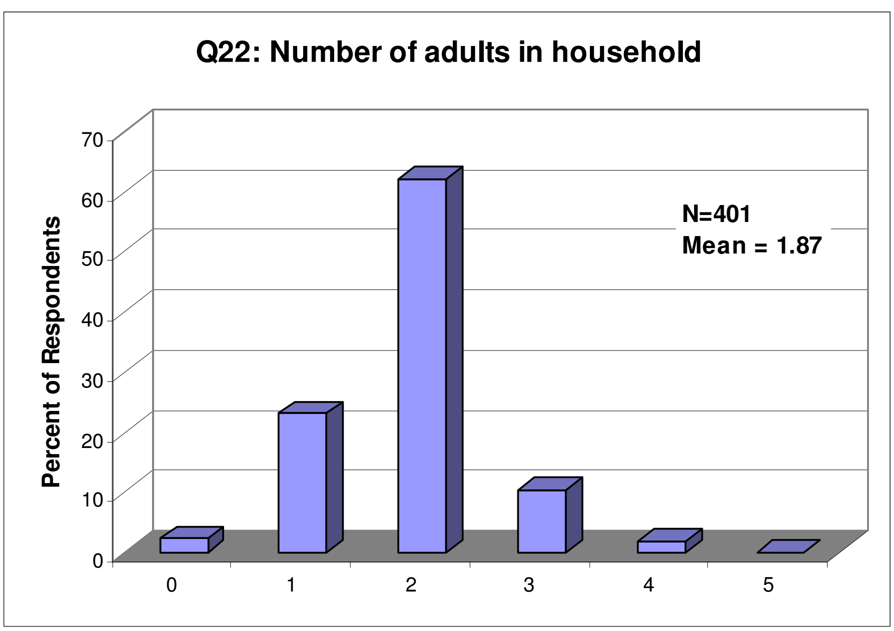
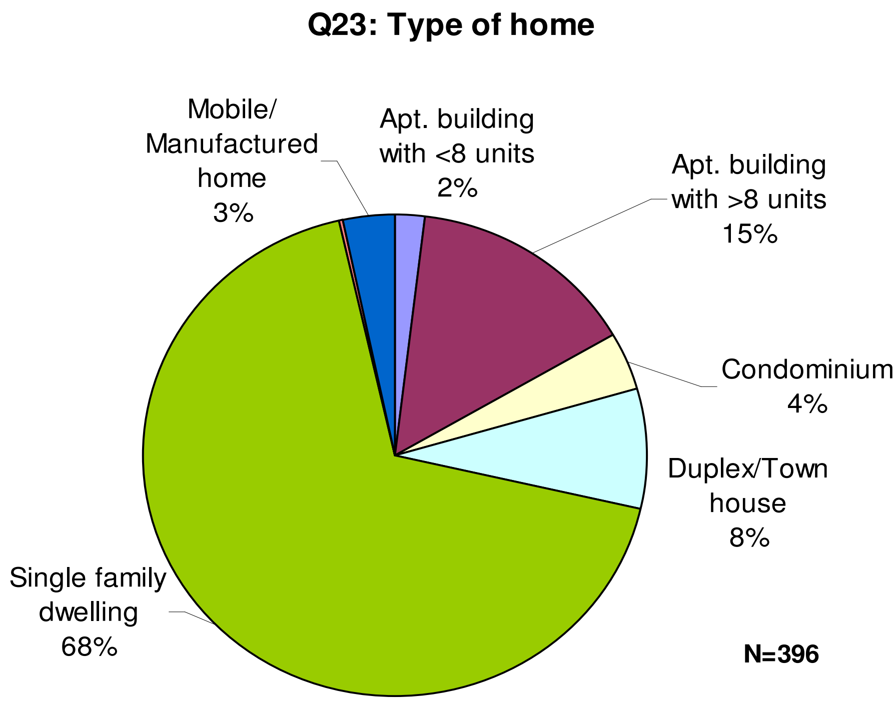
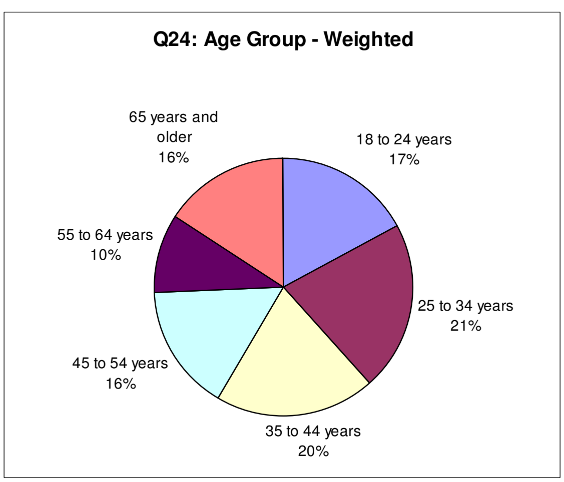


Figure 2-34: Type of Home



The “unweighted” age group of respondents is the actual percentage of respondents in each age category of those that completed the survey. The “weighted” age group represents an adjustment of the unweighted data to correspond to the actual adult demographics of the City of Tucson as reported in the 2000 Census. The weighting calculation and adjustment was discussed at the beginning of Section 2.1.

Figure 2-35: Age Group of Respondents



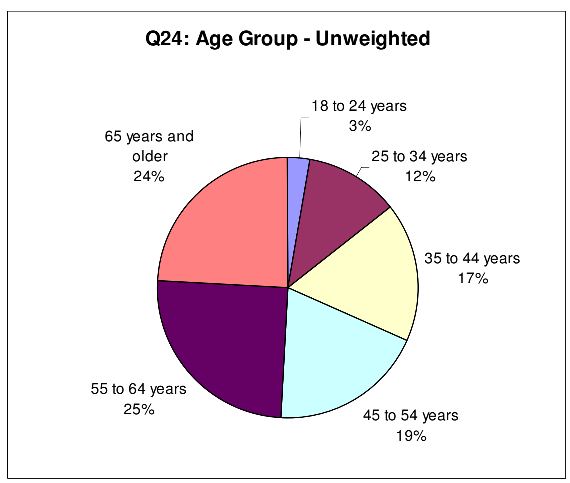


Figure 2-36: Years at Current Address

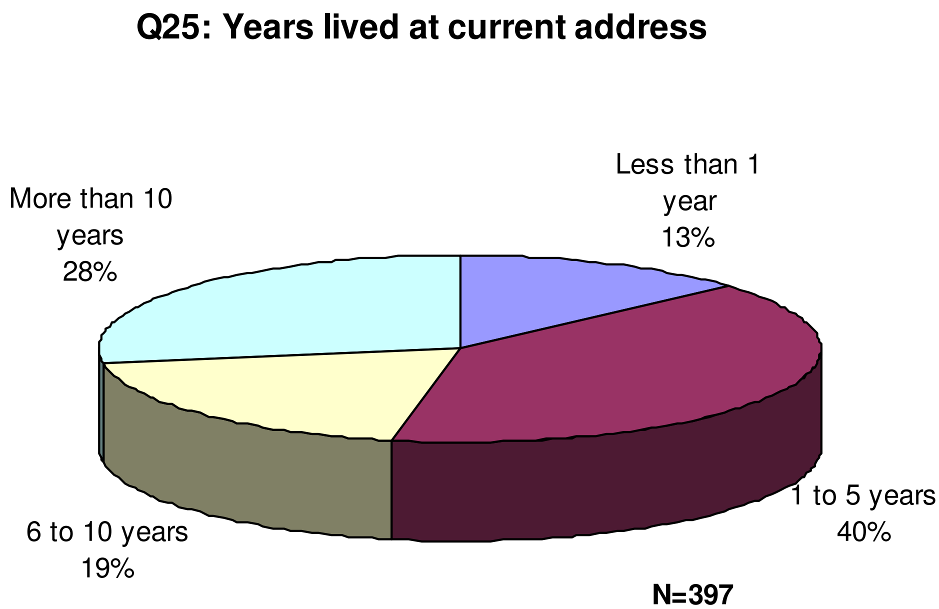
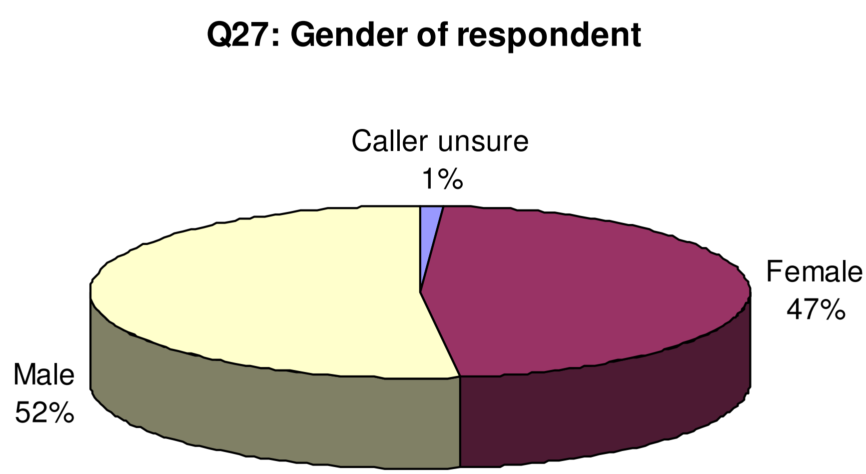


Figure 2-37: Gender of Respondent



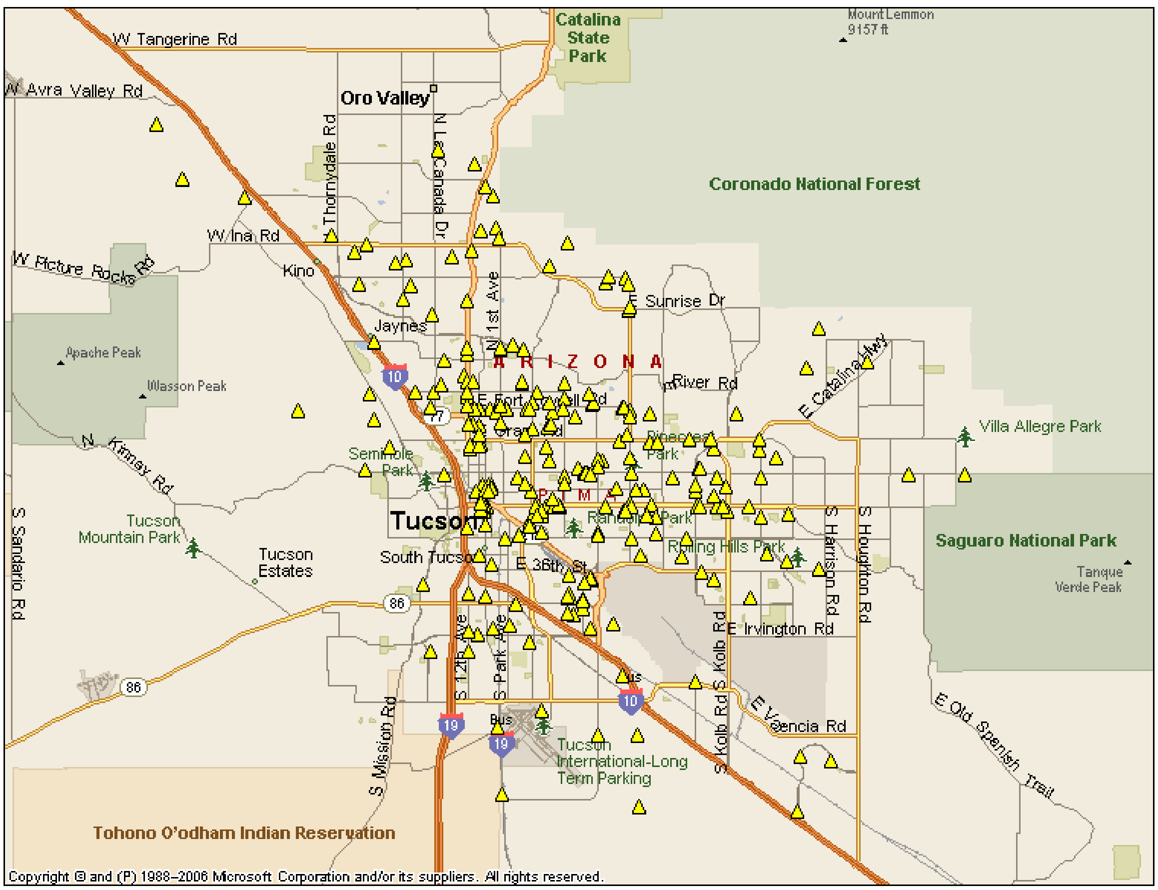
2.5 Business Survey Results

We conducted telephone interviews of 250 randomly-selected businesses in the City of Tucson between January 5 and January 16, 2007. Given an estimate of 27,000 businesses in the City of Tucson, 250 responses provide results at the 95 percent probability level with a confidence interval of ±6.2 percent at the aggregate level.

2.5.1 Business Characteristics

The locations of the business responding to the survey are shown in Figure 2-34. As seen, the responses are geographically dispersed.

Figure 2-38: Location of Business Respondents



As seen in Figure 2-35, approximately 59 percent of the business respondents were companies with less than five employees, while only 10 percent had 20 or more employees.

Figure 2-39: Number of Employees

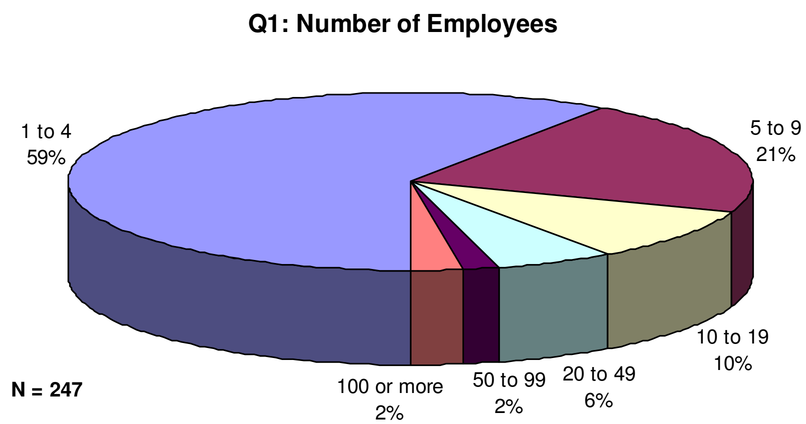


Figure 2-36 presents the location of the business by the number of employees.

Figure 2-40: Number of Employees - Location

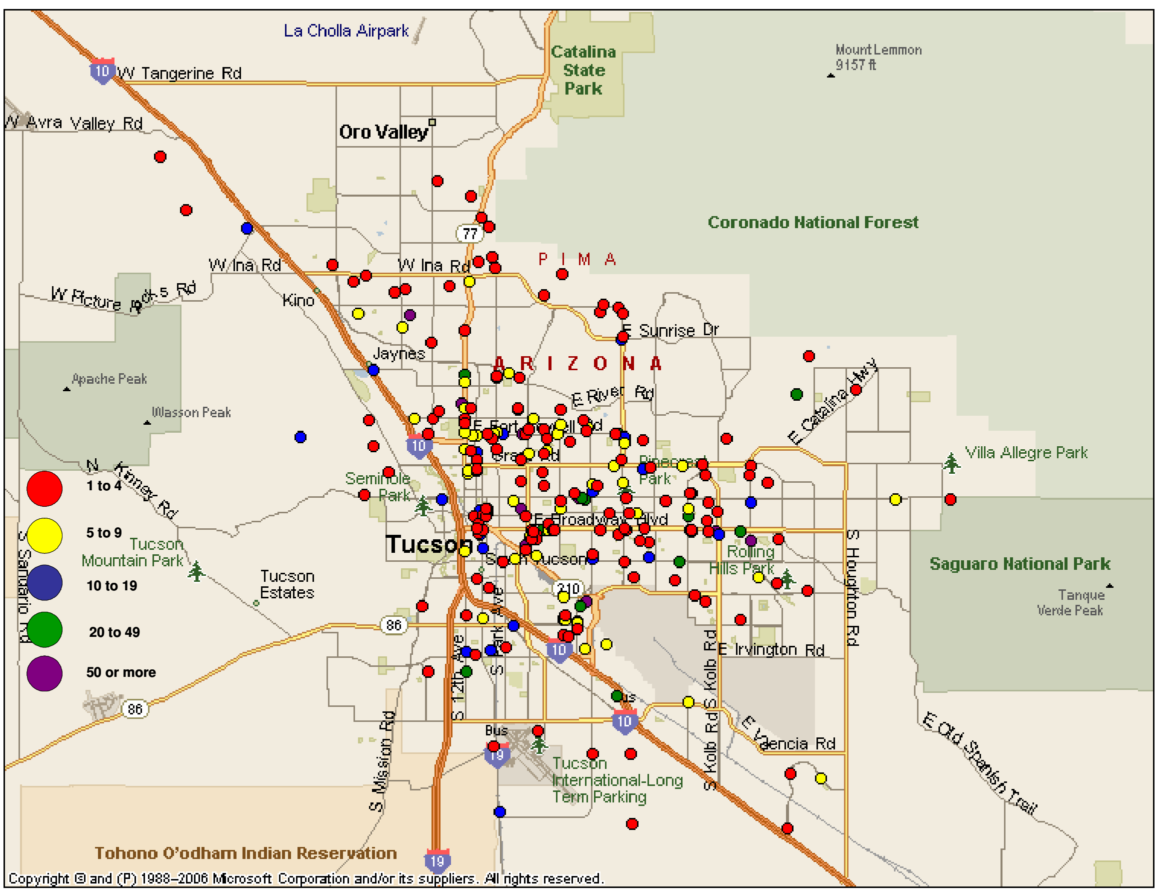
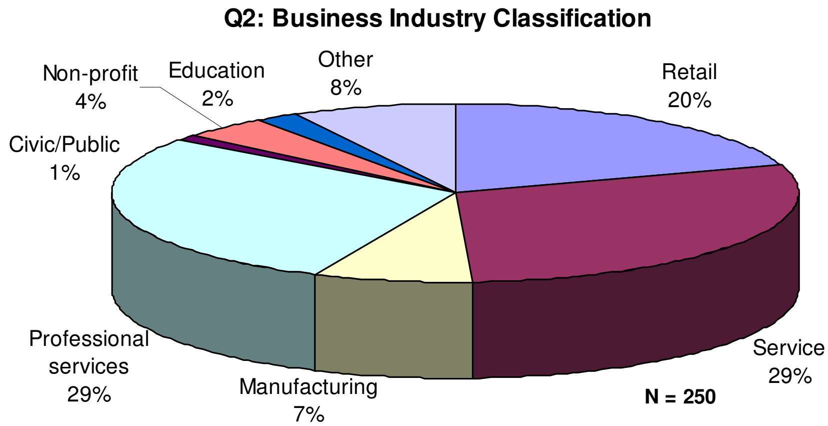


Figure 2-37 shows that nearly 60 percent of the survey respondents were in the services industry and another 20 percent were in the retail sector. Only seven percent were in the manufacturing sector. The civic/public, education, and non-profit sectors combined totaled seven percent of business respondents.

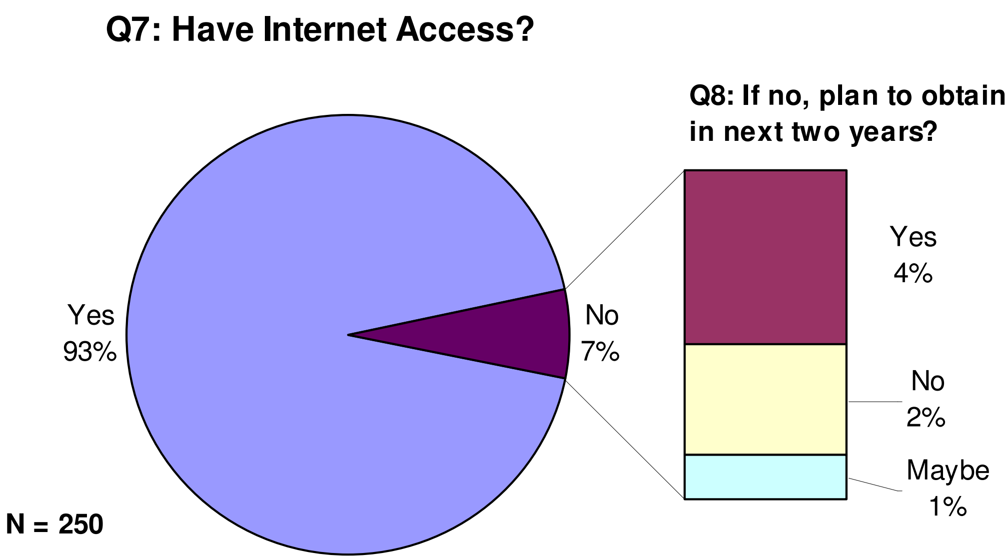
Figure 2-41: Industry Category



2.5.2 Business Internet Service

Approximately 93 percent of Tucson businesses surveyed had Internet access, and an additional four percent indicated that they planned to get Internet access within the next one to two years. This is slightly higher than the 87 percent of Tucson homes that currently have Internet access.

Figure 2-42: Internet Access at Business



Businesses that do not currently have Internet access are mostly in the service or retail sectors (see Figure 2-39). As indicated in Figure 2-40, nearly all of businesses without Internet access have fewer than 10 employees.

Figure 2-43: Internet Access vs. Business Type

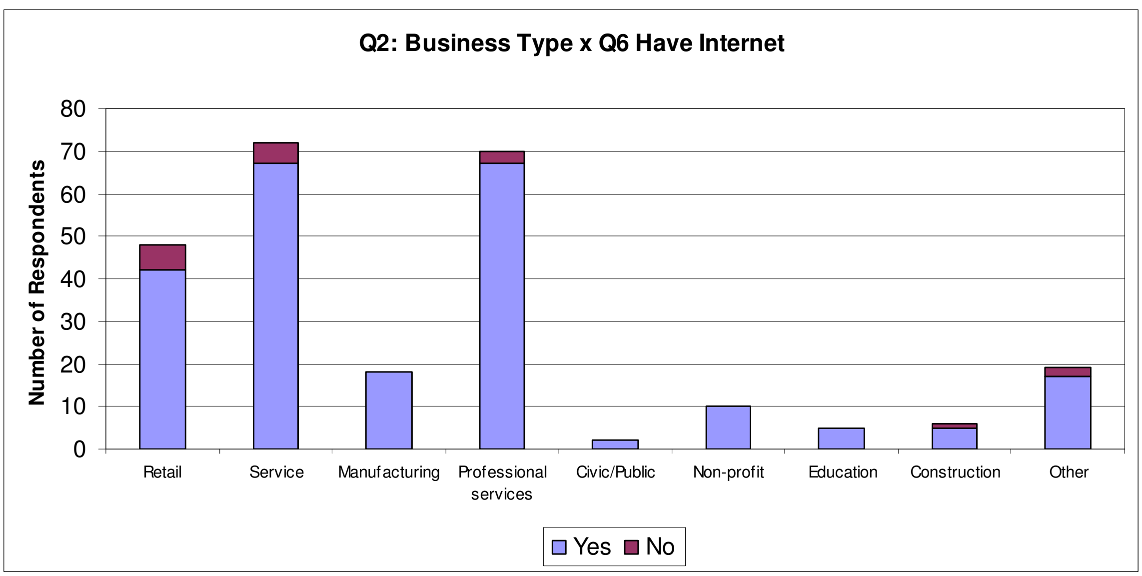
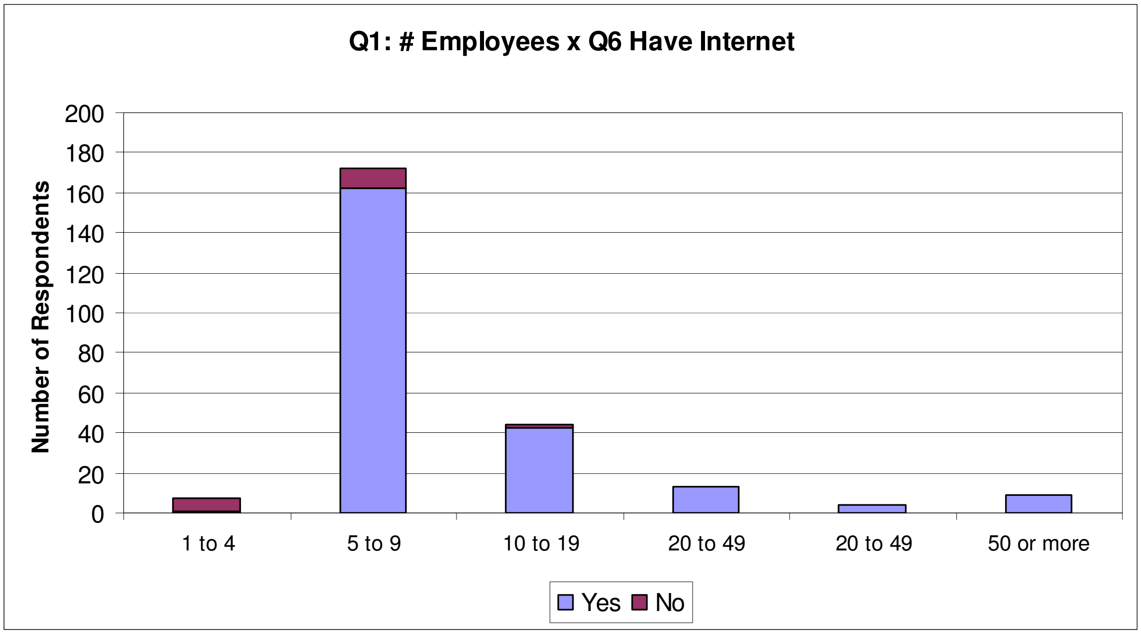
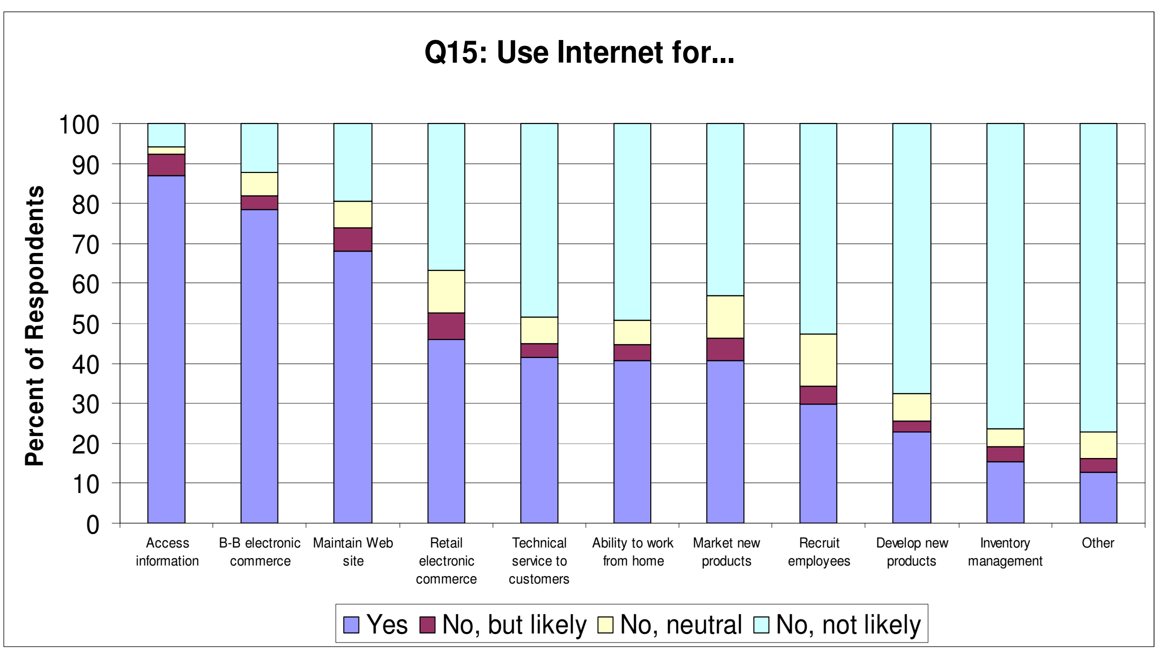


Figure 2-44: Internet Access vs. Number of Employees



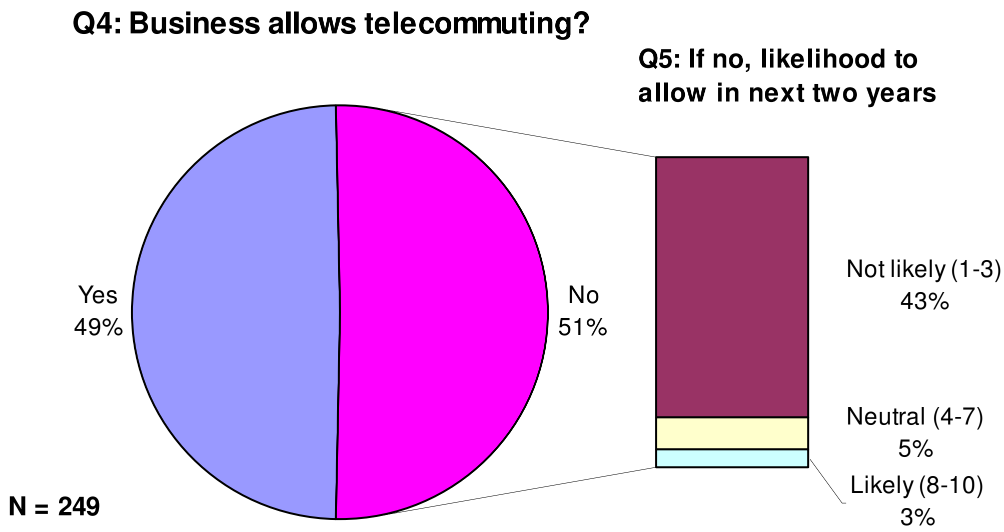
Tucson businesses use the Internet for a variety of purposes. The range of uses of the Internet is shown in Figures 2-41. More than two-thirds of businesses use the Internet to access information, to maintain a Web site, or for business-to-business electronic commerce. Between 40 and 50 percent of businesses use the Internet for retail electronic commerce, providing technical service to customers, marketing new products, or allowing employees to work from home.

Figure 2-45: Internet Uses



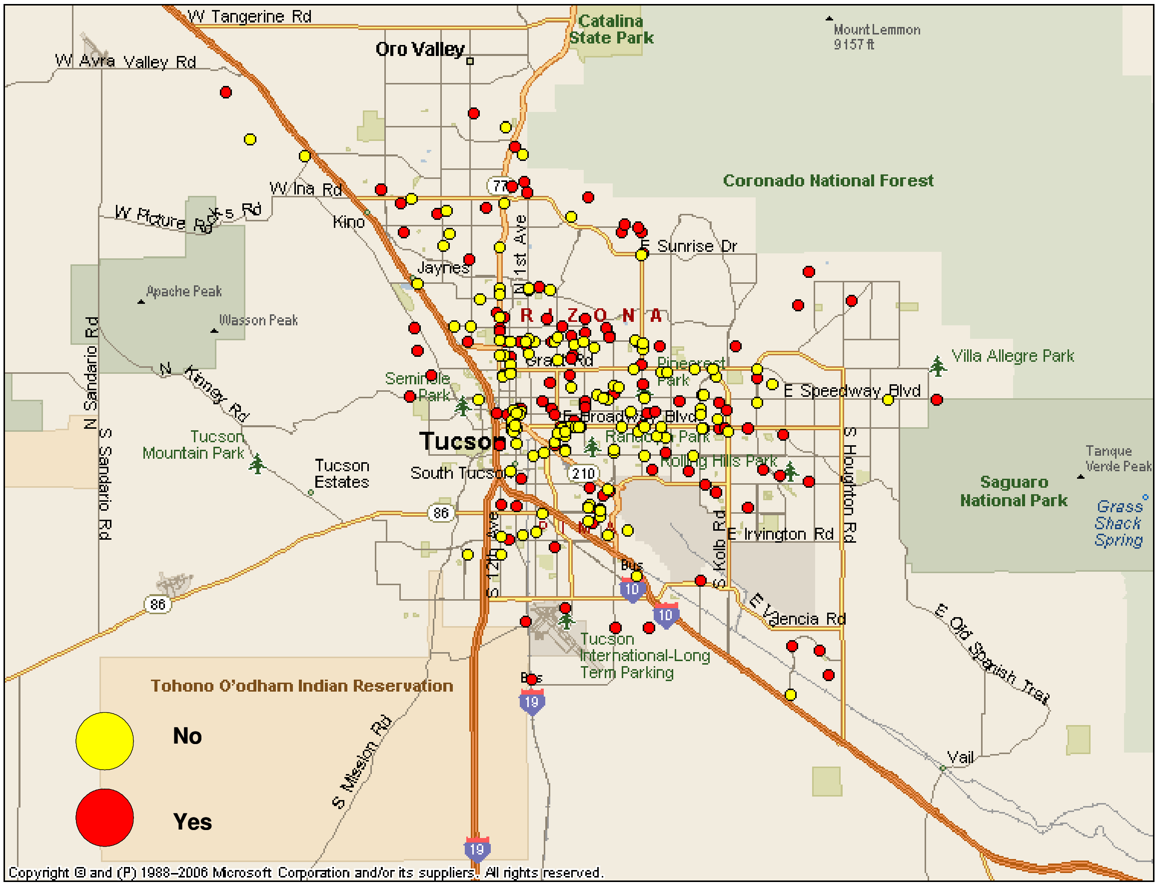
Nearly one-half of businesses allow telecommuting, and another three percent indicate that they were likely to allow telecommuting within the next two years.

Figure 2-46: Business Telecommuting Policy



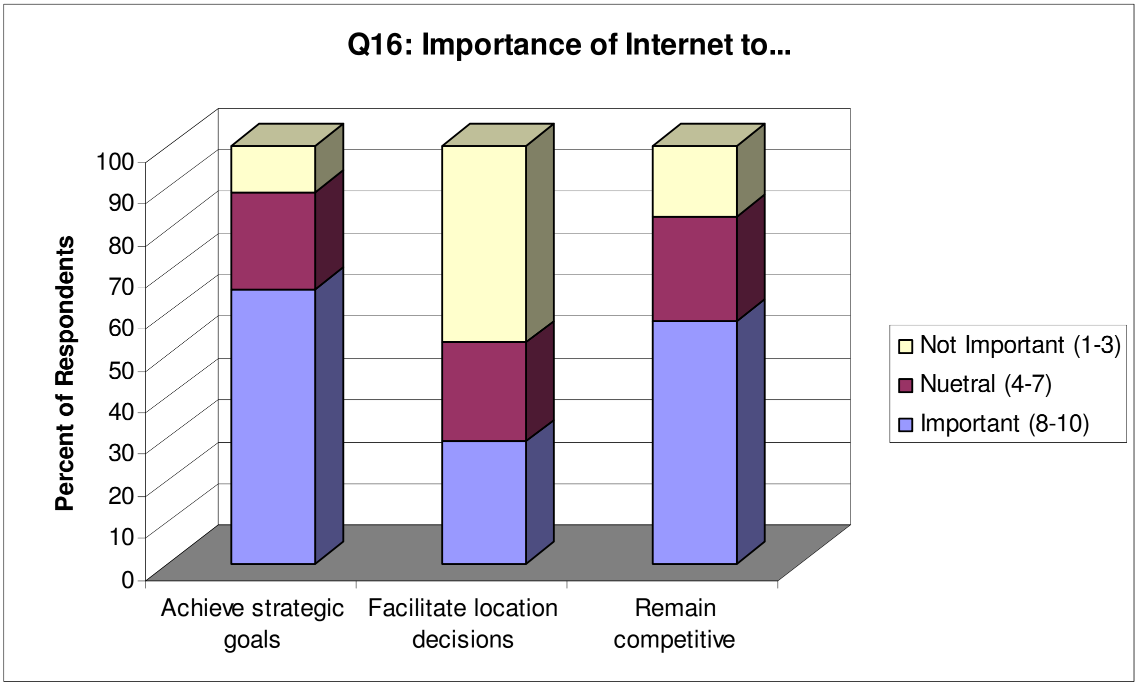
In Figure 2-43 we show the location of the businesses and there position regarding telecommuting. We do not observe any apparent patterns based upon the business location.

Figure 2-47: Business Locations vs. Allowing Telecommuting



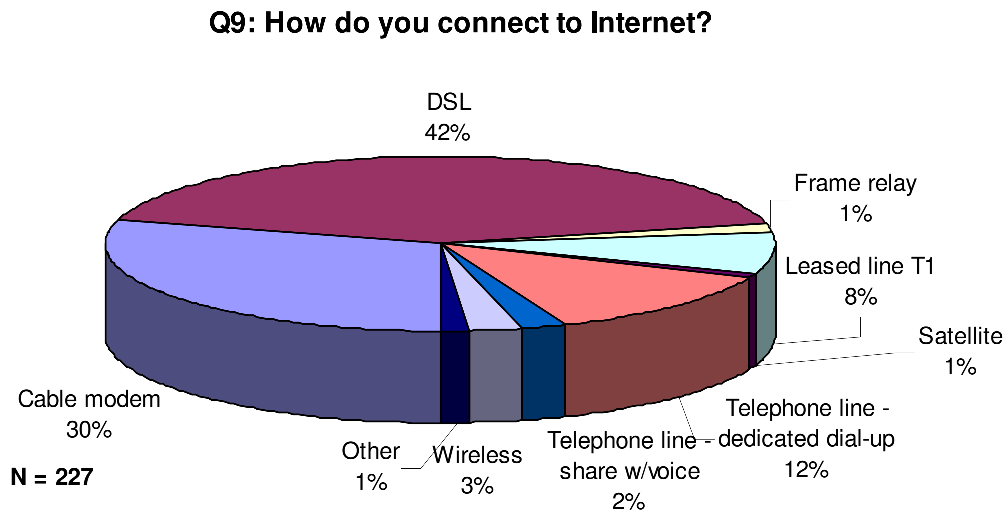
As illustrated in Figure 2-44, nearly two-thirds of businesses stated that the Internet was important for achieving the company's strategic goals. Approximately 60 percent indicated that the Internet was important for remaining competitive. Less than one-third said that the Internet was important to facilitate location decisions.

Figure 2-48: Importance of the Internet



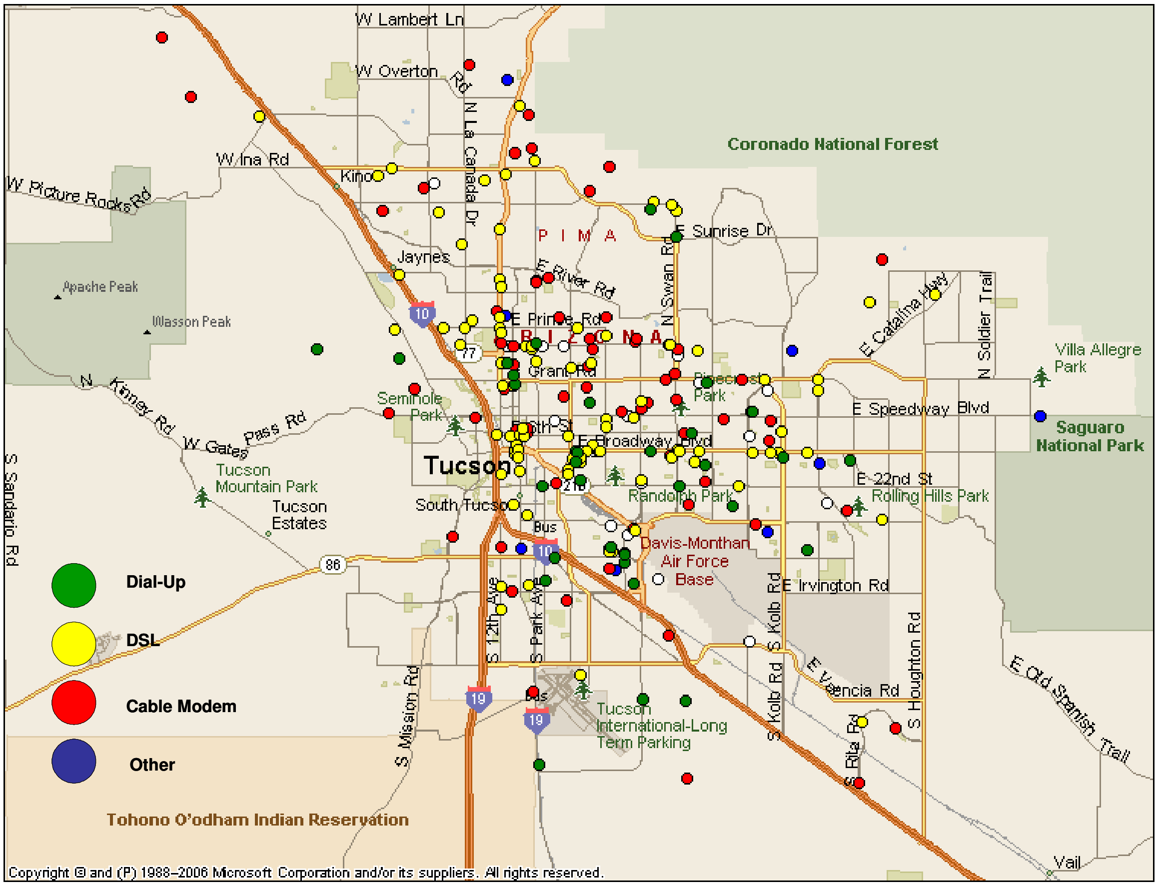
Unlike the residential market which cable modem was the dominant Internet connection, DSL is the prominent business connection. Figure 2-45 shows that approximately 42 percent of business customers connect to the Internet via a DSL line while an additional 30 percent connect using a cable modem. Only 14 percent of businesses connect via a telephone line.

Figure 2-49: Type of Internet Connection



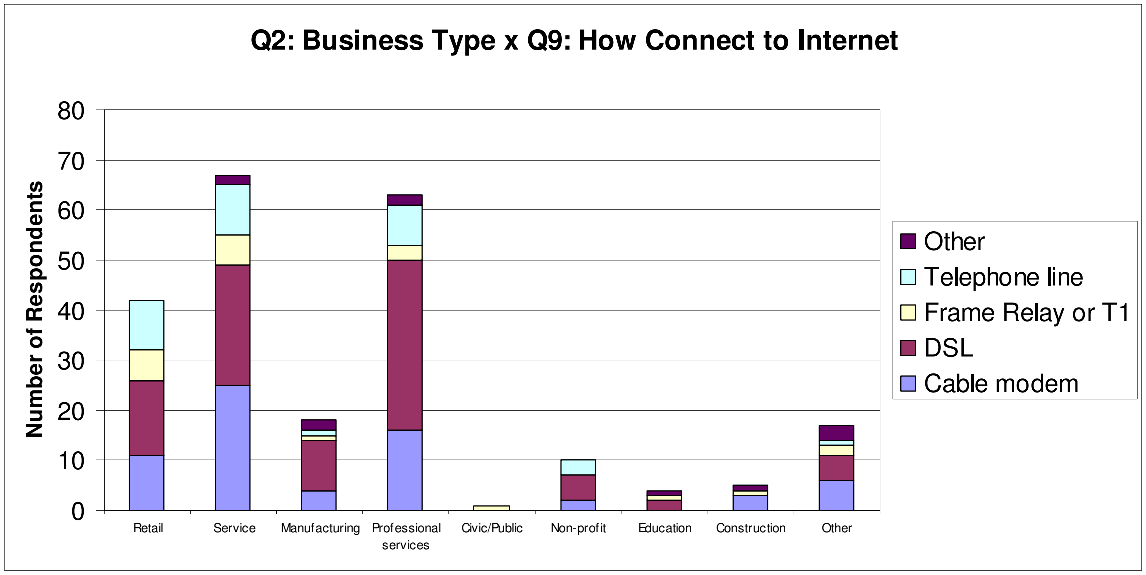
The type of Internet connection at a given respondents location is shown in Figure 2-46. Unlike the residential survey findings, we do not see patterns indicating potential gaps in DSL coverage.

Figure 2-50: Type of Internet Connection by Location



Of the 14 percent of businesses that currently connect via a telephone line, most are in the retail, service, or professional services sectors.

Figure 2-51: Business Type vs. Internet Connection



Nearly two-thirds of businesses indicate that their connection speed is fast enough for their needs. Only seven percent indicated that their connection speed was very slow, most of which connected via a telephone line.

Figure 2-52: Internet Speed Perception

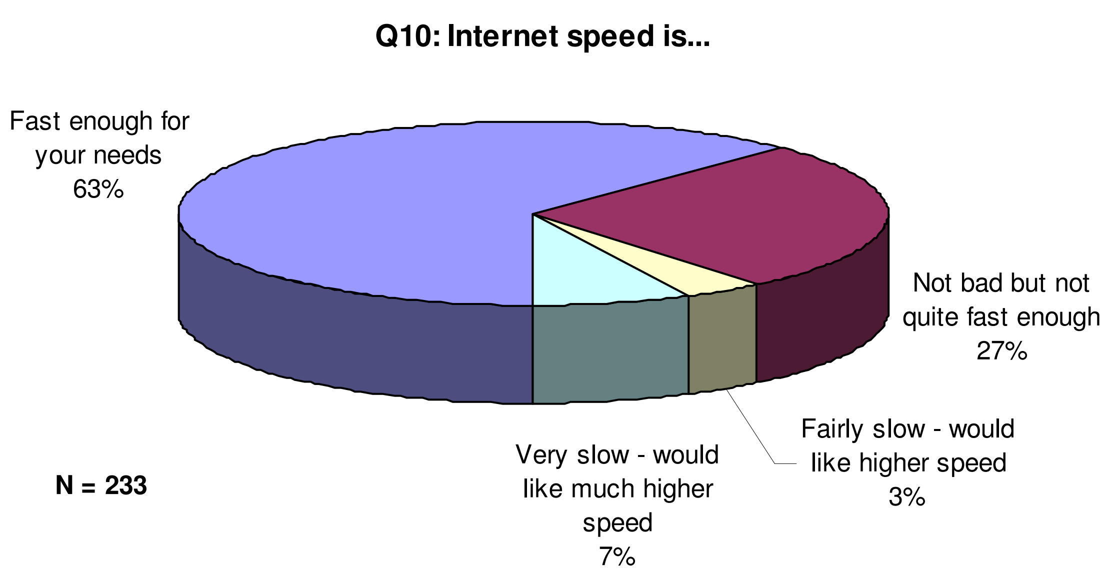
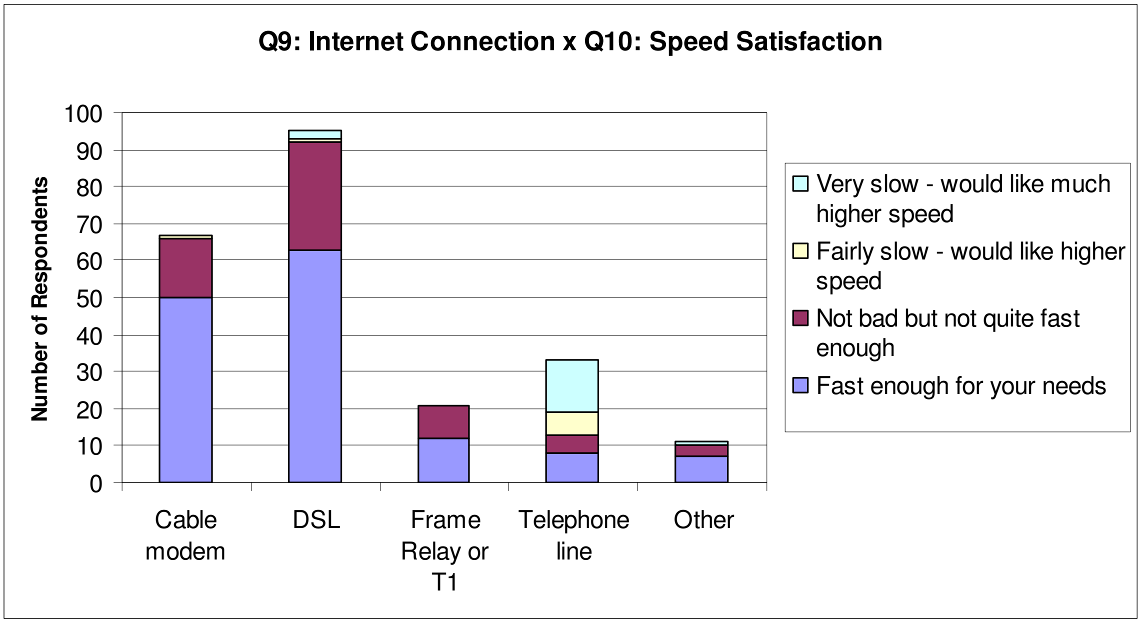


Figure 2-53: Internet Connection vs. Speed satisfaction



Qwest is the largest business Internet provider in Tucson, with a 36 percent market share, followed by Cox Communication with 23 percent and America Online (AOL) with nine percent. Nearly one-fourth of the market is comprised of smaller Internet providers, none of which have greater than a three percent market share.

Figure 2-54: Business Internet Market Shares

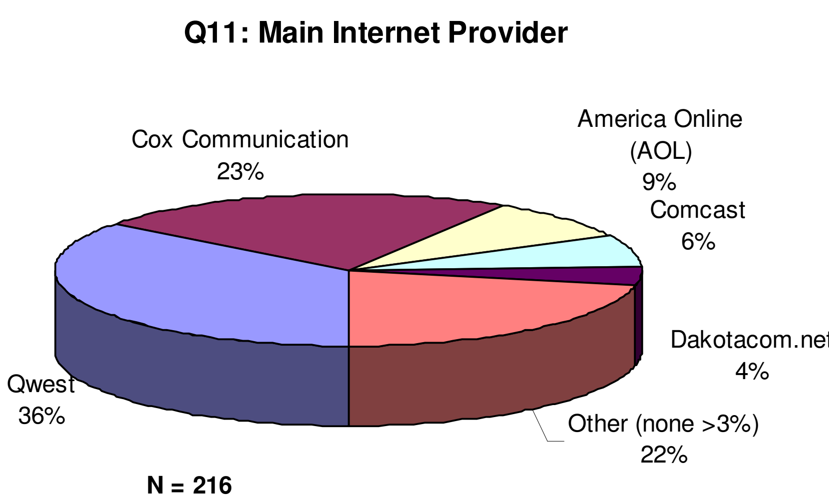
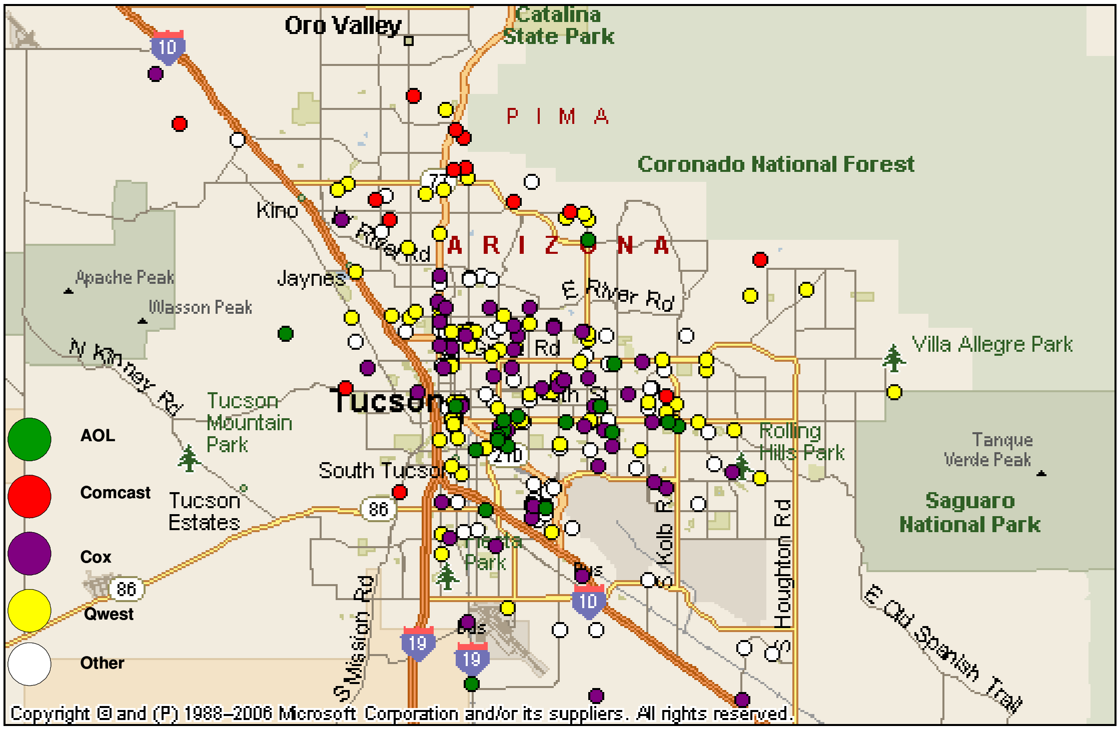


Figure 2-51 shows the geographic distribution business Internet services. As expected we see boundaries between Comcast and Cox due to their franchised service areas. We do however see potential cluster of AOL's customers, especially along S. Kino between E Broadway and Hwy 210.

Figure 2-55: Business Internet Provider Customers



The mean price paid for Internet service is approximately $75 per month across all respondents, or $60 per month excluding the very large users with prices in excess of $300 per month. Approximately two-thirds of businesses pay between $25 and $99 per month for Internet service, while 18 percent pay less than $25. Only 17 percent of businesses pay $100 or more for Internet service.

Figure 2-56: Tucson Role in Wireless Internet

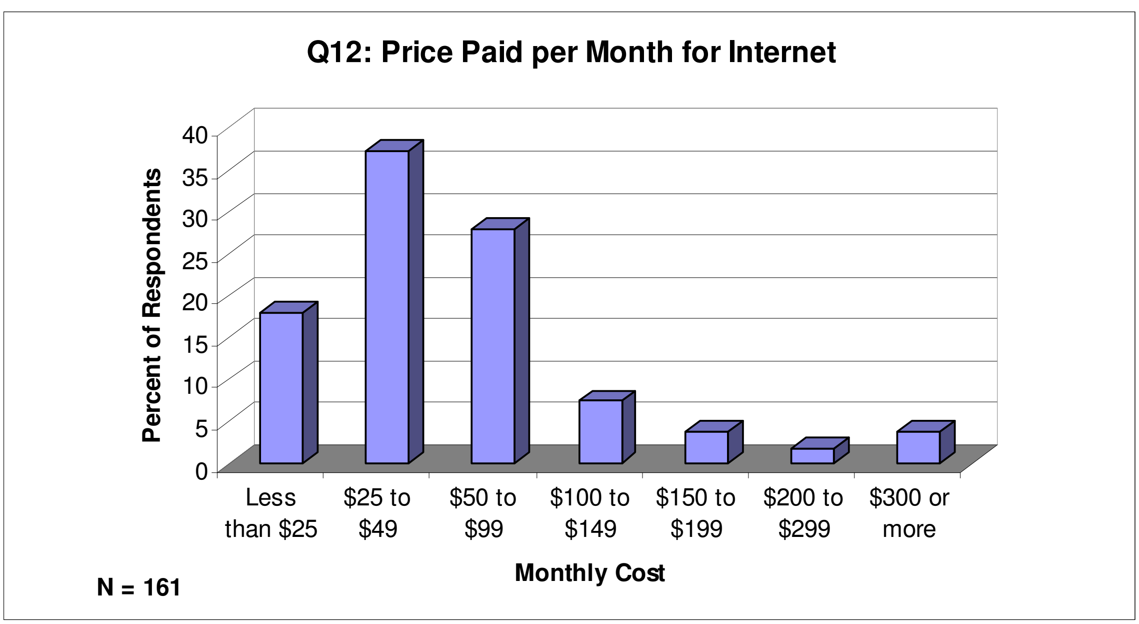
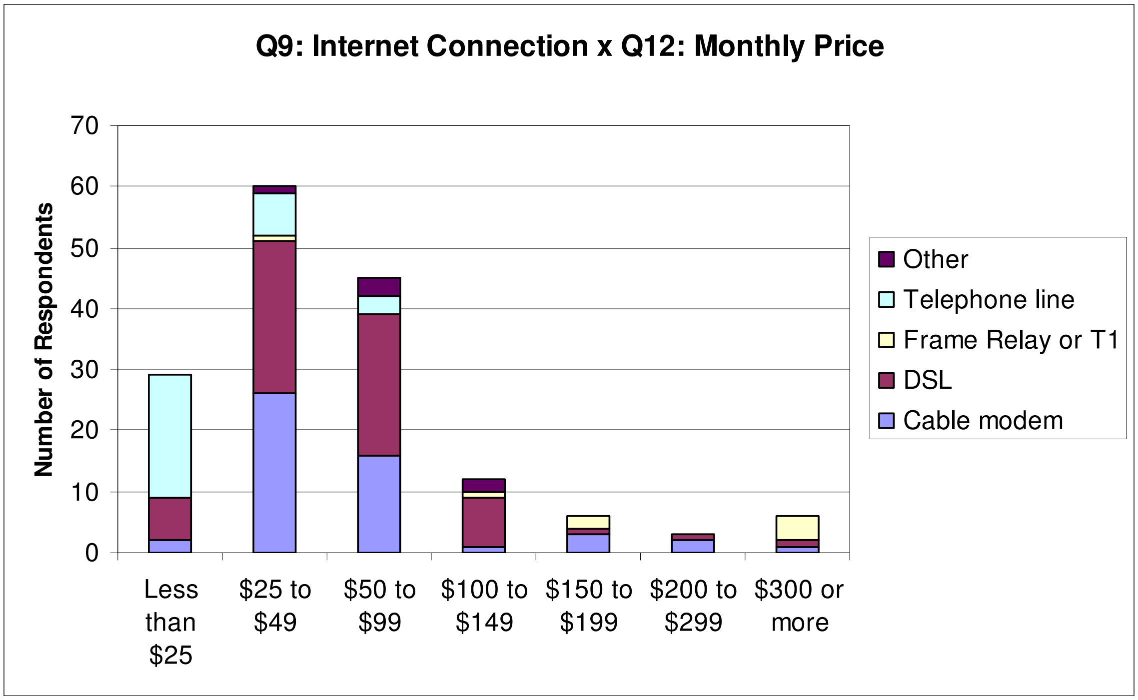


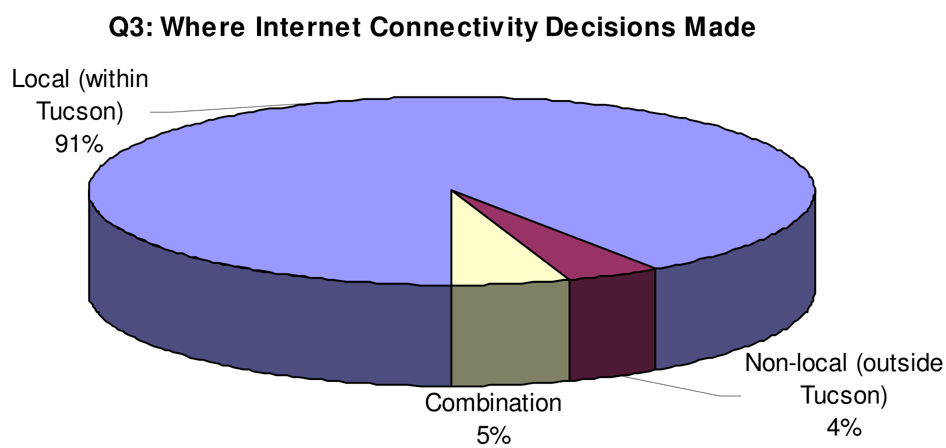
Figure 2-53 graphs the Internet connection type and the monthly service price. Most of the respondents paying less than $25 per month for Internet service connect using a telephone line; although some indicate that they have DSL or cable modem service. Most respondents paying $300 for Internet service connect via a frame relay or a T1 line.

Figure 2-57: Internet Connection vs. Monthly Price



As seen in Figure 2-54, approximately 96 percent of the businesses surveyed indicated that decisions regarding Internet service are made, at least partly, at their Tucson office location.

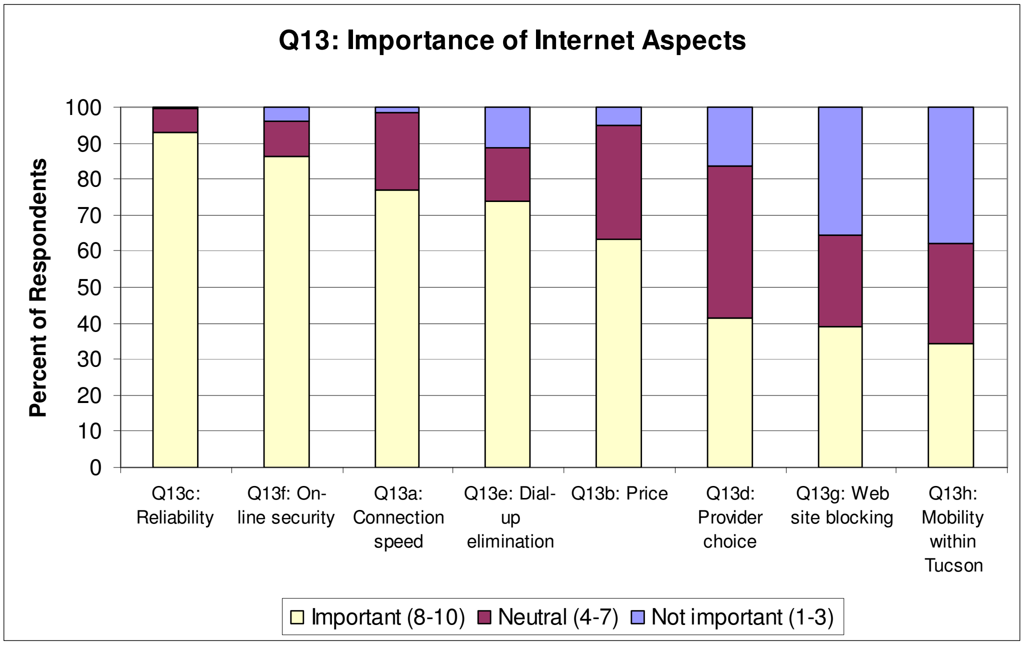
Figure 2-58: Location of Connectivity Decisions



2.5.3 Business Internet Aspects

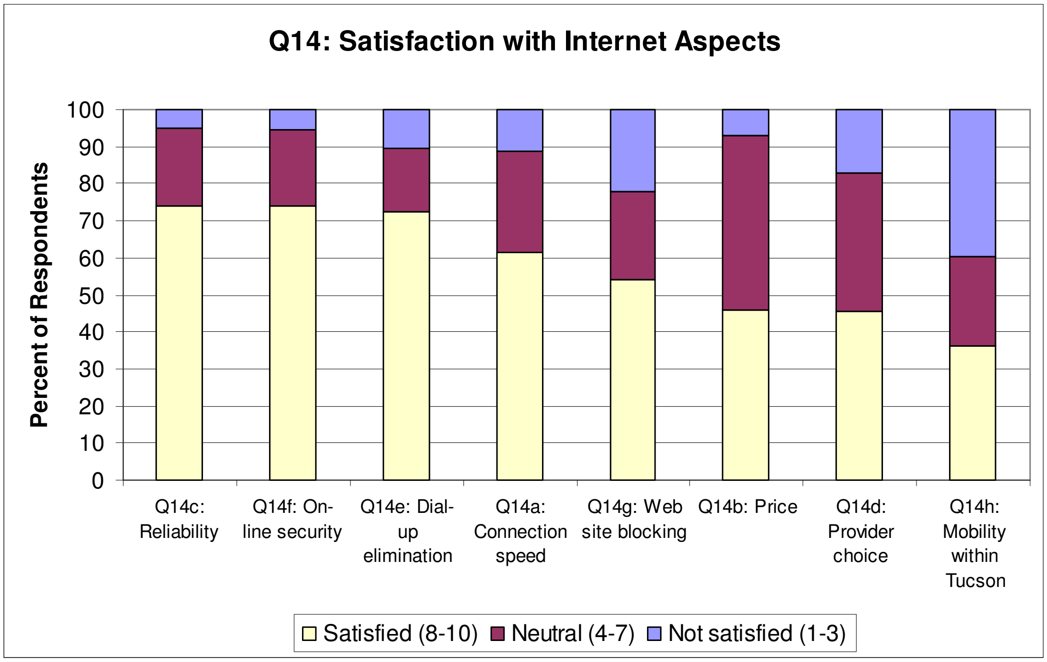
Reliability is the single most important aspect of Internet services for businesses. On-line security ranks second, followed by connection speed. Price is in the middle level of importance compared to other aspects about which respondents were asked. Mobility ranks of the lowest importance among these Internet aspects.

Figure 2-59: Importance of Internet Aspects



In general, business respondents are quite satisfied with the reliability of their current Internet service and are relatively satisfied with their connection speed. This is illustrated in Figure 2-56.

Figure 2-60: Satisfaction with Internet Aspects



Comparisons of the importance and satisfaction with different aspects of Internet service provide insight into the areas in which the current market is over-providing or under-providing different aspects of Internet service. Figure 2-57 compares Internet service importance and satisfaction.

Figure 2-61: Comparison of Importance and Satisfaction of Internet Aspects

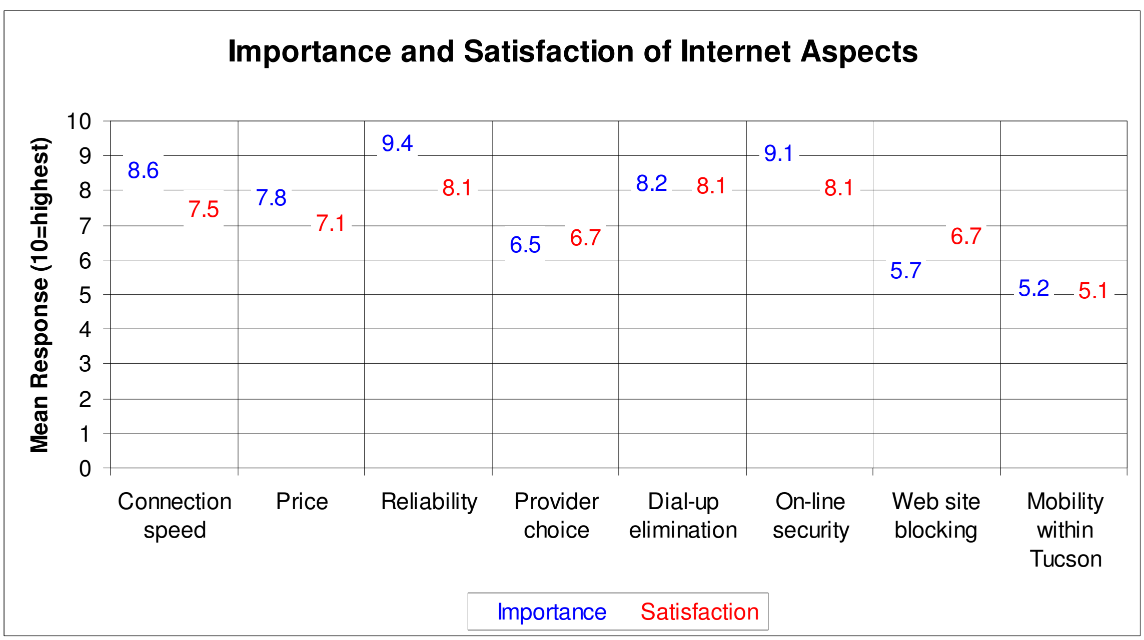


Table 2.3 indicates that the market is not meeting expectations for connection speed, price, reliability, or on-line security. All of these aspects ranked statistically higher in mean customer importance than in mean customer satisfaction.

Table 2-3: Significance of Importance and Satisfaction of Internet Aspects

	Mean Importance	Mean Satisfaction	GAP* < -- >	Significance?
Connection speed (n=230)	8.6	7.5	-1.1	Expectations not met
Price (n=229)	7.8	7.1	-0.7	Expectations not met
Reliability (n=230)	9.4	8.1	-1.3	Expectations not met
Provider choice (n=220)	6.5	6.7	0.2	Not significant
Dial-up elimination (n=220)	8.2	8.1	-0.1	Not significant
On-line security (n=230)	9.1	8.1	-1.0	Expectations not met
Web site blocking (n=228)	5.7	6.7	1.0	Expectations exceeded
Mobility within Tucson (n=225)	5.2	5.1	-0.1	Not significant

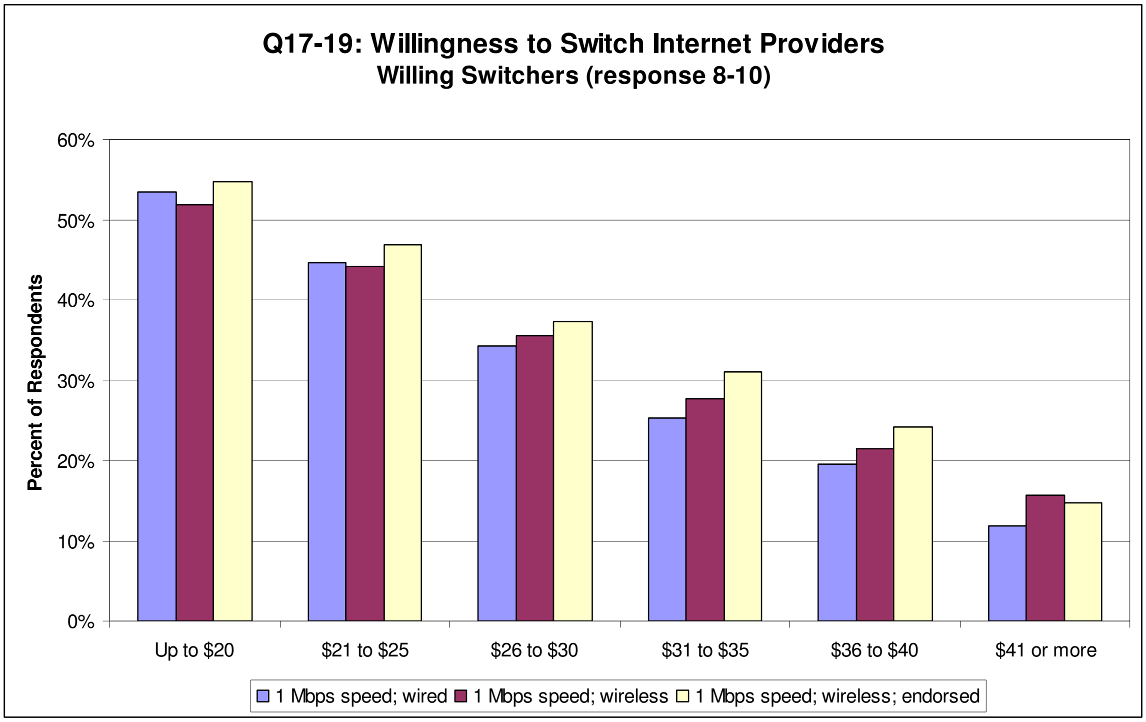
*Difference is statistically significant: *p<.05*

2.5.4 Business Willingness to Switch Internet Providers

Business respondents were asked about their willingness to switch Internet providers for high-speed service, high-speed wireless service, or high-speed wireless access endorsed by the City of Tucson at a variety of price levels.

More than one-half of businesses said that they would be willing to switch Internet providers for a monthly price of $20 per month or less, while less than 15 percent would be willing to switch for a price greater than $40 per month. The differences between high-speed wired service (1 Mbps), high-speed wireless service, or high-speed wireless service endorsed by the City were not statistically significant at most price levels, although there appears to be some advantage to a City-endorsed wireless system in the middle price range. The percent of respondents willing to switch for various price and service options are illustrated in Figure 2-58.

Figure 2-62: Willingness to Switch Internet Providers



There is no observed major significance of willingness to switch to a high-speed service under $25 per month between business areas. However a small gap does appear along S. Kino between E Broadway and Hwy 210. These findings are shown in Figure 2-59. Please note in Figure 2-59 the “Green Square” indicates respondents willing to switch service for under $20 per month, will the “Yellow Pin” represents respondents willing to switch service for $21 to $25 per month.

Figure 2-63: Willingness to Switch Internet Providers for Under $25 per Month

As seen in Figure 2-60, as we increase the proposed price of the Internet offering, we do see a reduction of the respondents willing to switch providers, but no clear geographic patterns are seen.

Figure 2-64: Willingness to Switch Internet Providers

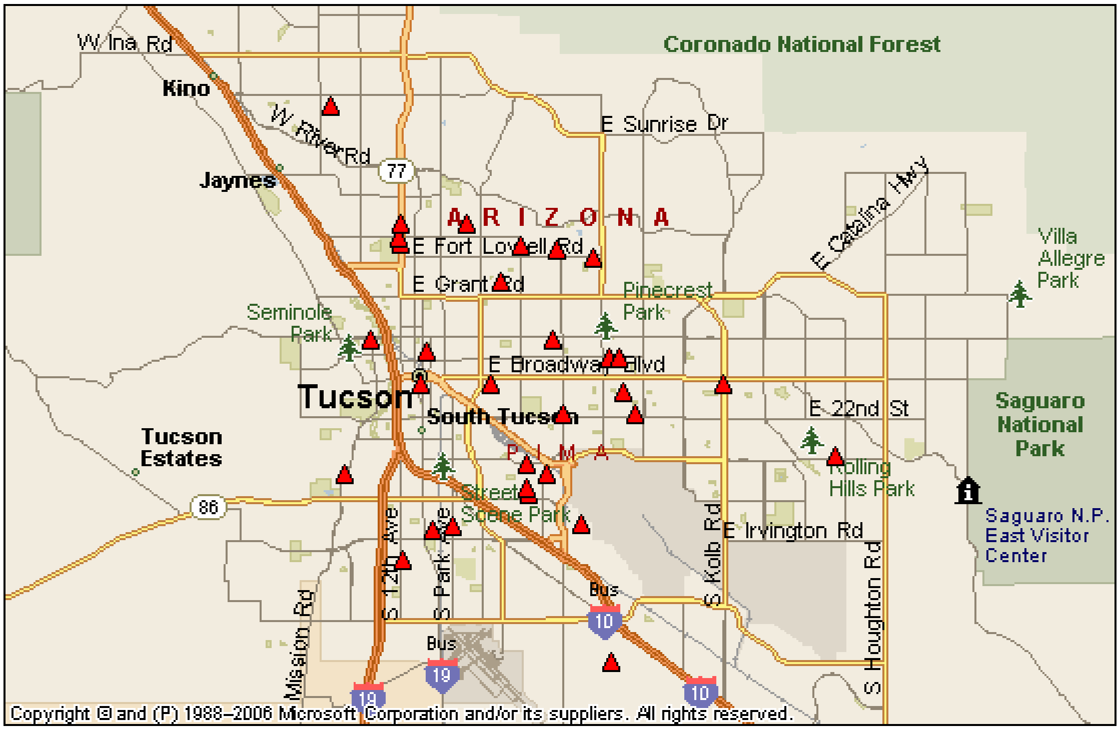
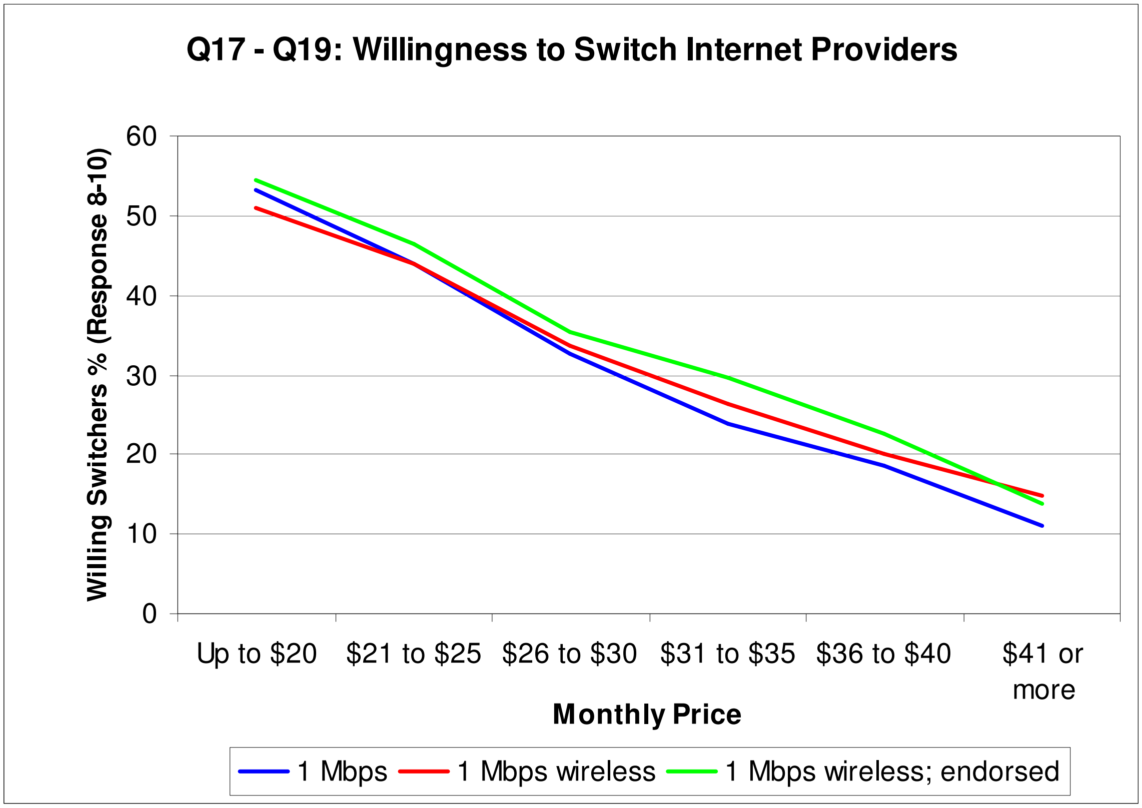


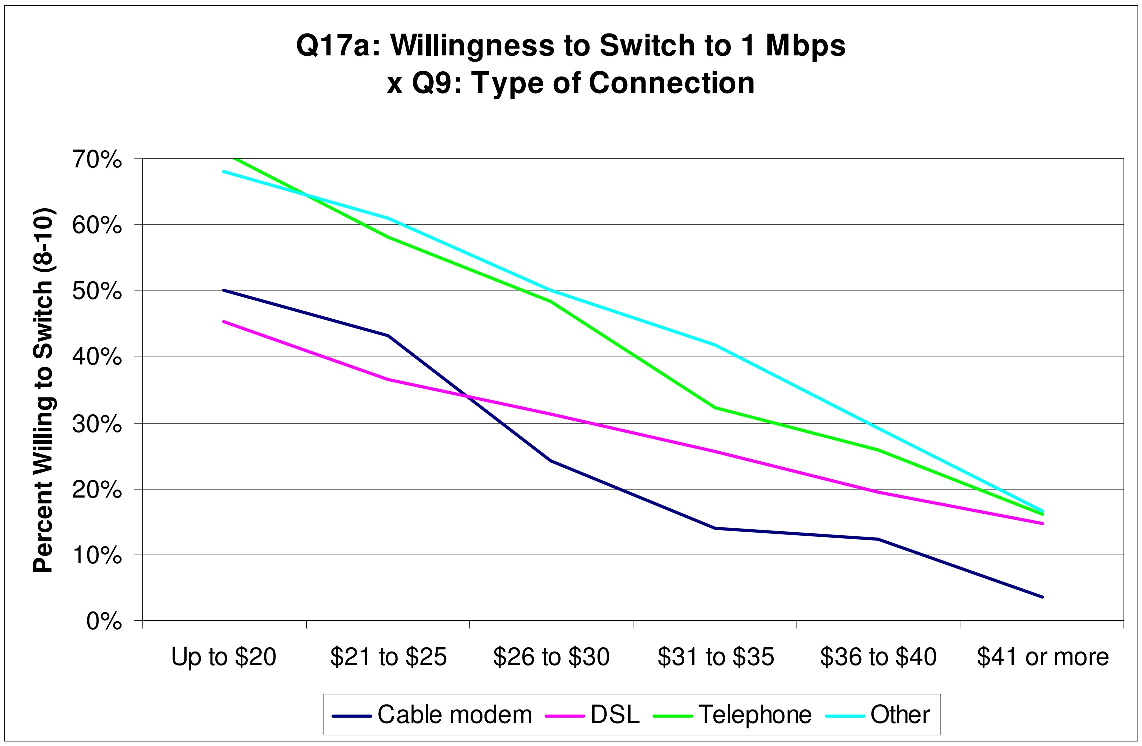
Figure 2-61 compares willingness to switch to a 1 Mbps wired service by type of current connection. Results are similar for switching to 1 Mbps wireless service and 1 Mbps wireless service endorsed by the City of Tucson.

Figure 2-65: Willingness to Switch Internet Providers



Willingness to switch at different price levels is dependent upon the current Internet connection type. Businesses that currently have telephone (dial-up) service or that have "other" service (frame relay, T1, or satellite) are much more willing to switch at most price levels than are cable modem subscribers or DSL subscribers. However, their willingness to switch may be for different reasons. Telephone line users are likely seeking faster service at the same price. Other subscribers are likely seeking similar service at a reduced price.

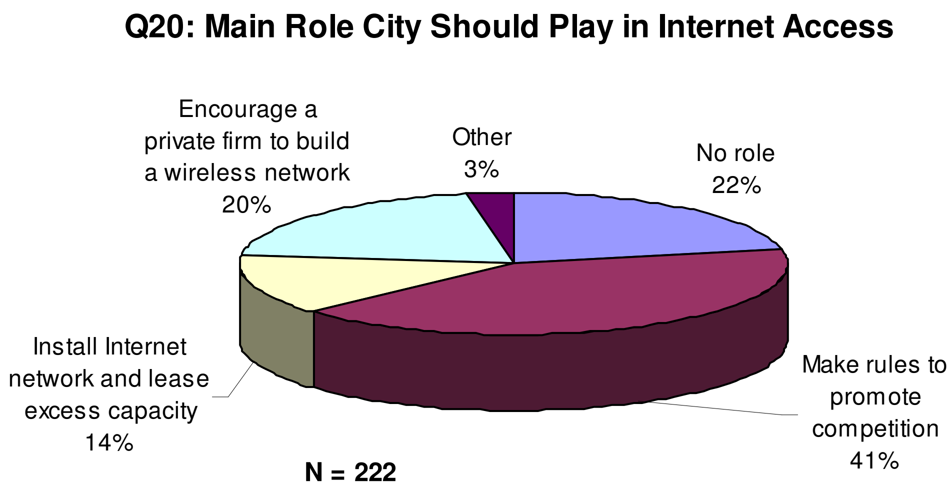
Figure 2-66: Willingness to Switch Providers vs. Type of Connection



2.5.5 Business Perceptions

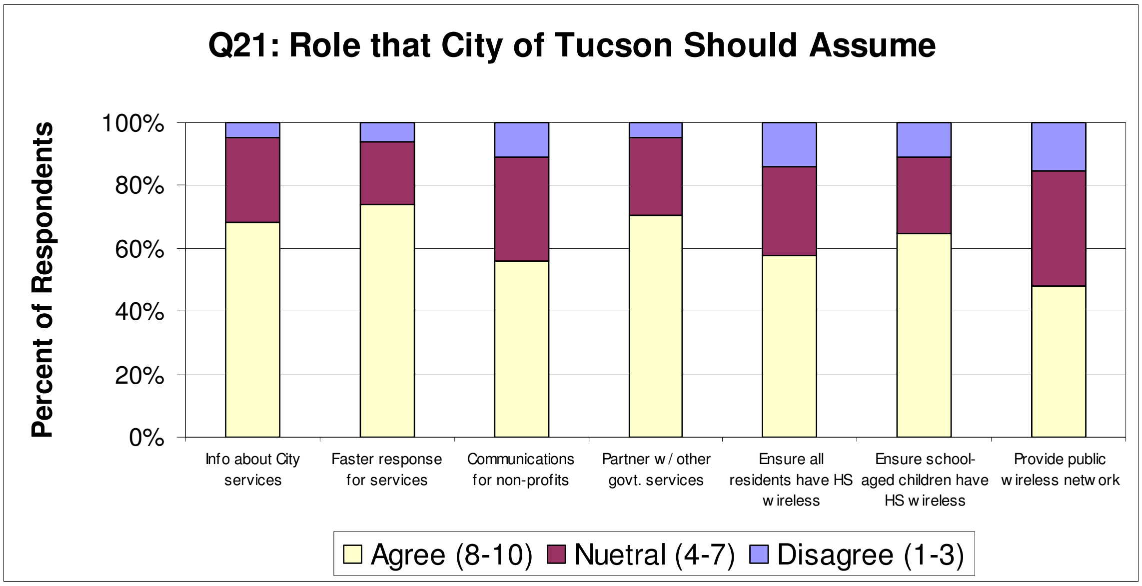
Tucson businesses were asked what they believed the City's **main** role should be to help ensure high-speed Internet service is available and affordable. Approximately 41 percent indicated that the City should make rules to promote competition. Another 20 percent thought that the City should encourage a private firm to build a wireless network while 14 percent thought that the City should install a wireless Internet network. Approximately 22 percent of business respondents thought the City should have no role in Internet access.

Figure 2-67: Tucson Main Role in Wireless Internet



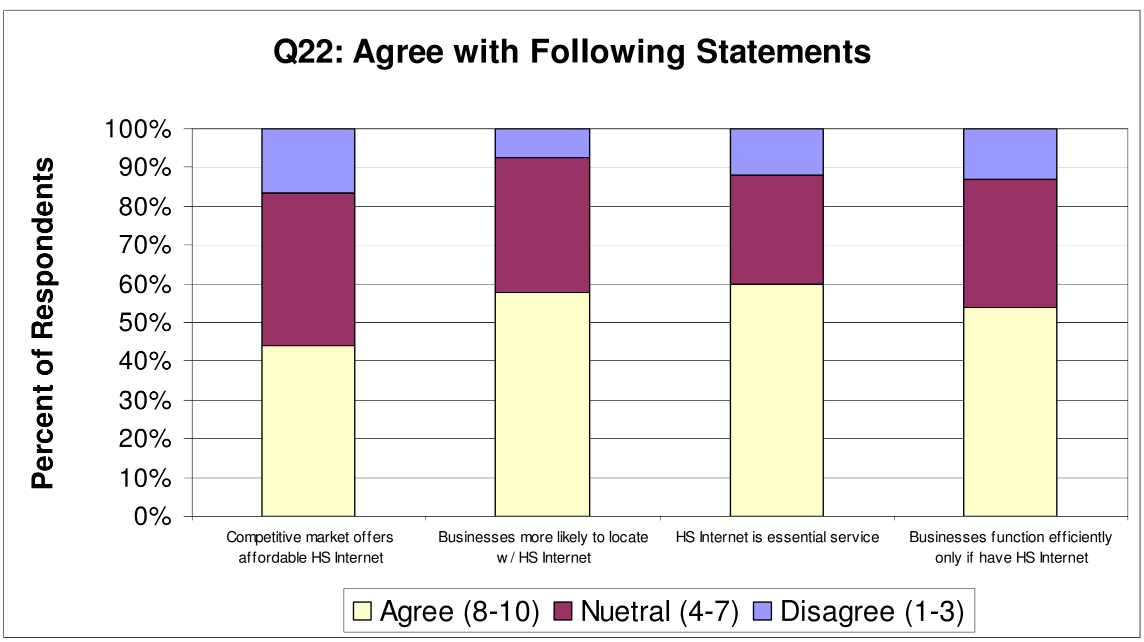
More than two-thirds of respondents agreed that the City should facilitate access to electronic information and services by providing information about city services, providing faster response times for city services, and partnering with other government services to reduce communications costs. Slightly less than one-half of business respondents indicated that the City should provide a public wireless network.

Figure 2-68: Tucson Roles in Wireless Internet



More that one-half of respondents agreed that businesses were more likely to locate in an area with competitively-price high-speed Internet access, that high-speed Internet was an essential service, or that businesses can function effectively only if they have high-speed Internet access. Slightly less than one-half agreed that the competitive market currently provides high-speed Internet access at prices that even the smallest business can afford.

Figure 2-69: Role of the Internet



3. Competitive Provider Assessment

This section of the report provides a brief overview of the existing broadband landscape in the City of Tucson including a review of potential availability gaps, locations of WiFi hot-spots, and summary of existing services.

In our assessment of the residential and business broadband marketplace in Tucson, there were many factors taken into consideration. The marketplace is not simply about demand, but also whether providers can supply the services requested and have capacity for improvement of their networks and products. One question or concern we have is the ability of the existing providers to meet growing consumer expectations and demands for enhanced performance, mobility, and reliability.

3.1 "Pipe" Versus "Services"

Many consumers confuse the broadband network or "pipe" with "services." They are actually two separate things.

The broadband network ("pipe") is the medium over which data, and increasingly voice and video packets are sent and received over the Internet or private networks. It is helpful to perhaps equate the "pipe" with the much used metaphor of the "Information Superhighway." This highway ("pipe" or network) is the road that cars, trucks, and other vehicles drive on. Without the highway, the vehicles have nothing to travel on.

"Services" are the various voice, video, and data transmissions that can be sent or received on the network or pipe. Some examples of services include:

- E-mail from Yahoo or Hotmail;
- Streaming video from CinemaNow, Disney, Movielink ; and
- Voice over Internet Protocol (VoIP) telephone from Vonage or Skype.

While there is significant competition in the provision of programming and services, there is not always significant competition in the provision of networks or pipe. Recent rulings by the Federal Communications Commission (FCC) and the courts have allowed the network owners to close their networks to competition. This is a departure from the common carrier rules under which the telephone networks have operated and under which Internet service providers (ISPs) offered competitive dial-up modem service. As a result of these rulings and decisions, many of the ISPs have ceased offering Internet service because they cannot access the distribution network – at any price.

To further confuse the mater, there is no universal definition of broadband. The FCC defines "high speed" or "broadband" as "connections that deliver services at speeds exceeding 200 kilobits per second (kbps) in at least one direction."[7] This definition is

[7] "FCC Consumer Facts, High-Speed Internet Access – "Broadband," FCC Website, http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State _Link/IAD/ hspd0705.pdf, accessed February 7, 2007.

inadequate – broadcast quality streaming video requires at least 700Mbps – 2 ½ times greater than the FCC definition. Consumers will continue to demand higher speeds and enhanced services which exceed the broadband definition-of-the-day.

3.2 Availability and Gaps for Internet Access

As part of our assessment, we examined and interviewed the current providers who have facilities-based networks and services in Tucson. We found there are reported pockets or gaps in the Tucson marketplace that have limited or no services available – most based upon the type or location of the structure or dwelling, topology or terrain, and the technology used to provide the services.

3.2.1 DSL

Qwest is the incumbent local telephone provider and has a facilities-based DSL network in Tucson. In our discussions with Qwest, the company refused to provide overview or detailed coverage maps or facilities locations despite repeated requests in conversations with multiple representatives.[8] Resellers of Qwest DSL and other providers who lease lines and place equipment to provide DSL service are only able to offer the same speeds and capabilities that Qwest offers.

One of the identified DSL coverage gaps is the West side[9] of Tucson.[10] This area was identified by residents and businesses which attempted to acquire services. To fill this gap, Simply Bits deployed a wireless offering.

A residence or business may be within the qualifying area to receive DSL, but may find that it is not available due to a lack of adequate circuits or other users in that area taking up the available bandwidth. This can result in one address getting DSL and the next one (even in the same building) not being able to get service. Please see Section 3.4.1 for additional information regarding DSL coverage.

3.2.2. Cable Modem

As noted earlier, both Cox and Comcast serve Tucson with cable modem services for Internet access. Cox has a franchise agreement to cover the majority of the community and Comcast has a franchise to serve a small area in the Northwest portion of the city. Cable modem service is available to subscribers wherever the cable company has constructed adequate network facilities to support high-speed Internet access. In theory, the service is available wherever the network exists. However, there are some areas where there may not be adequate cable plant in place due to low density of houses or businesses or construction in the area. Areas of new development often will have to wait to obtain service until the network is extended. Both Cox and Comcast claim that

[8] Interviews and inquiries of Qwest personnel took place during the months of January and February, 2007.
[9] This area is West of Interstate 10 and off of Sweetwater near the Tucson Mountains. This area also was identified in the survey results as having limited or no DSL coverage.
[10] Interview with Mike Bernstein, Co-Founder, Simply Bits, February 10, 2007.

availability in new construction areas must be verified with an exact street address and zip code before service can be provided.

Another situation that often denies cable modem service to residents involves apartment buildings. Many times building owners will sign exclusive agreements with satellite or other providers of video and Internet services that preclude the cable company from providing service in the building. Locating these buildings requires a site-by-site survey.

3.2.3 Satellite

So long as the customer has the appropriate dish and a clear exposure to the Southern sky, service should be available according to the providers we interviewed. Some factors that can interfere with the signal performance include trees, structures or buildings, electrical storms, heavily cloud cover, etc.

3.2.4 Wireless -- Fixed

There are a number of factors that can effect and/or prevent customers of fixed wireless from accessing the Internet. These networks are usually a series of towers and mounted antennas that must have the ability to communicate directly with each other. The antennas and equipment placed on these towers and buildings are limited in their range and ability to completely cover an entire area. Providers will claim to have large coverage areas of the community, but complete 100 percent coverage is not really a possibility – in reality the fixed wireless technologies deployed in Tucson will see 10 percent to 20 percent of households not able to receive adequate coverage. Providers of these services will try to overlap their tower ranges to blanket the most populated and demanding areas of users.

Some of the other factors that can cause interference or blockage of the signal from one tower to another include:

- Building reflections from tall buildings or buildings with reflective materials;
- Building construction materials – stucco, concrete, etc. can be difficult to penetrate with a wireless signal; and
- Large canopy of trees or foliage.

3.2.5 Wireless – EVDO/3G

The users of this wireless technology must have a data card from their provider as well as a computer (usually a laptop) or PDA (Palm, Blackberry, or other handheld computer device). Successful connection to the Internet is dependent upon a good signal from the provider's network. Some of the factors that can affect the signal quality include:

- Network capacity and usage;
- Building construction materials – the signal must be able to penetrate; and
- Trees and foliage

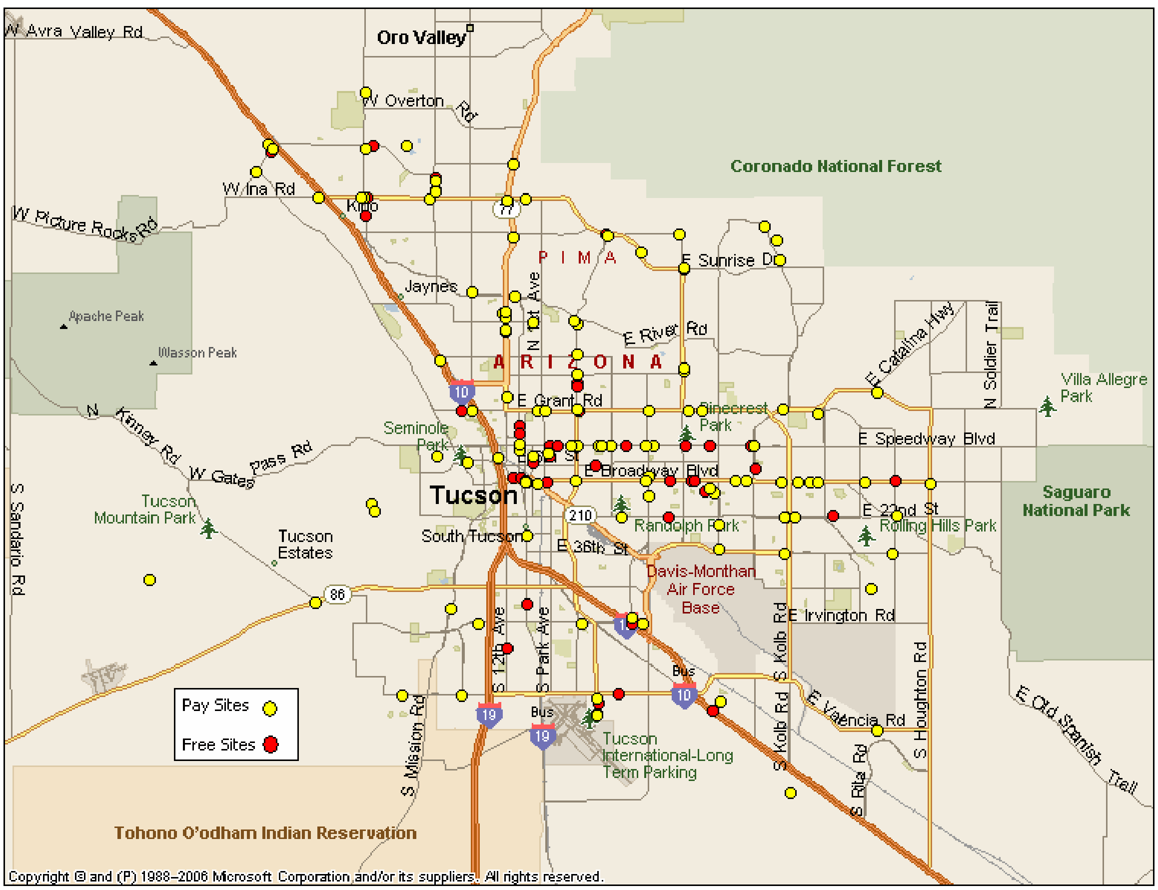
The providers we identified and interviewed claim to have very strong signals throughout the city limits. They also report that strong signal coverage is less likely in the lesser developed areas outside the city and in the mountains.

3.3 WiFi Hot Spots Locations

WiFi hot-spots provide the ability for a Tucson visitor or resident to access the Internet at their place of business, public areas, or other locations. Access to the hot-spots at times are free, all others for a daily or monthly access charge.

We identified[11] 187 WiFi hot-spots in Tucson, of which 53 offer free access to their patrons or visitors. Included in the 53 free sites are the Public Libraries, Jacome Plaza, and the open area outside the Pima County Courthouse. The majority of free sites are coffee shops and other restaurants. The 134 sites requiring payment or subscription are dominated by McDonalds with 23 sites, The UPS Store with 20 sites, and Starbucks with 18 sites. The complete list of located hot spots is included in Appendix D, and is shown in Figure 3-1.

Figure 3-1: Identified WiFi Hot Spots



[11] Sources: http://reviews.cnet.com/4520-6659_7-726628-1.html and http://www.wi-fihotspotlist.com/

3.4 Existing Networks and Services

Our assessment of competition focuses on broadband products and services offered by providers to the residential and small/medium businesses in Tucson. We primarily examined networks that offer these products or services:

- Digital Subscriber Line (DSL);
- Cable Modem;
- Satellite Broadband;
- Dial-Up Telephone;
- Wireless – Fixed; and
- Wireless – EVDO/Third Generation (3G).

We identify the network providers and the services they offer in a series of tables in Appendix F. Table 1 in Appendix F identifies the providers in Tucson and the types of services they offer. Table 2 in Appendix F outlines the specific type of Internet access services offered to residents by each provider. Table 3 in Appendix F outlines the specific type of Internet access services offered to businesses by each provider.

3.4.1 The Phone Company: Qwest

Qwest is the incumbent local exchange carrier in Tucson and offers DSL service in areas within the City, particularly near the company's central offices.[12] Qwest is the only provider of DSL services with a full facilities based network in Tucson.

It is important to understand that determining availability of DSL can be difficult. DSL availability is measured by whether the location is in a given zone[13] near a central office or remote DSL access multiplexer (DSLAM) that is DSL capable and if the zone:

- Has circuits in the zone available;
- Has a percentage of the circuits configured to support DSL; and
- How many of the DSL circuits are already serving customers.

A given zone may be capable of DSL, but the circuit to a particular location may not be capable of supporting DSL or all of the available DSL circuits are used. This can result in a situation where one business or residence in the same area can get DSL service and their neighbor cannot. Actual availability must be confirmed on a case-by-case basis.

Although Qwest has records and details which allow a relative accurate estimate of DSL availability, they were unwilling to share this information. From review of survey data and discussions with the providers we strongly suspect not only do we see coverage

[12] Qwest considers the locations of its central offices to be "proprietary" information and would not provide information pertaining to them.
[13] Typically service is available 18,000 feet or less from the central office.

(availability gaps), but spot gaps as a result of capacity limits. This situation will result in one household being able to receive DSL, but the neighbor unable to.

DSL represents a relatively low-bandwidth form of broadband. It is a network of roads instead of superhighways. It runs on telephone network copper wires and is not as capable as fiber based or hybrid fiber/coaxial (HFC) based networks.

Qwest offers various DSL packages for residential and business customers and offers discounts for bundling with telephone service.

The Tables 2 and 3 in Appendix F include information on the various speeds and packages that Qwest offers to residents and businesses.

3.4.2 The DSL Resellers

There are a number of providers that are reselling Qwest DSL services or are leasing lines and are placing their own equipment on the network to offer DSL. These providers include:

- AOL
- Blue Mountain/BMI
- Cyber Trails
- EarthLink
- Everything DSL
- Extreme Internet
- Future Information Design/AZ Galaxy Online
- Gain Broadband/DakotaCom.Net
- Jivas Technologies
- Nationwide/The River
- NetZero
- Team Mates International
- Telebay/Broadband National

These providers offer various service packages based on the speeds offered by the networks they reside on. The majority of these providers are using the Qwest network and the speeds that are offered are the same as what Qwest is marketing. Many resellers will indicate that DSL service is available almost everywhere in the city, but needs conformation on an address-by-address basis. Because Qwest is the incumbent local exchange carrier (ILEC), their DSL service availability is likely the most accurate portrayal for the residents and businesses in Tucson of what is available.

The Tables 2 and 3 in Appendix F include information on the various speeds and packages that these providers offer to residents and businesses.

3.4.3 The Cable Companies: Cox and Comcast

Cox is the dominant cable company servicing the majority of Tucson with cable television service. Comcast is an additional provider that has only has a small portion of the Northwest section of the City and serves the surrounding county area.

Both Cox and Comcast offer their residential and business customers cable modem Internet access on their hybrid fiber/coaxial based networks in all the areas that those networks serve. There are some locations, particularly in the Northwest portion of the city, where the two provider networks meet and may even overlap depending on the network routing (underground and aerial) for each company. Both providers require customers to have specific locations verified for service availability within their networks.

Cox offers discounts to their customers on "triple play" packages and other bundled packages of services to residents and businesses. The Cox triple play includes cable modem Internet access, cable television video services, and telephone service. Customers who subscribe to all of these services receive deeper discounts than those who purchase services separately.

Comcast does not offer telephone services in Tucson at this time, but does offer bundled packages for cable modem Internet access and cable television service to residents and businesses.

Cable modem service offers higher speeds and capabilities than DSL due to the HFC network. These networks consist of a fiber backbone with coaxial cable to the home or business. Cable modem service can often be limited in areas of a community if population density does not warrant the cost of cable plant construction.

Tables 2 and 3 in Appendix F include information on the various speeds and packages that Cox and Comcast offer to residents and businesses.

3.4.4 Cable Modem Resellers

We found there are several national ISPs that provide Internet browsing and email services with cable modem services as part of their offerings. These providers include:

- AOL
- EarthLink
- NetZero
- Telebay/Broadband National

Because these services are dependent upon the local cable company's network, the speeds, packages, and availability are the same as what Cox and Comcast offer.

Table 1 in Appendix F indicates the services offered by these providers to residents and businesses.

3.4.5 Satellite Broadband Providers: Dish Network and HughesNet

Some consumers who do not subscribe to cable television or cannot obtain cable modem service choose to purchase satellite broadband. Typically, this is more common in rural areas where there is no broadband option other than satellite. Satellite broadband cannot match the speeds and capabilities of cable modem or DSL service. It is also more costly than the other services. Satellite transmission has latency and delay issues that do not allow for reliability when attempting some applications.

We found two national providers that offer satellite broadband and installations in Tucson so long as the location has the proper dish and a clear line of sight to the Southern sky. These providers are HughesNet (formerly DirecWay) and Dish Network.

Both providers offer packages of varying speeds and prices, but the greatest download speed is 1.5 Mbps. This pales in comparison to the download speeds of 7 Mbps and above offered by DSL and cable modem services.

Dish Network also offers satellite video services, but HughesNet does not directly offer video service.

Tables 2 and 3 in Appendix F include information on the various speeds and packages that HughesNet and Dish Network offer to residents and businesses.

3.4.6 Dial-Up Telephone Providers

There are several local and national providers of dial-up telephone based Internet access in Tucson. The companies we found to be providing this service include:

- Access4 Internet
- AOL
- Blue Mountain/BMI
- Cyber Trails
- EarthLink
- Future Information Design/AZ Galaxy Online
- Jivas Technologies
- Localnet Corp.
- Netlink/Jellico
- NetZero
- PeoplePC
- Qwest
- Telebay/Broadband National

These connections are based upon the capability of the modem used by the customer and the capability of the telephone line. The speeds available (56 kbps) are far inferior to those offered via cable modem and DSL. Customers subscribe to the monthly service and call a telephone number to be connected via their modem to the Internet. The prices for these services range from approximately $10 to $25 per month.

Dial-up service fits the needs of users who do not wish to pay higher prices, access or download large files, or only occasionally check e-mails. Consumers continue to increase their demand for speed and capacity, so it is not anticipated that dial-up Internet access will be part of the next generation of products and services.

Tables 2 and 3 in Appendix F include information on the various speeds and packages that these providers offer to residents and businesses.

3.4.7 Wireless (Fixed) Providers

There are three providers of fixed wireless based Internet access in Tucson. These providers include:

- Trico Electric Cooperative/Transworld Network
- Gain Broadband/DakotaCom.Net
- Simply Bits

All three of these companies/partnerships have fixed wireless antennas mounted throughout areas in the city. Depending on the proximity to an antenna, wireless signal availability, and other factors, consumers may be able to subscribe to this service. Each of the companies requires verification of an exact location prior to quoting service availability. All three serve both residential and business customers in Tucson.

Trico Electric Cooperative/Transworld Network reports it has limited coverage of the city. Potential customers are urged to call to schedule a site survey to determine the availability of service in their area.

Gain Broadband/DakotaCom.Net estimates that their service covers approximately 70 percent of the city. The company indicates that their network is point-to-point and point-to-multi-point and offers high-speed wireless connectivity.

Simply Bits estimates that their point-to-multi-point service covers approximately 98 percent of the city plus some surrounding communities and county areas. The company indicates that their network has an OC12 dual fiber backhaul and that there are nearly 40 towers around Tucson. These towers are all linked and redundant according to the company. They also offer VoIP telephone service to their customers. Simply Bits also indicates that they are currently providing wireless services to Pima County for internal use.

Tables 2 and 3 in Appendix F include information on the various speeds and packages that these providers offer to residents and businesses.

3.4.8 Wireless (EVDO) Providers

Mobile wireless Internet access via Evolution Data Optimized (EVDO) or similar third generation (3G) technology is offered by three national cellular providers in Tucson. These three providers are:

- Sprint/Nextel
- Cingular/AT&T
- Verizon

Customers use data cards in their laptops or use their PDA devices to access the Internet. All three providers cite varying speeds available via their networks and offer various packages for residents and businesses.

Tables 2 and 3 in Appendix F include information on the various speeds and packages that these providers offer to residents and businesses.

There is much talk of fourth generation or 4G wireless broadband technologies on the horizon. These are technologies with standards developed by working groups of the Institute of Electrical and Electronics Engineers (IEEE) and are known by standards numbers 802.11 (WiFi), 802.16 (WiMax), and 802.20. These will also include new enhanced generations of wireless technologies (EVDO and 1xEVDO).

3.5 High Capacity Transport Providers

We found several providers who offer higher bandwidth network capability to medium and larger businesses in Tucson. The technology offered is above T1 capability[14] and includes such circuits as Frame Relay, Point-to-Point, and others. The providers offering these services are:

- Cyber Trails
- Gain Broadband/DakotaCom.Net
- Login Inc.
- Qwest
- Simply Bits

Each of these providers will customize a network solution for businesses and offer varying circuits and prices. Businesses are required to call and discuss these services before quotes will be provided.

Table 1 of Appendix F outlines these providers and services.

[14] T1 is usually defined as a service providing a 1.5 Mbps rate both upstream and downstream.

4. Leverage Existing Assets

This section of the report is intended to provide City decision-makers with suggested approaches and considerations that may encourage a private investment in Tucson. In particular, this section provides a discussion on how leveraging existing City assets could improve financial projections for a City-wide WiFi deployment. The more existing assets are made available to the private sector provider, the easier it is to shift away from the anchor tenant model to a model that may lower or reduce the required investment.

The projected operating margins for City-wide WiFi networks are relatively low; as a result, it is likely that private investment in City-wide networks will be rare unless the City takes steps to enhance the attractiveness of such an investment. If there was a high probability of obtaining a substantial rate-of-return on their investment, providers would jump onto the WiFi deployment bandwagon. In order to encourage private investment, the City of Tucson must explore methods that improve projected WiFi operating margins.

The anchor tenant model is the most common approach currently used by municipalities to encourage private investment.[15] This model provides substantial guaranteed cash-flow to the provider for municipal use of the network, increases the ability of the private provider to obtain the required capital to deploy a WiFi network in the community, and increases the projected operating revenues of the business. Tucson prefers not to become an anchor tenant – and intends rather to pursue an approach which does not require a financial investment.

To help encourage investment, it is important to examine assets from a business perspective. These assets include any available community resource that increases operating margins by:

1. Reducing operating costs such as pole attachment fees, energy fees, customer acquisition, and maintenance.
2. Reducing the required investment to deploy the City-wide WiFi networks.
3. Increasing the number of anticipated consumers without lowering per customer margins.

This section provides a framework to explore ways to leverage assets. The examples used in the framework are just examples, and by no means an exhaustive list.

4.1 Reducing Operating Costs

4.1.1 Pole Attachment/Energy Cost

[15] Please see Section 7 for details regarding the Anchor Tenant and other business model elements.

One of the highest operating costs excluding staffing is pole attachment and minimum energy fees. These fees are estimated at $16 per month per attachment ($4 for pole attachment and $12 for energy fee).[16]

Potential methods to reduce the pole attachment/energy fees include adding the WAP to the agreement for powering the street lamps. The success of this approach depends upon the City of Tucson agreements with Tucson Electric Power Company (TEP). The agreement with TEP may prohibit adding non-City-owned devices to the lampposts electric supply.

Another approach is to leverage the Tucson climate through solar power WiFi solutions. Use of solar power, with battery backup eliminates the minimum energy charge assessed by the electric company. To facilitate the solar power approach, the City of Tucson may consider offering assistance in obtaining Rights-of-Way and permitting for free standing poles to mount the WAP, solar panel, and backup battery. An example of a solar power installation is show in Figure 4-1.

Figure 4-1: Solar Power Wireless Access Point Example

[16] Based upon typical rates charged by electric companies since Tucson Electric Power has not established rates. Please see Section 4.2.5 for additional details.

4.1.2 Reduce Customer Acquisition Costs

Name recognition and product branding are essential elements when entering a new market place. Obtaining market recognition requires expensive advertising and marketing programs – companies whose name is not recognizable often spend $250 to $500 to capture a new customer – for a $20 per month gross revenue stream. The City of Tucson, through press releases, public education forums, and existing communication channels can substantially reduce the provider's cost of obtaining credibility and name recognition.

Another consideration is to use City of Tucson brand name or endorsement for the new service offering. The survey, however, includes that this approach has minimal value or impact on a consumer's decision to purchase the product. However, if the provider's brand is used in conjunction with access to City communications channels it may reduce the cost of marketing the service by raising the credibility level of the provider.

In addition, interest and support of closing the digital divide is high across Tucson businesses and residents[17]. The surveys indicated that:

Residences supported public WiFi efforts:

- Over 50 percent indicated that the City should deploy wireless in public areas.
- Over 60 percent felt the City should help ensure all residences have high-speed access.
- Over 65 percent felt the City should help ensure all school age children have high-speed access.

Businesses supported public WiFi efforts:

- Over 45 percent indicated that the City should deploy wireless in public areas.
- Over 55 percent felt the City should help ensure all residences have high-speed access.
- Over 60 percent felt the City should help ensure all school age children have high-speed access.

Promotion of digital inclusion efforts can assist the provider in capturing market share. A press release and public statements from the Mayor's office regarding the benefits of WiFi will assist the provider with educating the reluctant consumer and capturing market share.

Other potential methods include:

- Include information on WiFi services in City of Tucson mailings, newsletters, cable access channel and other citizen communications.

[17] See Section 2.1.6 and Section 2.2.5 for additional details regarding the perceptions of the Tucson market.

- Provide access to water billing and other records which provide potential customer contact information.
- Facilitate involvement with the Chamber of Commerce, local real estate professionals and other private organizations.
- Promote availability of services with the Visitors and Convention Bureaus, and directly with entertainment and tourism venues.

4.2 Reducing the Required Investment

The City of Tucson has developed a significant amount of connectivity infrastructure assets through master planning, project coordination, construction, and asset management. Infrastructure that may reduce investment includes fiber optics, conduit, and other physical assets, such as buildings and other fixtures.

The following sections describe the assets that may be available to the City of Tucson for further communications deployments.

4.2.1 Conduit

Maximizing the use of available, non restricted conduit is a key component of reducing initial provider investment. Permitting a provider access to existing conduit substantially reduces the overall project cost by reducing the need for costly boring and street cuts and decreasing labor and equipment hours. The difference in cost between new underground construction and pulling fiber through existing conduit is about $100,000 per mile.

Communication conduit may be installed for an incremental cost during Right of Way capital improvement projects (CIP). Examples of CIPs that offer excellent opportunities include sidewalk, curb and gutter repair, new area development, street repaving or reconstruction, sewer and water improvement projects and trail-way construction.

4.2.2 Antenna Mounting Facilities

The City of Tucson and other public entities have several assets for mounting antennas to establish wireless networking links. Assets that are most often used for mounting antennas include:

- Multi-story buildings;
- Existing tower structures;
- Water towers; and
- Lamp posts.

4.2.3 City of Tucson Buildings

The City of Tucson and the School Districts have over two hundred public facilities including school buildings, libraries, recreation centers and governmental offices. Government buildings are prime locations for secure storage of electronic equipment because they provide easy access to power and heating, ventilation and air conditioning (HVAC). The ability to house equipment at these locations facilitates the maintenance and operations of a WiFi network and provides for physically secure network assets. It greatly reduces the provider's expenditures for installation of vaults or purchase of real estate to house equipment.

4.2.4 Staff Resources/Expertise

Providers considering WiFi deployment understand the technology, the Internet, and how to operate a competitive business. Therefore, when they enter the Tucson market their needs are focused on understanding the unique characteristics of Tucson - the market, the opportunity, the community. Understanding the market is a costly but necessary first step for any provider entering a new market. The market research conducted as part of this study provides potential providers with a solid foundation for understanding their market. In addition to providing the market research results, Tucson staff is able to assist the provider in applying for city, county, and state permits and has access to GIS maps and other information. Staff also possesses knowledge of unique community characteristics that can assist a new market entrant.

4.2.5 Pole Attachments

Pole attachment agreements provide space on a utility pole for the attachment of fiber optic cables, WAPs, and other devices. These agreements are typically limited to fiber optic cables owned and operated by the owner of the agreement. A cable provider is not permitted to allow another provider to overlash facilities because this reduces pole owner revenues and also makes it difficult for attachees to easily access, maintain and operate the plant. It is likely that any existing pole attachments held by the City of Tucson could not be used by a third party WiFi provider; however, this asset should be examined before it is ruled out.

Tucson Electric Power[18]

TEP provides electric service to residents and businesses located in Tucson since 1892. Although the City of Tucson owns the street lights on all public streets, TEP provides private streets and commercial properties with "dusk to dawn" street lighting as requested.

TEP allows providers of video and telecommunications services to attach to their poles and street lamps for certain fees. The current pole attachment fees are shown in Table 4-1:

[18] Details regarding TEP in this section are from CTC staff conversations with Margo Benson, Project Manager for Telecommunications, TEP, March 7 through 9, 2007.

Table 4-1: Tucson Electric Power Pole Attachment Rates

Provider	Fees
Cable TV Companies	$10.30 per pole per year plus
Fiber Telecom Companies	$15.34 per pole per year plus metered electric rates
Cellular Companies	Current market rate (varied rates for each company)
Wireless Internet Companies	Have not had any apply. Would have to set a rate.

TEP offers a variety of metered electric rates depending upon the entity and the rate tariffs that have been approved by the Arizona Corporation Commission (ACC). The ACC is the regulatory body elected to oversee and approve rate adjustments of utilities in Arizona.[19] Some of these rates include Municipal Service, General Service, Traffic Signal and Street Light Service, and others.

In our conversations with TEP, they mentioned that several wireless Internet providers have inquired in recent years about placing Wireless Access Points (WAPs) on their poles. The majority of the wireless Internet providers were looking for placement in the foothills areas of the city where TEPs' facilities are underground. Many of the wireless companies who have expressed an interest in pole attachments have TEP prepare a quote and then do not call back. To date, TEP has not granted pole attachments to any wireless Internet providers in Tucson. If any providers should request an attachment to a TEP pole, a new rate for the attachment and energy would need to be created and approved by the ACC.

4.3 Increasing the Number of Subscribers

Hand-in-hand with efforts to reduce customer acquisition costs is increasing the size of the market (number of households acquiring high-speed Internet) and the market share (percent of total high-speed market using WiFi service).

Examples of increasing market size include:

- Encourage local business to offer WiFi services at employee homes as part of a benefit package.
- Consider offering WiFi access to City employees as part of a benefit package.
- Encourage schools to encourage students to obtain access.
- Work closely with the Chamber of Commerce and other agencies to encourage use of the service by all members.
- Leverage the City of Tucson Community Services Department which owns and manages 1,505 public housing units located throughout the City.

[19] Arizona Corporation Commission Website, http://www.cc.state.az.us/about/index.htm, accessed March 14, 2007.

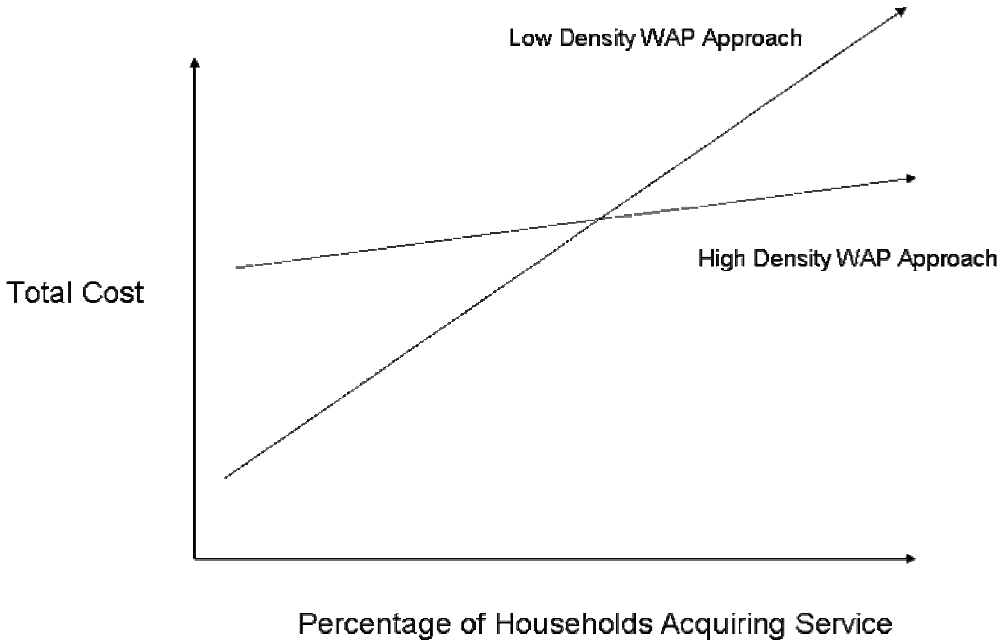
5. Conceptual WiFi Design

This section examines the engineering considerations and the implementation costs that must be considered with respect to the general feasibility of constructing a City-wide WiFi network, whether a City-owned or a commercial network capable of offering high-speed data services to residents and businesses.

At first glance, the Tucson area appears ideal for a WiFi implementation. The landscape is relatively flat, and does not have heavy tree foliage. With these characteristics one might anticipate excellent WiFi coverage. However, our expectations of coverage are reduced, particularly for indoors, due to the prevalent housing construction methods in the region. The majority of housing units appear to have stucco siding, which is usually formed around a metal wire mesh than can effectively block radio signals of many kinds. Moreover, many of the yards have concrete block fences, for which the thickness, density, and supporting metal rebar causes them to act as significant barriers for WiFi signals. These conditions affect the not only the WiFi network design, but the required installation and equipment at each consumer location.

Given the particular challenges to WiFi, we offer two types of design strategies for consideration. The first strategy, is to increase the Wireless Access Point (WAP) density to a sufficient level to allow the majority (90 percent plus) of households to access the network with their Customer Premises Equipment (CPE) located indoors. The second strategy is to require all consumers to have an external CPE installation. The external CPE requirement increases the consumer installation cost, but lowers the required WAP density. The resulting implementation cost is dependant upon the percentage of households that acquire a WiFi service ("take rate"). As shown in Figure 5-1, the low density WAP approach with an external antenna is more cost effective when a lower percentage of consumers acquire WiFi services. Determination of the most effective strategy (cost and performance) requires three steps. First, field testing is required to better predict the impact of the housing construction. Second, a detailed design is required for determination of WAP placement based upon the characteristics of the selected WiFi network vendor and the consumer implementation strategy. Third, preparing a cost-benefit analysis that balances operational, customer acquisition, and other costs.

Figure 5-1: Total Cost vs. Implementation Strategy



Depending upon the deployment strategy and vendor selection[20], the WiFi implementation cost estimate[21] ranges from $15.2 million to $29.4 million. This estimate does not include the consumer costs. Assuming that 20 percent of households acquire a WiFi service, the resulting estimate ranges from $25.6 million to $35.4 million. The cost comparison of the two vendor approaches is shown in Table 5-1.

Table 5-1: Total Implementation Cost vs. Implementation Strategy

Cost Estimate	Tropos		Sky Pilot	
	Low Density WAP Approach	High Density WAP Approach	Low Density WAP Approach	High Density WAP Approach
Total Network Costs	$ 16,917,130	$ 29,420,920	$ 15,162,959	$ 26,405,879
Total CPE Costs	$ 10,489,750	$ 5,979,158	$ 10,489,750	$ 5,979,158
Total Estimated Cost	$ 27,406,880	$ 35,400,078	$ 25,652,709	$ 32,385,037

As shown in Figure 5-1, there is a cross-over point for which WAP strategy offers the lowest cost, depending upon the take rate for the WiFi service. As seen in Table 5-2, the cross-over point is at 56 percent for Tropos and 49 percent for Sky Pilot. At a take rate

[20] For vendor placeholders we have shown cost estimates for Tropos and Sky Pilot. Use of Tropos and Sky Pilot in the estimate is not an endorsement of either vendor. Please see Section 5.2 and Attachment C for additional information regarding the WiFi vendors.
[21] The conceptual design is based upon industry rule-of-thumbs and is subject to change during a more detailed design.

below the cross-over point, the low density WAP strategy offers the lowest implementation cost. Above the cross-over point, the high-density WAP strategy offers the lowest implementation cost.

Table 5-2: Cost Estimate per Home Passed

Cost Estimate Per Household Passed	Tropos		Sky Pilot	
	Low Density WAP Approach	High Density WAP Approach	Low Density WAP Approach	High Density WAP Approach
Total Network Costs	$ 81	$ 141	$ 73	$ 126
Total CPE Costs	$ 250	$ 143	$ 250	$ 143
Breakeven Customers	117,093		103,432	
Breakeven Percentage	56%		49%	

We must caution about selecting the strategy solely on the implementation cost analysis. The low density WAP strategy does appear the most logical from the cost perspective, but other factors are just as important. For example are consumers willing to accept an external installation which requires drilling a hole through the premises outside wall? Will consumers accept the aesthetics of an outdoor CPE and antenna (white bow approximately 10 inches x 10 inches x 4inches)? In Figure 5-2 through Figure 5-4 we show example of external CPE installations. In addition, we present a summary of advantages and disadvantages of the two WAP strategies in Table 5-3.

Figure 5-2: Roof Top External CPE Installation

Figure 5-3: Antenna Mast Mounting of External CPE

Figure 5-4: Side of House External CPE Installation

Table 5-3: Comparison of WAP Strategies

Strategy	Advantages	Disadvantages
Low Density WAP	Lowest cost per household passed. Defers the required investment until customers activation.	Requires a truck-roll to activate a customer.
		Some consumer may decline to participate due to requirement of having an outdoor CPE (aesthetics and coordination with provider).
		Can expect to see a higher percentage of coverage gaps due to shadowing and other propagation effects.
		Provider does not have control over the CPE used by roamers and other mobile users. These users may experience spotty coverage.
High Density WAP	Majority of consumers are able to place CPE without having the provider make an on-site visit.	Highest cost per household passed. The required initial investment may discourage implementation.
	Outdoor coverage for roamers is more consistent, and may have a better experience when using the standard wireless laptops.	
	Less obtrusive installation at customer premises.	
	Increases potential to provide the opportunity of all residents to participate in a WiFi offering.	

5.1 WAP Density Factors

In examining other municipal WiFi implementations, one lesson learned is the required number of Wireless Access Points (WAPs) is often higher than originally anticipated. Eighteen month ago, many vendors advised communities that an average WAP density of 20 per square mile was adequate. Recently, vendors and advisors adjusted the estimates to 30 to 45 WAPs per square mile. The reality is the number of WAPs is dependant upon housing density, type of housing construction, terrain, nature of service offerings, and other attributes.

Private and municipal WiFi deployments often have opposing goals. Private deployments are often designed to maximize revenues, which results in targeted deployments or just covering the easy to reach households. Municipal owned City-wide WiFi deployments have the objective of providing service to all households regardless of incremental consumer cost, or maximizing participation, and often intend to provide reliable coverage for public safety first responder applications. A reasonable compromise between these opposing objectives may be the use of external CPE for hard-to-reach locations, and consideration of alternative technologies, such as Broadband-over-Powerline (BPL)[22] for apartment buildings, condominiums, and office complexes.

[22] There are two types of BPL. The first creates a Local Area Network (LAN) in the building complex which operates on the low-side (480 volts or under) of the electric distribution transformer, the other creates a Wide Area Network (WAN) to connect multiple buildings or locations together which operates on the high-side of the transformer (typically greater than 12.5 KV). Use of BPL to create a LAN within a building is proven technology. Use of BPL for a WAN has had mixed results.

Spacing of required WAPs varies with services and applications supported. Provision of a retail service to serve indoor locations requires a higher density of WAPs than support of services or applications to outdoor locations or users.

The required density of WAPs increases with higher bandwidth services. The higher the reliability and speed of speed of service the higher the WAP density. For example, provision of a retail service offering the majority of consumers with a 2 Mbps service requires a higher density of WAPs than a 1 Mbps offering. In addition, high numbers of customers in a given area requires a higher density of WAPs.

Expectations of Customer Premises Equipment (CPE) requirements impact the required WAP density. Many WiFi vendors claim that consumers are able to access the network while indoors via a standard laptop wireless card. Our experience with City-wide implementations suggests that this expectation is optimistic, and the majority of consumers will require a higher power[23] CPE.

The provider's ability to influence where the consumer places the CPE placement is one of the most critical factors. The WiFi signal is degraded each time it passes through a wall or other barrier. Ideally the CPE is placed next to a window[24] facing the closest WAP. Allowing CPE installation in basements is not advisable.

Type of siding and construction used impacts the WiFi design. Steel siding, brick, and stucco construction present a challenge for WiFi propagation. These areas may require a higher WAP density or use of external antennas at the consumer premises.

Multiple Family Households (MFHs,) Office buildings and other multi-tenant facilities often require indoor AP's or another technology to deliver reliable service. If served by an outdoor WAP, these facilities often require the WiFi signal to pass through multiple walls to reach the desired location and have multiple floors.

Optimum WAP spacing is often not practical. Spacing of WAPs is impacted by the ability to obtain attachment agreements for lamp posts, utility poles, and other vertical assets. The result is that in some neighborhoods the WAP density is higher than required, and in others the resulting WAP density is lower than desired. In addition, how streets are laid out will impact the required number of AP's. For example winding streets require higher AP densities.

5.2 City-Wide Wireless Cost Estimate

We developed two cost estimate approaches. The first uses an average WAP density of 20 per square mile and assumes that each consumer will require an external CPE or

[23] 200mW vs. 50mW
[24] Most windows readily pass the WiFi signal. However some high-efficiency windows will actually block the WiFi signal. In these cases the CPE is best located along a wall facing the closet WAP or located externally (outside).

antenna. The second estimate uses an average WAP density of 40 per square mile and assumes that ten percent of consumers will require an external CPE or antenna. Please note that these estimates offer a rough order of magnitude and required access point densities maybe higher or lower.

The Multi-Family Households (MFHs - apartments and condominiums) pose a unique challenge because they are large, built with brick or concrete, and each living unit may not have an outside wall or a window that faces a WAP. As indicated larger MFHs are likely to require additional indoor WAPs or use another technology. For cost estimation purposes, we assumed that an addition WAP is required for every 50 households in a MFH with 50 or more households. An inventory of MFHs and a site survey of selected MFHs are recommended during the detailed design.

The estimated total number of Tucson households is shown in Table 5-4. As seen in Table 5-3, slightly more than 12 percent of Tucson households in structures housing more than 50 units. In some WiFi implementations these types of households omitted from coverage plans.

Table 5-4: Estimated Tucson Households[25]

Structure	Number of Households	Percent
1-unit, detached	102,023	48.6
1-unit, attached	17,586	8.4
Duplex	7,076	3.4
3 or 4 units	8,589	4.1
5 to 9 units	9,447	4.5
10 to 19 units	11,713	5.6
20 to 49 units	10,122	4.8
50 or more units	25,996	12.4
Mobile home	16,325	7.8
Boat, RV, van, etc.	915	0.4
Total housing units	209,792	100

For comparison, we have prepared two estimates. The first based upon using Tropos and the second using Sky Pilot. **Please note that we are not recommending any particular radio vendor -** Tropos and Sky Pilot are just examples. We recommend that if a City-owned WiFi pilot or City-wide network is pursued, a Request-for-Bid (RFB) process be used for vendor selection. Further, if Request-for-Proposal (RFP) is issued to encourage a WiFi implementation - many of the providers such as EarthLink[26] and MetroFi[27] have negotiated supply contracts with a preferred WiFi hardware vendor.

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[25] Source: http://www.ci.tucson.az.us/planning/data/housing/householdsizepima.pdf, based upon the 2000 census data.
[26] EarthLink has a preferred vendor relationship with Tropos.
[27] MetroFi has a preferred vendor relationship with Sky Pilot.

5.2.1 Low Density WAP Approach

Cost Estimate (Tropos)

We based the first cost estimate on a Tropos design. (This is the vendor selected by EarthLink for San Francisco CA, Philadelphia PA, and others).

The Tropos mesh consists of:

- WAPs are placed at an average density of 20 per square mile;
- Every gateway serves 8 WAPs;
- A total of 520 additional WAPs are placed near selected MFHs;
- The gateways are served by 52 point-to-multipoint radio base stations for backhaul;
- Each base station is supported by leased Ethernet services which require fiber extensions; and
- Each consumer requires an external CPE. The cost of the external CPE is estimated at $150 plus $150 in installation costs.

The resulting cost estimate for implementation of a Tropos network is approximately $16.9 million including the radio hardware, installation, and engineering. The above costs do not include the high-powered[28] CPE, bandwidth shapers, servers, maintenance, operations, and staffing costs. Assuming that 20 percent of households acquire a service, the addition of the CPE and installation increases the cost estimate by approximately $10.5 million for a total of $27.4 million.

A layout of the Tropos installation is shown in Figure 5-5. A summary of the low WAP density Tropos cost estimate is presented in Table 5-5. Please note that the cost estimate assumes that 20 percent of the City of Tucson land area is open and is not covered with the WiFi network.

[28] 200 mW wireless bridge or router.

Figure 5-5: Tropos Configuration

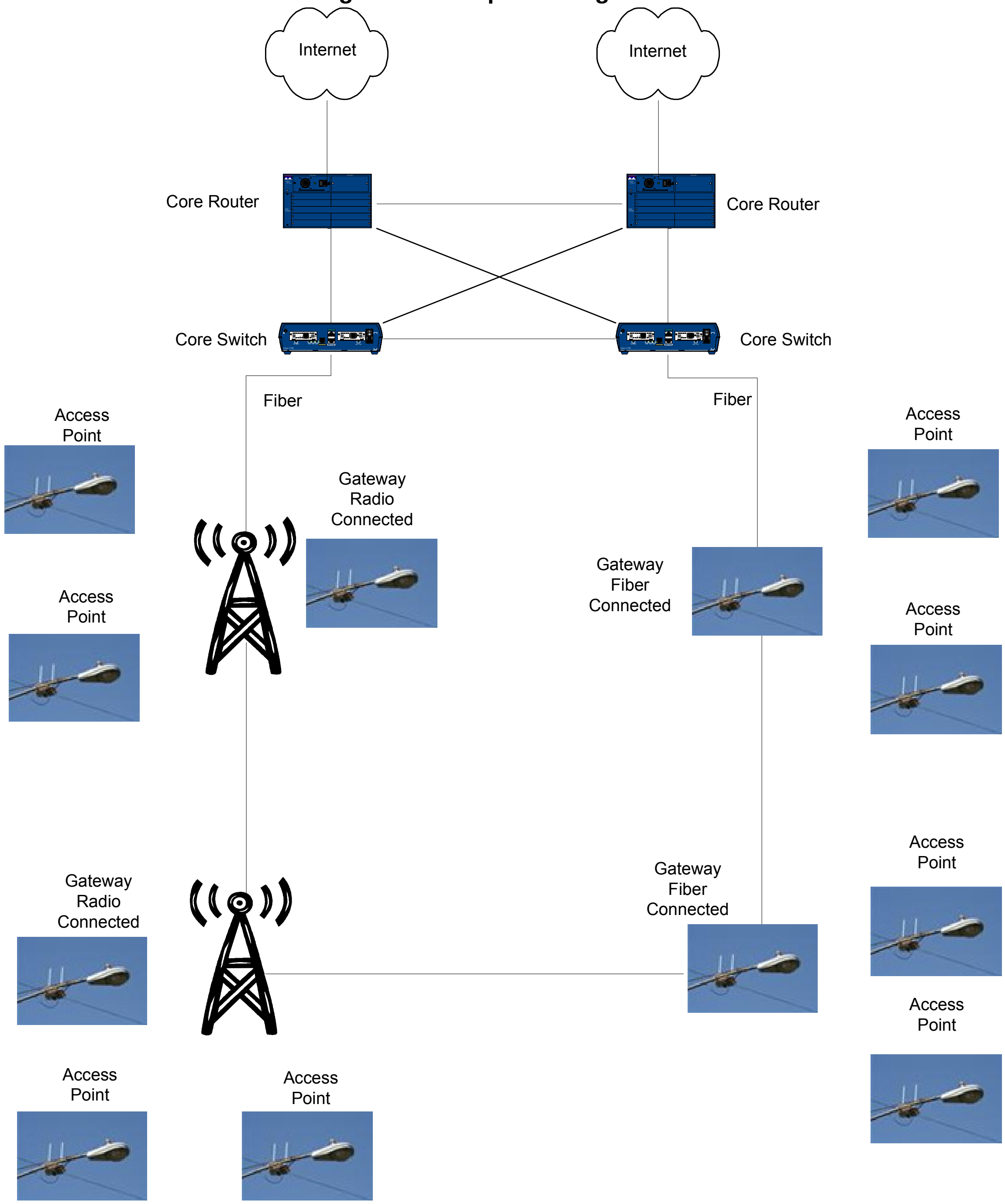


Table 5-5: Cost Estimate – Low Density WAP Approach (Tropos Equipment)

Total number of Tropos nodes (Includes MFH Gateway's)	3,640		209,792	Households
Total number of gateways	910		195	Total Land Area (sq. miles)
			20%	Open Area
			156	Net Land Area (sq. miles)
Total number of fiber connected gateways	-		0.00%	of gateways
Total number of wireless backhauled gateways	910		100.00%	of gateways
			20	nodes per sq. mile
			8	AP's per gateway
			25,996	Households in MFH's 50 units or larger
			520	MFH gateways
			3	sq miles per base station
			52	Base Stations
			20.00%	of Households aquire a service
			41,959	total consumers
	0.00%	$	125	CPE & Installation unit cost (Outdoor)
	100.00%	$	250	CPE & Installation unit cost (Outdoor)

Network Equipment	**Unit Price**	**Qty.**	**Total Price**
Tropos 5210 light pole radios	$ 2,800	2730	$ 7,644,000
Tropos 5210 light pole radios w/battery backup	$ 3,300	910	3,003,000
Tropos 5210 20ft. NEMA power cord	$ 190	3640	691,600
Tropos Node Management Software (NMS)	$ 150	3640	546,000
Fiber to 100Mbps Ethernet media converter/repeater for gateways & base stations	$ 1,200	52	62,400
Wall mount outdoor equipment cabinet for fiber media converters	$ 300	52	15,600
Base Station (BS) Radio & Antenna	$ 2,500	52	130,000
Client Station (CS) Radio & Antenna	$ 1,200	910	1,092,000
Router	$ 50,000	2	100,000
Core Switch	$ 25,000	2	50,000
Fiber Extensions	$ 8,000	52	416,000
		Total Network Equipment	**$ 13,750,600**
Spare Network Equipment		5%	of network quantity
Tropos 5210 light pole radios	$ 2,800	137	$ 383,600
Tropos 5210 light pole radios w/battery backup	$ 3,300	46	151,800
Tropos 5210 20ft. NEMA power cord	$ 190	182	34,580
Tropos Node Management Software (NMS)	$ 150	182	27,300
Fiber to 100Mbps Ethernet media converter/repeater for gateways & base stations	$ 1,200	3	3,600
Wall mount outdoor equipment cabinet for fiber media converters	$ 300	3	900
Base Station (BS) Radio & Antenna	$ 2,500	3	7,500
Client Station (CS) Radio & Antenna	$ 1,200	46	55,200
		Total Spare Network Equipment	**$ 664,480**
Installation/Contingency/Engineering Costs			
Installation AP's	$ 300	3640	$ 1,092,000
Installation BS's	$ 2,000	52	104,000
Installation CS's	$ 300	910	273,000
Installation Routers & Switches	$ 3,000	4	12,000
Installation Fiber Extensions	$ 1,000	52	52,000
Integration (per AP)	$ 150	3640	546,000
Engineering	$ 200,000	1	200,000
Project Management	$ 200,000	1	200,000
Contigency	5%		687,530
		Total Installation/Contingency/Engineering Costs	**$ 3,166,530**
		TOTAL WIRELESS NETWORK ESTIMATE (Not Including Customer Costs)	**$ 16,917,130**
		Cost Estimate (per square mile)	$ 108,444
		Cost Estimate (per household/business passed)	$ 81
		TOTAL CPE PURCHASE AND INSTALLATION COST ESTIMATE	**$ 10,489,750**
		TOTAL COST ESTIMATE	**$ 27,406,880**

Cost Estimate (Sky Pilot)

The second cost estimate is based upon a Sky Pilot design (This is the vendor selected by MetroFi for San Jose CA, Aurora, IL, and others). The cost estimate for the Sky Pilot technology is similar from the access point perspective. As is the case of the Tropos design, the Sky Pilot mesh consists of:

- WAPs placed at an average density of 20 per square mile.
- 520 additional WAPs are placed near selected MFHs
- Each consumer requires an external CPE. The cost of the external CPE is estimated at $150 plus $150 in installation costs.

However:

- Each node is backhauled with a proprietary point-to-multipoint radio link (Sky gateway).
- Each point-to-multipoint base station is supported by leased Ethernet services which require fiber extensions.

For Sky-Pilot, we estimate that 104 point-to-multipoint base stations (Sky Gateways) are required.

The cost estimate for implementation of a Sky Pilot network is approximately $15.2 million, including radio hardware and installation and engineering. The above costs do not include the high-powered[29] CPE, bandwidth shapers, servers, maintenance, operations, and staffing costs. Assuming that 20 percent of households acquire a service, the addition of the CPE and installation increases the cost estimate by approximately $10.5 million for a total of $25.7 million.

A layout of the Sky Pilot installation is shown in Figure 5-6. A summary of the Sky Pilot estimate is shown in Table 5-6.

[29] 200 mW wireless bridge or router.

Figure 5-6: Sky Pilot Configuration

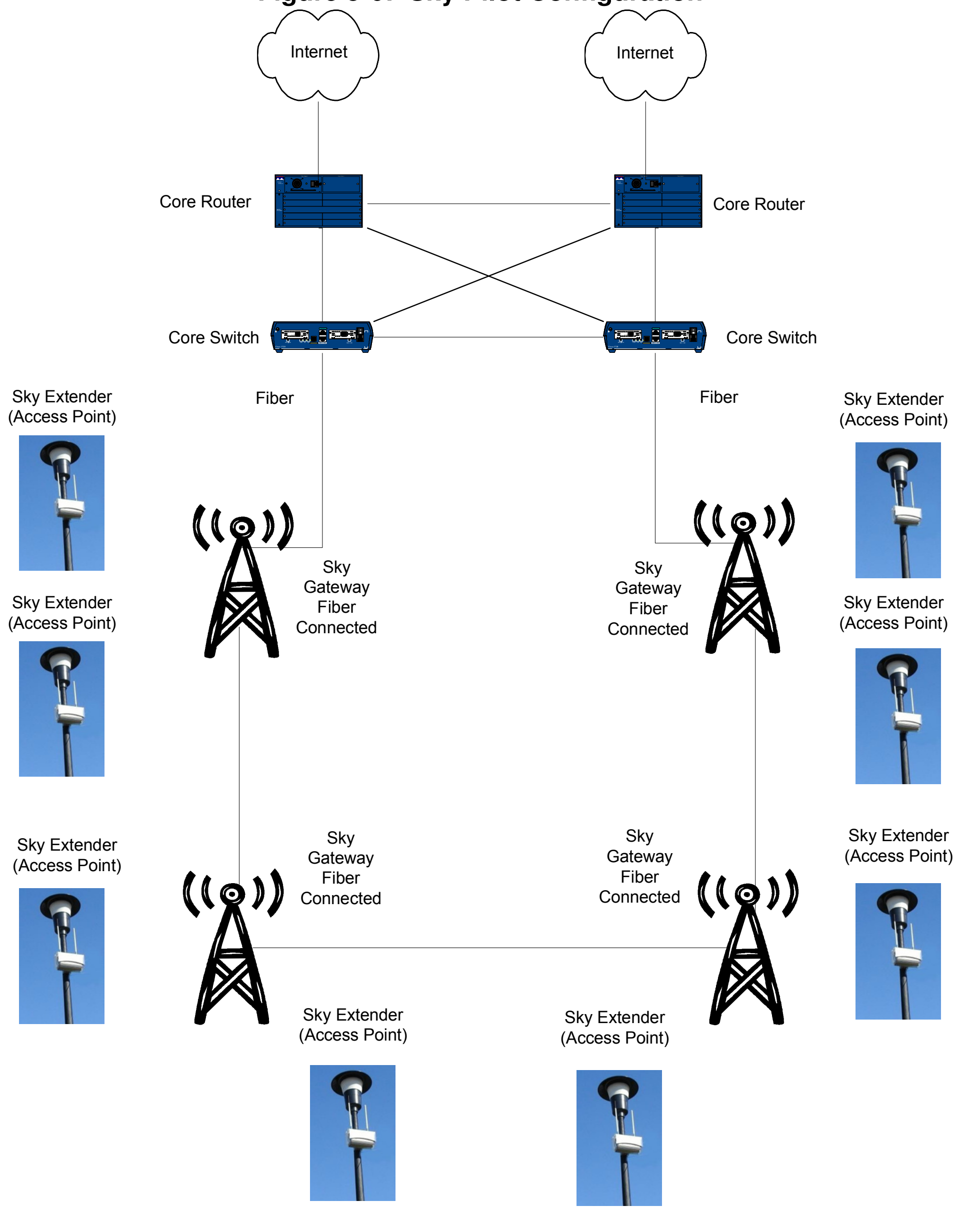


Table 5-6: Cost Estimate – Low Density WAP Approach (Sky Pilot Equipment)

Total number of Sky Extender - Dual Band	3640	209,792	Households
		195	Total Land Area (sq. miles)
		20%	Open Area
Total number of SkyGateways	104	156	Square Miles
		20	nodes per sq. mile
		1.5	sq miles per gateway
		25,996	Households in MFH's 50 units or larger
		520	MFU gateways
		20.00%	of Households aquire a service
		41,959	total consumers
	0.00%	125	CPE & Installation unit cost (Outdoor)
	100.00%	250	CPE & Installation unit cost (Outdoor)

Network Equipment	**Unit Price**	**Qty.**	**Total Price**
SkyGateway	$ 4,080	104	$ 424,320
Sky Extender - Dual Band	$ 2,975	3640	10,829,000
Router	$ 50,000	2	100,000
Core Switch	$ 25,000	2	50,000
Fiber Extensions	$ 6,000	104	624,000
		Total Network Equipment	**$ 12,027,320**

Spare Network Equipment		5%	of network quantity
SkyGateway	$ 4,080	6	$ 24,480
Sky Extender - Dual Band	$ 2,975	182	541,450
		Total Spare Network Equipment	**$ 565,930**

Installation/Contingency/Engineering Costs			
Installation AP's	$ 300	3640	$ 1,092,000
Installation Gateway	$ 2,000	104	208,000
Installation Routers & Switches	$ 3,000	4	12,000
Installation Fiber Extensions	$ 1,500	104	156,000
Integration (per AP)	$ 150	3640	546,000
Project Management	$ 200,000	1	200,000
Contigency	$ 200,000	1	200,000
Contigency	6.00%		721,639
		Total Installation/Contingency/Engineering Costs	**$ 3,135,639**

TOTAL WIRELESS NETWORK ESTIMATE (Not Including Customer Costs)	**$ 15,162,959**
Cost Estimate (per square mile)	$ 97,199
Cost Estimate (per household passed)	$ 73
TOTAL CPE PURCHASE AND INSTALLATION COST ESTIMATE	**$ 10,489,750**
TOTAL COST ESTIMATE	**$ 25,652,709**

5.2.2 High Density WAP Approach

Cost Estimate (Tropos)

In Table 5-7 we show the cost estimate for the high-density WAP approach using the Tropos equipment. Increasing the WAP density to 40 per square mile increases the estimated cost to approximately $29.4 million, including radio hardware and installation and engineering. The above costs do not include the high-powered[30] CPE, bandwidth shapers, servers, maintenance, operations, and staffing costs. Assuming that 20 percent of households acquire a service, the addition of the CPE[31] and installation increases the cost estimate by $6.0 million for a total of $35.4 million.

.

[30] 200 mW wireless bridge or router.

[31] Assumes that 10 percent of consumers will require an external installation and that the remaining consumers are able to connect using a high-power indoor CPE (estimate cost of $125).

Table 5-7: Cost Estimate – High Density WAP Approach (Tropos Equipment)

Total number of Tropos nodes (Includes MFH Gateway's)	6,760	209,792	Households
Total number of gateways	1,300	195	Total Land Area (sq. miles)
		20%	Open Area
		156	Net Land Area (sq. miles)
Total number of fiber connected gateways	-	0.00%	of gateways
Total number of wireless backhauled gateways	1,300	100.00%	of gateways
		40	nodes per sq. mile
		8	AP's per gateway
		25,996	Households in MFH's 50 units or larger
		520	MFH gateways
		3	sq miles per base station
		52	Base Stations
		20.00%	of Households aquire a service
		41,959	total consumers
	90.00%	$ 125	CPE & Installation unit cost (Indoor)
	10.00%	$ 300	CPE & Installation unit cost (Outdoor)

Network Equipment	**Unit Price**	**Qty.**	**Total Price**
Tropos 5210 light pole radios	$ 2,800	5460	$ 15,288,000
Tropos 5210 light pole radios w/battery backup	$ 3,300	1300	4,290,000
Tropos 5210 20ft. NEMA power cord	$ 190	6760	1,284,400
Tropos Node Management Software (NMS)	$ 150	6760	1,014,000
Fiber to 100Mbps Ethernet media converter/repeater for gateways & base stations	$ 1,200	52	62,400
Wall mount outdoor equipment cabinet for fiber media converters	$ 300	52	15,600
Base Station (BS) Radio & Antenna	$ 2,500	52	130,000
Client Station (CS) Radio & Antenna	$ 1,200	1300	1,560,000
Router	$ 50,000	2	100,000
Core Switch	$ 25,000	2	50,000
Fiber Extensions	$ 8,000	52	416,000
		Total Network Equipment	**$ 24,210,400**

Spare Network Equipment		5%	of network quantity
Tropos 5210 light pole radios	$ 2,800	273	$ 764,400
Tropos 5210 light pole radios w/battery backup	$ 3,300	65	214,500
Tropos 5210 20ft. NEMA power cord	$ 190	338	64,220
Tropos Node Management Software (NMS)	$ 150	338	50,700
Fiber to 100Mbps Ethernet media converter/repeater for gateways & base stations	$ 1,200	3	3,600
Wall mount outdoor equipment cabinet for fiber media converters	$ 300	3	900
Base Station (BS) Radio & Antenna	$ 2,500	3	7,500
Client Station (CS) Radio & Antenna	$ 1,200	65	78,000
		Total Spare Network Equipment	**$ 1,183,820**

Installation/Contingency/Engineering Costs			
Installation AP's	$ 300	6760	$ 2,028,000
Installation BS's	$ 2,000	52	104,000
Installation CS's	$ 300	1300	390,000
Installation Routers & Switches	$ 3,000	4	12,000
Installation Fiber Extensions	$ 1,000	52	52,000
Integration (per AP)	$ 150	6760	1,014,000
Engineering	$ 200,000	1	200,000
Project Management	$ 200,000	1	200,000
Contigency	5.00%		1,210,520
		Total Installation/Contingency/Engineering Costs	**$ 5,210,520**
		TOTAL WIRELESS NETWORK ESTIMATE (Not Including Customer Costs)	**$ 29,420,920**
		Cost Estimate (per square mile)	$ 188,596
		Cost Estimate (per household/business passed)	$ 141
		TOTAL CPE PURCHASE AND INSTALLATION COST ESTIMATE	**$ 5,979,158**
		TOTAL COST ESTIMATE	**$ 35,400,078**

Cost Estimate (Sky Pilot)

In Table 5-8 we show the cost estimate for the high-density WAP approach using the Sky Pilot equipment. Increasing the WAP density to 40 per square mile increases the estimated cost to approximately $26.4 million, including radio hardware and installation and engineering. The above costs do not include the high-powered[32] CPE, bandwidth shapers, servers, maintenance, operations, and staffing costs. Assuming that 20 percent of households acquire a service, the addition of the CPE[33] and installation increases the cost estimate by approximately $6.0 million for a total of $32.4 million.

[32] 200 mW wireless bridge or router.
[33] Assumes that 10 percent of consumers will require an external installation and that the remaining consumers are able to connect using a high-power indoor CPE (estimate cost of $125).

Table 5-8: Cost Estimate – High Density WAP Approach (Sky Pilot Equipment)

Total number of Sky Extender - Dual Band	6760	209,792	Households
		195	Total Land Area (sq. miles)
		20%	Open Area
Total number of SkyGateways	104	156	Square Miles
		40	nodes per sq. mile
		1.5	sq miles per gateway
		25,996	Households in MFH's 50 units or larger
		520	MFU gateways
		20.00%	of Households aquire a service
		41,959	total consumers
	0.00%	125	CPE & Installation unit cost (Outdoor)
	100.00%	250	CPE & Installation unit cost (Outdoor)

Network Equipment	**Unit Price**	**Qty.**	**Total Price**
SkyGateway	$ 4,080	104	$ 424,320
Sky Extender - Dual Band	$ 2,975	6760	20,111,000
Router	$ 50,000	2	100,000
Core Switch	$ 25,000	2	50,000
Fiber Extensions	$ 6,000	104	624,000
		Total Network Equipment	**$ 21,309,320**
Spare Network Equipment		5%	of network quantity
SkyGateway	$ 4,080	6	$ 24,480
Sky Extender - Dual Band	$ 2,975	338	1,005,550
		Total Spare Network Equipment	**$ 1,030,030**
Installation/Contingency/Engineering Costs			
Installation AP's	$ 300	6760	$ 2,028,000
Installation Gateway	$ 2,000	104	208,000
Installation Routers & Switches	$ 3,000	4	12,000
Installation Fiber Extensions	$ 1,500	104	156,000
Integration (per AP)	$ 150	6760	1,014,000
Project Management	$ 200,000	1	200,000
Contigency	$ 200,000	1	200,000
Contigency	6.00%		1,278,559
		Total Installation/Contingency/Engineering Costs	**$ 5,096,559**
		TOTAL WIRELESS NETWORK ESTIMATE (Not Including Customer Costs)	**$ 26,405,879**
		Cost Estimate (per square mile)	$ 169,269
		Cost Estimate (per household passed)	$ 126
		TOTAL CPE PURCHASE AND INSTALLATION COST ESTIMATE	**$ 5,979,158**
		TOTAL COST ESTIMATE	**$ 32,385,037**

5.3 Downtown Wireless Cost Estimate

A potential starting point for a City-wide WiFi implementation is a pilot covering downtown Tucson. The cost estimates for downtown coverage are show in Table 5-9.

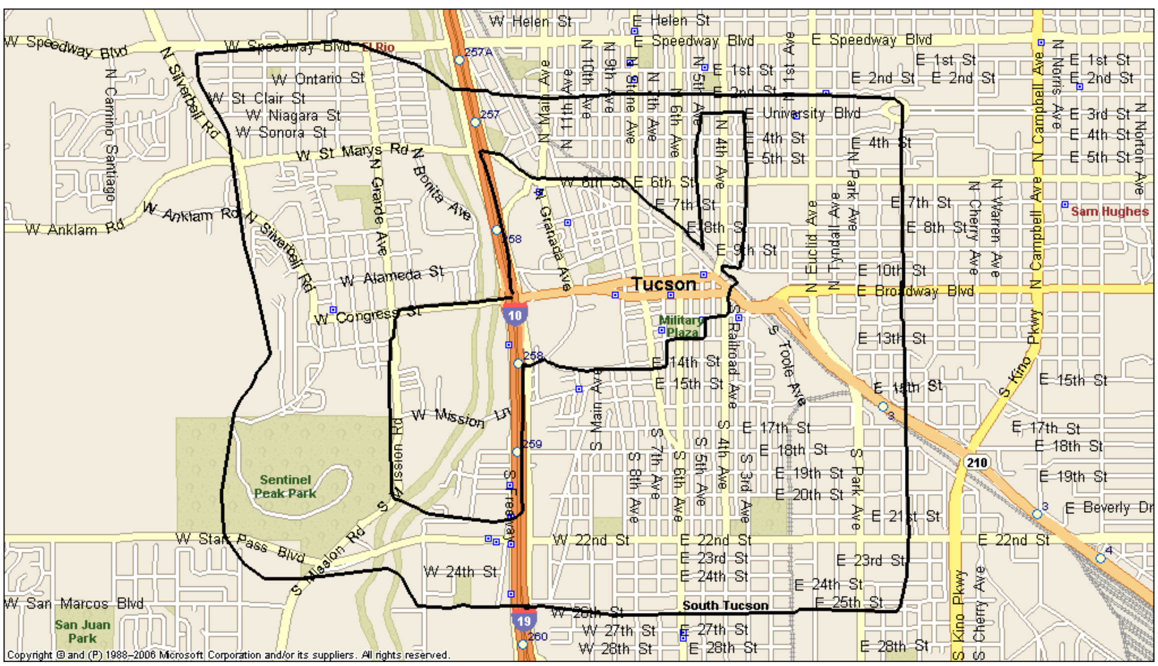
Table 5-9: **Downtown Coverage Cost Estimate**

Cost Estimate	Tropos		Sky Pilot	
	Low Density WAP Approach	High Density WAP Approach	Low Density WAP Approach	High Density WAP Approach
Downtown & Neighborhoods	$ 1,362,919	$ 1,992,898	$ 1,293,928	$ 1,859,678
Downtown	$ 482,925	$ 653,675	$ 475,492	$ 633,597

The coverage areas indicated in Table 5-9 are shown in Figure 5-7.

- The "Downtown" area or inner ring in Figure 5-7 provides coverage in the Sentinel, Presidio, Convention, Congress, and 4^{th} Avenue districts.
- The "Downtown & Neighborhoods" or outer ring in Figure 5-7 expands the coverage to covers all the Rio Nuevo neighborhoods[34] except for KB Home Star Pass Heights.

Figure 5-7: Downtown Coverage Options



The cost estimate shown in Table 5-9 does not include subscriber CPE and installation costs, program management, or other operational costs.

34 See http://www.ci.tucson.az.us/rioneuvo/livingdowntown/idex.html for additional details.

6. Digital Inclusion

This section of the report is intended to provide City decision-makers with suggested approaches and considerations for development of Digital Inclusion efforts in Tucson. In particular this section provides a definition of the Digital Divide and an overview of required elements of inclusion efforts.

6.1 Digital Divide Defined

The "digital divide" is a term that characterizes a gap between "information haves and have-nots," or in other words, between Americans who use or have access to telecommunications technology and those that do not. One important subset of the digital divide debate concerns high-speed Internet access, also referred to as broadband.[35] [36]

The digital world, with the Internet as its vehicle, is exploding. The World Wide Web is rapidly emerging as the one-stop place for information anytime, anywhere. What happens to those without Internet Access? What can be done to mitigate the "digital divide"?

Digital inclusion initiatives must take into consideration the many facets of "closing the digital divide." Up until recently, "bridging the digital gap" meant implementing programs that provided computers and software and in some cases included basic computer training. However, in the last few years, computers have become more affordable and are commonplace in households. Currently larger barriers to using digital technology are the high recurring monthly fees to access the Internet and a lack of understanding regarding the value high-speed access brings to a household or small business.

Four components of supply/demand gap areas of digital divide are:

1. **Access:** Inadequate access to reliable and affordable broadband services.
2. **Equipment:** Inability to afford computers, modems, software, etc.
3. **Awareness:** A lack of knowledge or understanding regarding educational, social and economic value of Internet access.
4. **Expertise:** The shortage of expertise needed to leverage and use broadband services.

[35] Lennard Kruger, Angele Gilroy, *Broadband Access and the Digital Divide*, Congressional Research Services, The Library of Congress, Updated January 17, 2006.

[36] The Federal Communications Commission (FCC) defines broadband as a service which provides 200Kbps connection speed in at least one direction. The FCC definition is dated, since at least 700 Kbps is required for quality video streaming, and many industry advisors predict a need for 10 Mbps to every household in the next 10 years.

These areas are not independent of each other. In fact, because they most often work had-in-hand they complicate digital divide initiatives. For instance, in most areas of Tucson, there are high-speed options for businesses and homes. The issue is therefore not inadequate access but rather the fact that these services are costly and that the perceived lack of value outweighs the cost.

The interdependence of digital divide components also relates to equipment affordability. While it is significant to note that computer costs have dropped off in recent years; keeping current with new software or emerging devices is cost-prohibitive for some households. Equipment and software quickly becomes dated and consumers are often forced to choose between expensive upgrades or new hardware and recurring monthly access fees.

Awareness and expertise are critical components of digital divide. If a lack of full appreciation or understanding for broadband connectivity exists; selling high-speed access is more difficult. A perceived lack of value or need directly affects consumer willingness to pay for services. To understand this relationship the report examines different types of access users.

In Tucson, there are many different types of Internet access users. They range from advanced users to non-users.

- At one end of the spectrum are 'non-access users'. This group does not have any Internet connectivity and perceive little to no benefit in the service. Some members of this group may feel threatened by the technology. They may never have used online bill payment services or sought information from the Internet; or they may view access solely as an entertainment option.

- Further up the spectrum are 'low-speed connecters.' This group likely has some understanding of the benefits and limited expertise in connectivity uses; however, they are currently meeting perceived needs through dial-up access. For this group, low data intensity activities like e-mail constitute their primary use. This group also has limited knowledge regarding the true value of high-speed access.

- Just beyond this group, are higher-level users that understand the benefits of increased access speed; however, these users perceive the costs as outweighing service value. This group may rely on availability of high-speed access at work, school or at the library.

- Finally, at the farthest end of the spectrum are the highest level access users who "need speed at any cost." This group is willing to pay for high speed access regardless of cost. For this group, it is a cost of doing business or a necessary quality-of-life item.

Examination of this spectrum illustrates that a "one-size-fits-all" solution will not meet the needs of the entire community. To achieve a solution for the greater majority requires reviewing multiple approaches with an eye toward maximizing resources.

CTC's research in Tucson also uncovered a perceived communication gap between consumers and Internet access firms. Consumers report that often an access provider markets services from a technical standpoint instead of in a more understandable manner (lay person terms). The industry uses a lot of acronyms and assumes that the consumer is fairly computer-literate. If technical nuances are not understood; the consumer may become frustrated and decide not to purchase the service or may purchase a service that does not meet their needs. At the same time, service providers report that users do not fully understand their connectivity requirements and many times do not have the expertise to clearly communicate issues to the provider. In other words, the technical support staff is not able to determine what the consumer is trying communicate. While both of these positions are based upon perceptions and are not necessarily indications of reality; perceptions become reality in the eye of the viewer. To address these perceptions, the overall city strategy needs to address perceived issues on both sides of the user-provider communications model.

CTC's experience shows that the first steps to advance universal availability of affordable high-speed Internet services (mitigating the digital divide) are clarifying and defining needs between Internet users and Internet service providers and advancing and promoting awareness regarding the economic and lifestyle benefits of greater broadband access.

6.2 Example Digital Divide Approaches

Most municipalities have incorporated different methods of digital inclusion in their WiFi projects. A common approach to address the digital divides is to provide free or low-cost access to the Internet. The following outlines digital inclusion approaches being introduced in San Francisco, Philadelphia, and Minneapolis.

***San Francisco Approach*:** EarthLink will provide a free 300 kbps service for all residents, businesses and visitors. This level supports web browsing, checking and sending email and Voice over Internet Protocol (VoIP) services such as Skye. This free service, however, is pop-up advertising intensive.

EarthLink's' proposed standard service to the general public will provide a 1 Mbps symmetrical[37] service for a monthly rate of $21.95. For up to 3,200 qualified low-income residents, the 1Mbps symmetrical service is offered for $12.95 per month.

In addition to the above service offerings, EarthLink has agreed to provide funding for other digital inclusion efforts. However, the funding is dependent upon EarthLink reaching subscriber and profitability benchmarks.

[37] Symmetrical: Service in which upload and download speeds are equal.

Philadelphia Approach**:** EarthLink's' proposed standard service to the general public will provide a 1 Mbps symmetrical service for a monthly rate of $20. For qualified low-income households the cost is reduced to $10 per month.

The program includes free connectivity in some parks and free training and computers for up to 10,000 qualified low income families. Philadelphia is also partnering with private businesses to offer low or no cost computer loans.

In addition to the above service offerings, EarthLink has agreed to provide funding for other digital inclusion efforts. However, the funding is dependent upon EarthLink reaching subscriber and profitability benchmarks.

Minneapolis Approach**:** The agreement with U.S. Internet requires them to provide a 1 Mbps symmetrical service for a monthly rate of $20 to residents, $30 to businesses and $12 for City employees. For qualifying low-income residences, the monthly access fee drops to $10 per month.

The agreement also requires U.S. Internet to deploy 200 access points which will provide free access to pre-selected[38] Internet sites, and to develop a technical literacy program.

In addition to the above service offerings, U.S. Internet has agreed to provide funding for other digital inclusion efforts. However, the funding is dependent upon U.S. Internet reaching subscriber and profitability benchmarks.

6.3 Education System Needs

School districts are huge advocates of electronic learning. Some have efforts underway to address equipment and provide support for users. Other schools have moved from traditional text-booked based learning to an electronic, digital curriculum. For example, there are no attendance boundaries for high schools in the Vail School District therefore students choose between Vail High School, Cienega High School, and Empire High School. Students at Empire receive a laptop computer in place of textbooks and teachers use technology as a tool in and out of the classroom. The school's goal is to prepare students for the digital work world; where technology is integrated into jobs and careers. The District provides indoor Internet access and outdoor wireless coverage on the school grounds. The program changes the concept of a school day by permitting learning to extend to traditional "at home" hours. As innovative and visionary as this program is, it cannot be offered by all schools until ubiquitous coverage is available.

6.4 Internet Application vs. Service Bundling Savings

In an ideal world, "pipe" is treated just like streets and highways. The consumer choices the package delivery service to use. The package is not forced upon by "toll operator."

[38] Referred to as a "walled-garden" in which sites such as the city web site are the only ones that are able to be accessed.

Offering a low cost high speed Internet option is a starting point to ensuring consumer choice. Consumers desire high speed "always-on" access because they can obtain voice and video over the Internet for a low or not cost fee but should not be forced to purchase a more costly telephony service through bundling promotions. Separating the "pipe" (data connection) from the service (voice, video, and data product) enables the consumer to pay for the service they desire.

Cable television and telephone providers market "triple play" or bundling of voice, data and video service as cost-saving programs. The providers claim that the consumers realize enhanced options and reduced costs. This marketing approach is far from the truth. Bundling services with a single provider often limits consumer choice and increases net monthly subscriber fees. In most cases, in order to obtain advertised low-cost DSL access, it requires a subscription to local and long-distance telephone service – from the same provider. This requirement eliminates the consumer option and choice to use a lower cost Internet based telephone service such as Skype and Vonage.

Examples of Internet application providers for telephone service include:

- My Phone Company
- Others
- Packet 8
- Skype
- Sun Rocket
- Talk Parade
- Total Talk
- Vonage
- Yahoo

Examples of Internet application providers for video service include:

- Akimbo
- Cinemanow
- Guba
- JumpTV
- Movie Link
- NeepTV

For Internet-based telephone services, at least 100 Kbps is required. For broadcast quality of video streaming, at least 700 Kbps is required.

An example of provider bundling vs. enabling consumer choice through Internet is shown in Table 6.1. In this example, Qwest provides a DSL, local telephone, and long-distance bundle. Qwest claims that this bundle offers consumer choice and savings. The table illustrates the true story.

- A household which subscribes to Qwest telephone service, 25 minutes of long-distance, and a dial-up Internet service (Column A) will pay approximately $47 per month. If the same household was to use DSL[39] rather than dial-up – the monthly price jumps to $77 per month (Column B). If the same household subscribes to a 1 Mbps WiFi service, hardware lease, and a 500 minutes of local and long-distance service will pay approximately $46 per moth (Column C).

- If a household desires call features such as caller ID, unlimited long-distance, and call waiting, the service bundle jumps to $109 per month (Column D). The equivalent service with WiFi and unlimited telephone from Vonage is $57 per month (Column E).

The true story is that access to low-cost high-speed Internet can result in a reduction of monthly voice, video, and data services costs for many households.

Table 6-1: DSL and Telephone vs. WiFi and VoIP

	A	B	C	D	E
Service, Taxes, and Fees	POTS Telephone (No features) (Note 2)	POTS (no features) plus stand alone DSL	Vonage (500 Minutes Local & Long Distance)	Home Phone Package w/DSL w/ unlimited long distance	Vonage (Unlimited Local & Long Distance)
Local Telephone	$ 13.50	$ 13.50	$ 14.99	$ 25.99	$ 24.99
Long-Distance (Note 1)	6.24	6.24	-	25.00	-
DSL (1.5 Mbps plus Modem)	-	36.99	-	31.99	-
Dial Up Access	9.99	-	-	-	-
WiFi (1 Mbps with bridge)	-	-	24.99	-	24.99
Customer Access Fee	6.50	6.50	-	6.50	-
Federal Access Charge	6.31	6.31	-	6.31	-
911 & Other Fees	-	-	1.98	-	1.98
Universal Service Fund	1.92	1.92	0.92	4.95	0.92
Arizona Taxes	2.41	4.60	3.24	6.73	4.05
Federal Taxes	0.60	0.60	-	1.53	-
Total	$ 47.47	$ 76.66	$ 46.12	$ 109.00	$ 56.93

1. Assumes 25 minutes with basic long-distance package of $4.99/mo plus $.05 per minute unless noted. Additional Long Distance Plans: $25/mo for unlimited (POTS); $15/mo for unlimited w/Home Phone Pkg.; Emergency Plan ($.99/mo. Plus $.15 per minute); $30 per year plus $.05 per min. in-state calls and $.029 per min. for out of state calls.
2. POTS - Plain Old Telephone Service

[39] For a 1.5 Mbps service. Qwest advertises a DSL service for under $20 per month; however this is for a 256 kbps connection.

7. Business Model Considerations and Analysis

This section of the report is intended to provide City decision-makers with key elements of potential business models and with financial data by which to evaluate the feasibility and relative merits of alternative business models for a City-wide WiFi network. In addition, this section provides a comparison of selected municipal WiFi projects.

Municipalities are discovering that encouraging a provider to deploy a City-wide WiFi network is not as simple as contacting Google or EarthLink. These providers and others launch municipal WiFi systems only when projected operating margins show a sufficient rate-of-return on the investment – often enabled by guaranteed payments to the WiFi provider from an Anchor Tenant, the municipality.

The projected rate-of-return for a City-wide WiFi network is different for every market. The many factors that influence the rate-of-return include coverage requirements, cost to deploy the WiFi network, projected equipment life, potential market size and demand, and operational costs such as pole attachments, marketing, and maintenance.

This section examines several elements that are often used to construct a unique business model for a municipality. During discussions and negotiations with potential providers there is a give-and-take balance between - elements that lower the projected rate-of-return for the provider but address important City of Tucson goals and elements that increase the projected rate-of-return but does not require City of Tucson funding. A primary goal of the Request-for-Proposal (RFP) is to solicit creative responses and refine elements of a business model that will benefit both parties.

7.1 Summary of Potential Business Model Elements

Municipal WiFi business models are based upon community objectives, legislative considerations, risk aversion, financial objectives and other considerations. A successful model examines a community's unique needs and objectives to develop an approach that works for both the community and potential partners.

As discussed, in most cases in order to obtain a City-wide WiFi network a substantial financial commitment has been made by the municipality- either as anchor tenant or in network ownership. The exception to this is San Francisco in which EarthLink and Google have offered to deploy a WiFi network at no cost to the City and with no anchor tenant commitments.

The following paragraphs detail elements that are commonly used to develop a particular WiFi business model (anchor tenant, community branding, community operations, digital inclusion, economic development, ISP competition, open access, private enterprise, public-private partnerships, and universal access). The elements are not mutually exclusive, and in practice, the actual business models use a combination of these elements.

Anchor Tenant: The City encourages a private entity to build, operate and maintain the network by agreeing to purchase capacity for public service and some public safety applications. This is the key element of the model used by Minneapolis, Minnesota and Philadelphia, Pennsylvania.

- Principles: The City can fulfill internal needs using a WiFi network but does not want to own or operate the network. In addition, the City may also desire that residences and businesses have an alternative low-cost high-speed Internet access option.
- Financing: The Anchor Tenant element uses general operating budget funds to meet the city's obligations. Grants may cover some of the public safety functions costs.
- Primary Objective: To assist the provider with financing by guaranteeing an investment in the system and providing a fixed-source revenue stream. Given the magnitude of the financial commitment, the municipality is allowed to control or influence some aspects of the network such as capacity, coverage, and performance.

Community Branding: For new market entrants, one of the highest expenditures a company expects to make is creation of name recognition and branding. In this element, the City allows a private WiFi provider to use the city name to market the service. The consumer perception of the credibility of the service is often increased with us of the City name. Both the City of Aurora, Illinois and the St. Louis Park, Minnesota projects use community branding as a foundation in their business model.

- Principles: Obtaining market share is very expensive for new market entrants, and becomes a barrier to market entry for companies offering low-margin services, such as WiFi. Community branding may increase market share, reduce initial marketing expenses, raise the projected rate-of-return and lower the market entry barrier for new provider entrants into the market.
- Financing: This element often does not require municipal resources over and beyond allocating space in municipal publications and communications. Issuing targeted or specialized communication requires covering incremental costs with existing or expanded operating budgets.
- Primary Objective: Provide familiarity and credibility with the service provider to raise the consumers' comfort–level with contracting for the service. With municipal support, the provider can reduce marketing expenses and increase net contribution margins. Ensuring that the Cities brand image is maintained is critical if this element is used in the business model.

Community Operations: The municipality builds the network to increase or expand upon services and programs. The network provides voice and data service to municipal employees for use during the work day. Although the network is not marketed to residents, the spare capacity can be allocated for residential access. Oklahoma City, Oklahoma uses their network for community operations.

- Principles: The city implements a WiFi network to provide cost-effective communications support for city operations. Remote access to files, report writing programs and GIS applications increases efficiency. The city is able to improve upon and/or expand services by permitting employees in the field access to city databases.
- Funding: Funding for this initiative is generally taken allocated from general operating budgets.
- Primary Objective: To maximize efficiency, reduce the need to re enter handwritten field reports into the computer and permit field personnel access to GIS information and municipal databases and to municipality reduce overall staffing costs. The municipality is also able to expand upon services and programs that rely on in-the-field digital access (building permit approvals, occupancy permit processing, Fire Department inspection, social service files, etc).

Digital Inclusion: The municipality provides access in a City-wide or selected geographic area to assist in closing the Digital Divide. This element also requires attention to the other components of the Digital Divide including education, training, and equipment. Many agencies (schools, job training agencies, etc.) provide computer training. To reduce duplication of efforts coordination between other community agencies is important The Philadelphia, San Francisco, and Minneapolis models contain digital inclusion elements.

- Principles: Affordable high-speed access is an essential service to citizens. Those with high-speed access can participate in online services and programs; those without high-speed access are left behind.
- Financing: Digital inclusion programs are funded through traditional revenue sources as well as through grants and CDBG funds.
- Primary Objective: To provide a means to ensure equal access to the electronic world. Equipment costs have decreased and educational initiatives that provide computer training are on the increase. The Divide is increasingly seen as resulting from the consumer's inability or reluctance to pay monthly access fees; therefore, newer digital divide initiatives focus on reducing or eliminating monthly access fees.

Economic Development: An investment in the future is the focus of this model element. The municipality builds the network to provide affordable access for residents and businesses. The difference between this attribute and the Universal Access attribute is the inclusion of the small business sector and an emphasis on job creation and economic growth. This is a secondary attribute of St. Cloud, Florida model.

- Principles: The City seeks to encourage both businesses and residents to relocate to the community by providing an essential service at an affordable cost.

Upgrading the community's communication infrastructure is important to attracting "cutting edge" or "high tech" businesses to the area.
- Financing: Revenue sources are similar to Universal Access including assessment funding, general obligation bonds, user-based fees or allocations from the general fund. In addition, depending on the project, special assessments incrementally-based payoff period are a potential financing source.
- Primary Objective: The project promotes community growth and development of both traditional and new businesses. A projected increase in tax revenues offsets the initial network investment and on-going day-to-day operational costs.

ISP Competition Model: The municipality builds the wireless network and markets the service. They act as a utility provider and increase staffing levels to cover technical, sales, operational, and maintenance functions. In order to insure sufficient market share is obtained to reach a break-even cash flow, marketing the service is critical. Network performance, supplemental services and degree of technical support are established and clearly defined. Residents will judge the system by the degree of network reliability and customer service support.

- Principle: Since existing high-speed and broadband options are not meeting the needs of all residents and businesses in the community, the city steps in to provide a cost-effective service.
- Financing: The city makes an initial investment to build the system and market the services. The revenue stream from customers of the service pays for the maintenance and further system enhancements. Financing the network deployment is likely to require use of general obligation bonds.
- Objectives: To bring universal high-speed access to the community and promote competition in the marketplace. The City realizes at least a breakeven cash flow sufficient to support continued operation and development of the system. Customers are satisfied with the service – its reliability and speed. More residents and businesses switch to high-speed and prices for access decline.

Open Access: The municipality deploys a ubiquitous broadband network to connect residences and businesses. The municipality then leases the network to private sector service providers that in turn deliver retail services to the residences and businesses. The City of Boston's recently announced plans may evolve to contain open access elements. The City of Seattle is attempting to spur development of an open access Fiber-to-the-Premises (FTTP) network

- Principles: To entice businesses to invest in the community the barriers to entry must be minimized. Retail providers are constrained by the high initial investment needed to build a broadband network. By the municipality providing the network, private providers are able to focus on a retail service model and not be encumbered with the network investment and operation.
- Financing: The Open Access Model can consider use of), special assessments, revenue bonds, general obligation bonds or general operating funds. Financing payments are offset by lease fees charged to the retail providers.

- Primary Objective: Provide competitive choice in high-speed service for all residents and businesses by removing a formidable barrier to entry. New retail providers enter the marketplace, offering greater customer choices.

Private Enterprise: Broadband accessibility is determined by private companies responding to their perceptions of the market. Municipalities adopt a “laissez faire” approach and rely on private companies to build systems.

- Principles: Public entities should not compete with private companies for the provision of goods and services.

- Primary Objective: Let the market determine the availability of goods and services in a community.

Public/Private Partnership: A public entity collaborates with one or more private companies to build the network and/or provide services. The partner either supports components of the ISP or acts as a network leasing agent. Examples of this element used in business models are Moorhead Public Service, Moorhead, Minnesota and the City of St. Louis Park, Minnesota

- Principles: A public/private partnership makes sense when both sides of the partnership have significant items to contribute to the project. This element leverages to core competencies of each party. Municipalities tend to deal with infrastructure effectively whereas Internet Service Providers are versed in the delivery and support of retail services.
- Financing: The financing for this model depends upon the contributions of the municipality. For instance, access to poles, conduit and facilities are invaluable municipal assets that can be contributed at little to no municipal cost. The municipality could build the network and contract with a private company to operate and maintain the network in exchange for a portion of the revenues. In this case, funding the network infrastructure is from general obligation or revenue bonds.
- Primary Objective: To provide a universal access network by capitalizing on the assets each partner brings to the project. It relies on the strengths of each partner to integrate operations.

Universal Access: This element provides free ubiquitous wireless access to residents. A subset of universal access is deployment of WiFi in targeted (hot spots) in outdoor or indoor public areas. The hot-spot approach is the lowest cost and the most popular approach by municipalities’ to-date. The City of St. Cloud, Florida used Universal Access as the foundation for their City-wide wireless project.

- Principles: The general public is beginning to view universal high-speed access as an essential service. In the past, local government took a role in bringing essential services such as roads, water, and sewer to the community. Pooling or aggregating resources from citizens to provide essential services takes advantage of economies of scale and reduces costs paid by citizens for connectivity access. This business model element assumes that these citizens will use savings to acquire other goods and services which in turn stimulates the local economy.

- Financing: Revenue sources include assessment funding, general obligation bonds, user-based fees or allocations from the general fund.
- Primary Objective: To provide the residents of the community with free access to high-speed access so that they can take advantage of online resources, pursue opportunities in education, commerce, etc. The project facilitates citizen's future success in the 'new digital economy'.
- Secondary Objective: Provide access to area visitors so that the city is a more attractive destination for those needing online access. The local economy is rewarded when visitors purchase goods and services in the area.

The elements above are not mutually-exclusive. Multiple elements will need to be applied to develop a unique model which matches the City of Tucson's' unique goals and objectives.

7.2 Comparison of WiFi Projects

Municipal WiFi projects have common elements; however, specific components of the projects need to consider individual community needs. This section provides a brief comparison of five communities that have or are in the process of a WiFi implementation.[40] We examine projects in the following five communities:

- Chaska, Minnesota
- Minneapolis, Minnesota
- Philadelphia, Pennsylvania
- St. Cloud, Florida
- St. Louis Park, Minnesota

Please note that this section is not structured to provide a recommendation of one approach over another. When comparing the projects, it is important to review them in context of community goals and objectives. Each community has gone through a due diligence process and made educated choices based upon specific needs. By reviewing the approach in this context, you can better understand what elements of the model might apply to your situation. The drivers of the business model, technology, and other attributes are unique community goals and objectives. Comments regarding the attributes of a given approach are intended to help the reader understand some of the nuances and trade-offs that are required in developing a strategy.

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[40] Information for this article is based upon our experience, discussions with vendors and municipal representatives, attendance at various seminars and conferences, and day-to-day review of various articles published in newsletters and the web.

7.2.1 Primary Drivers

Table 7-1 shows the primary drivers (let's say the "meat" or "turkey") and secondary benefits (let's call it "gravy") for each community. Minneapolis MN is driven by public safety communication; St. Louis Park MN and Chaska MN are driven by retail services; Philadelphia PA by digital inclusion and retail services; and St. Cloud FL by economic development and retail services.

Table 7-1: Turkey or Gravy

	Chaska MN	Minneapolis MN	Philadelphia PA	St. Cloud FL	St. Louis Park MN
Digital Inclusion	Gravy	Gravy	Turkey	Gravy	Gravy
Economic Development	Gravy	Gravy	Gravy	Turkey	Gravy
Public Safety	Gravy	Turkey	Gravy	Gravy	Gravy
Internal Communication	Gravy	Turkey	Gravy	Gravy	Gravy
Retail Service	Turkey	Gravy	Turkey	Turkey	Turkey

7.2.2 Public Safety and Internal Communications Uses

Each of the approaches serves public safety, internal communications, and retail services differently. Table 7-2 and Table 7-3 address of public safety and internal communications applications.

Chaska MN, Philadelphia PA, and St. Louis Park MN are leveraging the ubiquitous availability of the standards based on 2.4 GHz licensed frequency for internal communication uses (inspectors and other mobile workforce). Use of the unlicensed standards-based approach, although it is secure as cable modem or dial-up, may not be appropriate for some first responder (public safety) applications.

Minneapolis' use of a licensed frequency with a proprietary interface offers the greatest security for sensitive data transfers. However, it reduces the possibility of obtaining ubiquitous coverage in Minneapolis/St. Paul metropolitan area by using the proprietary 4.9 GHz approach. Minneapolis will likely need to continue to use EvDO or other technology for ubiquitous coverage for mobile applications.

St. Cloud's use of the network for internal communications needs is not defined, but the deployment appears well suited to support inspectors and other mobile workforce needs. As in the case of the other communities, mobile workers traveling outside of the city boundaries are required to use a supplemental connectivity technology.

Table 7-2: Public Safety Communication Support

	Chaska MN	Minneapolis MN	Philadelphia PA	St. Cloud FL	St. Louis Park MN
Attributes	VPN over unlicensed 2.4 GHz WiFi	Licensed 4.9 GHz WiFi	VPN over unlicensed 2.4 GHz WiFi	VPN over unlicensed 2.4 GHz WiFi	VPN over unlicensed 2.4 GHz WiFi with possible upgrade to licensed 4.9 GHz WiMax
	Standard based CPE	Proprietary CPE	Standard based CPE	Standard based CPE	Standard based CPE
	Coverage ubiquitous in majority of Chaska	Coverage may not ubiquitous in Minneapolis	Desires ubiquitous coverage in Philadelphia	Coverage ubiquitous in majority of St. Cloud	Ubiquitous coverage planned in majority of St. Louis Park
	Coverage not ubiquitous in Minneapolis/St. Paul Metropolitan Area	Coverage not ubiquitous in Minneapolis/St. Paul Metropolitan Area	Coverage not ubiquitous in Philadelphia Metropolitan Area	Coverage not ubiquitous in Orlando Metropolitan Area	Desires coverage in surrounding communities.
	Supplement with EvDO or other technology?	Supplement with EvDO or other technology?	Supplement with EvDO or other technology?	Supplement with EvDO or other technology?	EvDO used today

Table 7-3: Internal Communication Support

	Chaska MN	Minneapolis MN	Philadelphia PA	St. Cloud FL	St. Louis Park MN
Attributes	VPN over unlicensed 2.4 GHz WiFi	VPN over unlicensed 2.4 GHz WiFi	VPN over unlicensed 2.4 GHz WiFi	VPN over unlicensed 2.4 GHz WiFi	VPN over unlicensed 2.4 GHz WiFi
	Standard based CPE	Standard based CPE	Standard based CPE	Standard based CPE	Standard based CPE
	Coverage ubiquitous in majority of Chaska	Desires ubiquitous coverage in Minneapolis	Desires ubiquitous coverage in Philadelphia	Coverage ubiquitous in majority of St. Cloud	Ubiquitous coverage planned in majority of St. Louis Park
	Coverage not ubiquitous in Minneapolis/St. Paul Metropolitan Area	Coverage not ubiquitous in Minneapolis/St. Paul Metropolitan Area	Coverage not ubiquitous in Philadelphia Metropolitan Area	Coverage not ubiquitous in Orlando Metropolitan Area	Coverage not ubiquitous in Minneapolis/St. Paul Metropolitan Area

7.2.3 Reliability, Availability, and Expandability

Another key difference is network availability during power outages. In Chaska, Minneapolis, Philadelphia, and St. Cloud, portions of the WiFi network are not operational during power outages. This is due to the fact that not all of the WiFi radios are equipped with back-up power. In the case of St. Louis Park, radio nodes are solar powered with battery backup allowing network communications during brief and extended power outages.

Another difference between the networks is in the use of fiber backhaul. Philadelphia, Minneapolis and St. Cloud are using radio backhaul for the WiFi radios; St. Louis Park and Chaska use a combination of wireless and fiber backhaul. The addition of radio and fiber backhaul positions the community to expand institutional connectivity options and expand available retail service either by third parties or the community. For example,

- Each of the networks use a point-to-multipoint radio network layer in their deployment that may be used to serve higher-end business customers or as an alternative for leased T1 lines
- Chaska and St, Louis Park have deployed a fiber backbone to support WiFi deployment. The fiber backbone is also used to support education and community needs as well as a potential to offer 100Mbps or greater connectivity services to selected users

7.2.4 Retail Services and Digital Inclusion

Table 7-4 presents the models for retail services and digital inclusion. Chaska, Philadelphia, and St. Louis Park appear to be pursuing networks allowing the opportunity for nearly all households to have the ability to participate. Mechanisms are in place to guide the subscriber with a connection. This is designed to maximize participation. The Minneapolis model provides lower coverage area and the retail provider is not planning on high customer interaction—in other words, it either works or it does not for a given customer. This "hands off" approach is designed to maximize provider revenues. The St. Cloud model provides a large-coverage footprint; however, it does not offer traditional help-desk support. St. Cloud provides consumer workshops and has arranged for retail outlets to sell appropriate required Customer Premises Equipment (CPE) and installation support.

Each model, with the exception of St. Cloud, has the basic price level for an always-on 1 Mbps connection in the $20 range. In addition to the monthly fee, in each of the models the consumer must either lease or purchase a CPE to access the network. Although it appears some of the models down-play the CPE requirements, field results from operational WiFi networks do indicate that the majority of households will require high-power CPE to access the network while indoors. Further, experiences in Chaska and St. Louis Park indicate that the largest use of municipal WiFi is from previous dial-up users seeking a low-cost high-speed alternative in their household. Use of municipal WiFi for portability has been minimal by consumers.

The approaches to support digital inclusion are in various stages of policy and procedure development. Philadelphia has chosen and published eligibility requirements for the digital inclusion program (details are available on their web site, http://www.wirelessphiladelphia.org). Chaska and St. Cloud do not appear to have a specific digital inclusion strategy. However, since St. Cloud's service is free it provides a foundation for other agencies or organizations to easily leverage.

Minneapolis and Philadelphia each have a $10 per month service available based upon a pre-determined needs test. St. Louis Park does not require the ISP to provide a low cost service, but is considering a voucher approach for low-income households. Minneapolis, Philadelphia, and St. Louis Park are aspiring to leverage net revenues from the offering to assist education, training, and equipment digital inclusion efforts.

Table 7-4: Retail Service and Digital Inclusion

	Chaska MN	Minneapolis MN	Philadelphia PA	St. Cloud FL	St. Louis Park MN
Retail Service	98% Coverage	90% Coverage	95%+ Coverage	95%+ Coverage	98% Coverage
	Experienced nearly 100% of subscribers require a high power CPE	Anticipates that approximately 10% of subscribers require a high power CPE	Anticipates that 90%+ of subscribers require a high power CPE. Supply of CPE determined by the ISP.	Customer responsible for supplying a high power CPE.	Anticipates that close to 100% of subscribers require a high power CPE.
	Experienced a substantial percentage of customers require an external antenna (actual percentage not provided).	Does not anticipate external antenna installations.	ISP responsible for determining if external antenna is required.	Customer responsible for determining if external antenna is required.	Anticipates that up to 10% of customers require an external antenna.
	Served over 2,500 paying subscribers with a city-wide WiFi network for almost 3 years	Served 5 non-paying subscribers in the initial pilot.	A pilot is in process. Selected subscribers in a pilot covering a 14 sq mile area.	Have over 8,400 registered users. It appears that a household can have multiple registered users.	Served 300 paying subscribers during a 6 month WiFi network pilot.
	Set Price	Price Influence	Price determined by ISP	Free Service	Price Approval
	Chaska Provided	Provider Branded	Provider Branded	St. Cloud Branded	St. Louis Park Branded
	5 year business model	10 year business model	5 year business model	5 year business model	5 year business model
	Designed to supply a low-cost high-speed alternative that all households have the opportunity to subscribe to. 1 Mbps service at $16 per month.	As a basic tier, offer a 1 Mbps $20 per month service to residents. Price fixed for a 10 year period.	As a basic tier, offer a 1 Mbps $23 per month service to residents.	Designed to supply a free high-speed alternative that the majority of households have the opportunity to subscribe to.	Designed to supply a low-cost high-speed alternative that all households have the opportunity to subscribe to. 1 Mbps service price at $20 per month.
Digital Inclusion	Uncertain on approach or considerations.	$10 per month 128 kbps service to identified low-income neighborhoods. A "walled-garden" free access is also available.	$10 per month high-speed service to eligible households. Free cash flow used to address training and hardware availability. In addition, each district will have a designated zone for free access.	Free Service	Focus on education and provision of refurbished PC's donated by the city, schools, and private sector. Future considerations include use of excess cash flows to address training, hardware availability and issuance of vouchers for low-income households.

7.2.5 Business Model Attributes

The business model, financing, partners/contractors and deployment status are shown in Table 7-5.

Another key factor to consider is population and governance structure of the community. Both Philadelphia and Chaska started their planning within a year of each other. Chaska is approaching the third year of operation while Philadelphia just began deployment last fall. Chaska was able to move quickly because of its size and the role of the municipal electric. As a utility, Chaska has financial resources and assets not available to Philadelphia and can make decisions in context of the electrical utility, not a political body.

Table 7-5: Business Model Attributes

	Chaska MN	Minneapolis MN	Philadelphia PA	St. Cloud FL	St. Louis Park MN
Business Model	Retail Service	Anchor Tenant - Discounts when other communities join program	Non-Profit Ownership, with City as an Anchor Tenant	Economic Development	Private-Public Partnership
Financing	Municipal Bonds, debt service covered with revenues from Internet service.	US Internet is seeking financing (may be a combination of debt and equity).	Grants, donations, and loans. Debt service covered with lease fees paid by the ISP.	Estimated that a portion of the household savings will be spent in local economy, thus increasing tax and other revenues to the City. It is estimated that the revenues from the "dollar churn" will offset the implementation and operational costs of the net	Municipal Bonds, debt service covered with lease fees paid by the ISP
Wireless Network Ownership	Chaska	US Internet	Wireless Philadelphia/EarthLink	St. Cloud	St. Louis Park
WiFi Vendor	Tropos	BelAir	Tropos	Tropos	Proxim
Partners or Key Contractor	Siemens	US Internet	EarthLink	HP	Unplugged Cities
Status	Operational	Implementation	Pilot	Operational	Implementation
Activation	4Q 2004	3Q 2007	3Q 2007	1Q 2006	2Q 2007
Population (2005 US Census Estimate)	22,820	372,811	1,463,281	22,508	43,296
Area (square miles)	14.3	58.4	135.1	9.2	10.9
Population Density (per square mile)	1,596	6,384	10,831	2,447	3,972

The choice of the business model affects the cash outlay and risk for each city.

- There are no public details regarding Chaska's current investment, operating costs, and business relationship with Siemens. Chaska has reported they are maintaining cash flow and have begun to pay debt service, including principal.
- Minneapolis does not make an investment for construction; however, they provide guaranteed payments to US Internet. The estimated payments are $2.4 million upon contract signing and $1.3 million each year for 10 years. In return, they receive access to the network for public safety and public service use. These payments do not include the cost for development of the plan and required radio hardware (vendor proprietary 4.9 GHz wireless cards).
- Like Minneapolis, Philadelphia does not have a direct investment in the network; however, they assisted in funding of the business plan and other planning activities. In addition, Philadelphia has agreed to be an anchor tenant, acquiring approximately $3.8 million[41] in services over the first five years of operation.
- St. Cloud has spent approximately $2.4 million to deploy the network. This investment is in addition to the annual fees paid to Hewlett Packard to operate and maintain the network. The City feels citizens will spend their connectivity fee savings locally, thus increasing taxes and other city revenues. St. Cloud feels that the increased revenues offset their investment and operating costs.
- St. Louis Park has an initial investment (capital and operating expenses) of $3.3 million and $400,000 annual operating and interest expenses in year two, declining to $300,000 in year five (decline due to interest expense), for a total commitment of $5.3 million during a 5-year period. In return for use of the

[41] Estimated from the Wireless Philadelphia Business Plan, February 9, 2005.

network, St. Louis Park receives $14 per month per subscriber from Unplugged Cities. Unplugged Cities also has responsibility for operating and maintaining the network.

Another factor to consider when examining business models is population density. Minneapolis' and Philadelphia's population density is considerably higher than the other communities. This condition makes these communities more attractive for private investment. The market potential based on a geographic density is nearly seven times larger in Philadelphia than in Chaska.

7.2.6 Models Do Not Necessarily Apply to Other Communities

At the beginning of this section, we indicated it is important to look at the models in context of community objectives. For example, let's compare Minneapolis and St. Louis Park.[42] Minneapolis is entering into an arrangement that they feel is equitable and meets their objectives. What happens if we apply the model to St. Louis Park?

Basing the payments on the ratio of geographic size between Minneapolis and St. Louis Park (ratio of five, 55 square miles vs. 11 square miles), St. Louis Park would pay US Internet $480,000 up front and $260,000 per year for the next 10 years, or a total commitment of over $3 million (56 percent of the commitment required for the network ownership).

In return, St. Louis Park would obtain access to the network for public safety and public service uses. Anticipated coverage is 50 percent to 60 percent of the community and St. Louis Park would need to acquire new cards for each device desiring access. This coverage requirement does not meet St. Louis Park's needs because they intend to require public safety communication access throughout the City and in surrounding communities.

The proposed network also does not provide for additional fiber to be deployed for support of advanced services and planned applications.

In return, US Internet would provide service to residents, including a subsidized service to low-income neighborhoods. The planned coverage (90 percent) falls short of St. Louis Park's 100 percent goal. The limited customer support offered by US Internet also does not meet St. Louis Park's expectations to have the opportunity for all residents to participate.

Applying the Minneapolis model to St. Louis Park does not meet stated goals and objectives. The reverse is also true. Applying the St. Louis Park model to Minneapolis does not meet Minneapolis' objectives. A successful project examines the community's goals, objectives and unique conditions and designs a tailor-made solution. It is therefore critical to choose the path based upon unique community conditions – not because another community has chosen a given path.

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[42] Based upon a detailed analysis conducted by the author on behalf of St. Louis Park, MN during their planning process.

7.3 Financial Analysis

Each financial analysis for the business models presented previously in this section will vary greatly. For example the analysis for St. Cloud Florida involves projecting potential increased tax revenues due to anticipated economic development and activities. For Philadelphia the analysis includes a comparison of avoided costs for leased T1 services to their committed anchor tenant payments, and Minneapolis's analysis is centered on consideration of benefits from new enabled applications in comparison to their anchor tenant payments.

The financial analysis in this section applies the St. Louis Park, MN model to the City of Tucson demographics and other attributes. The purpose of analysis is to provide Tucson decision makers a better feel for the economics of a City-wide WiFi deployment and provide insights during the evaluation of responses to the proposed WiFi Request-for-Proposal (RFP).

It is important to note that analysis in this section details only the quantifiable financial factors that are relevant to the business case for the network. Many of the additional benefits of the network include items as digital divide closure, economic development, small business empowerment, job creation, livability, education, and other factors are not included in the analysis. Further the St. Louis Park model is used only as an example – not a recommendation for the City of Tucson to pursue the model.

7.3.1 The St. Louis Park Business Model

The basis for the St. Louis Park model is city ownership of the WiFi network and providing a wholesale lease to a private ISP. In the model, the City has access for the network for their internal uses, leases capacity to a private management partner, sets policies, and approves all retail service offerings- including price. The management partner is responsible for the day-to-day operation and maintenance of the network acquiring customers, provides retail Internet services, and pays St. Louis Park a monthly fee based upon the number of subscribers on the network.

In developing the model, St. Louis Park's goals and objectives included:

- Reducing risk of operating expenses exceeding budget.
- Minimizing potential cash flow shortages if market share targets not reached.
- Maintaining St. Louis Park branding image.
- Maintaining a positive cash flow.
- Ensuring affordable high-speed access is universally available to residents.

The management partner has agreed to pay the City of St. Louis Park $14 per customer per month. There are however, many potential variations when the model is applied to other communities including refinements according to the local situation, interested management partners, and each party's assessment of risks. Having a clear understanding of which entity supplied which equipment was just as important as the day-today operational tasks. The negotiated agreement specifies that:

St. Louis Park owns and finances the WiFi network and:

- Acquired the wireless network electronic components (Wireless Access Points, gateways, and media converters);
- Contracted with an integrator for the initial installation and activation of the network, including basic coverage testing and performance verification;
- Acquired the core switches and routers;
- Provided physical space and support infrastructure (electrical power, climate control, physical security, etc.) as required to house central network components (switches, routers, and servers);
- Installed required fiber extensions;
- Provides community brand image;
- Approves service offerings and prices;
- Supports marketing efforts;
- Monitors financial performance;
- Monitors customer satisfaction;
- Finances network upgrades;
- Manages demarcation between St. Louis Park and the management partner, which allows replacement of management partner, if required;
- Maintains a customer "hot-line" to allow feedback regarding management partner performance;
- Approves all marketing and promotion activities;
- Controls and maintains potential advertising revenues (i.e., Google, Yahoo & others);
- Provides redundant Internet connectivity;
- Provided access St. Louis Park mounting assets for wireless network components; and
- Provides the CPEs and accessories.

The Management Partner will operate the ISP, lease access to St. Louis Park wireless network, and:

- Provided design, testing, and technical guidance, as needed, during the network implementation;
- Assisted in coverage testing and performance verification;
- Assisted in proof of performance and/or pilot testing;
- Modified and/or optimize configurations of the core switches, routers, and other wireless network components, as needed;
- Acquired and installed required servers and software for ISP hosting (billing, authentication, accounting, etc.) and email support (See Figures 3.1 and 3.2);
- Programs and installs the required CPEs and accessories;
- Issues monthly billing;
- Provides 24x7x365 help desk support for end users;

- Provides physical space and support infrastructure for help-desk, sales, and administrative personnel and systems;
- Provides physical space and support infrastructure (electrical power, climate control, physical security, etc.) to house central network components (switches, routers, and servers) not located at a St. Louis Park facility;
- Operates and maintains network;
- Directs sales and marketing efforts;
- Provided the authentication server;
- Maintains customer satisfaction;
- Conducts and schedules professional installations;
- Maintains and manages authentication (process and equipment);
- Provides email services, including performing server maintenance;
- Monitors network; and
- Collects operational statistics.

In the financing community, the key measurement for a municipal communications venture is cash flow - the ability to maintain sufficient cash flow to cover debt service (principle and interest), operating expenses, and ongoing network enhancements. The assumptions which have the greatest sensitivity, or impact to the projected cash flows are:

- WAP approach used ,
- Residential Market Share,
- Fees paid by the Management Partner,
- Pole Attachment Fees, and
- Connection fees charged to the consumer.

Please note that the business market share is not listed an assumption with a high sensitivity to the models cash-flow outcome. The reason is the overall number of businesses when compared to the number of households. This is not to say however the businesses are not important. In fact for economic development and other benefits, the business market is critical.

In Table 7-6 and Table 7-7 we show the projected cumulative cash balances for the SLP model applied to the Tucson market for the low-density and high-density WAP approaches discussed in Section 5. The shaded rows indicate the “base” assumptions as described in the remainder of this section.

Table 7-6: Sensitivity Analysis: Low-Density WAP Approach

Assumption		End of Year Cash Balance (Cummulative $) 1	2	3	4	5
Residential Market Share	45%	1,787,759	1,425,100	3,449,088	5,523,676	7,650,128
	40%	943,750	855,925	1,734,443	2,634,925	3,557,918
	35%	100,022	286,947	20,134	(253,349)	(527,335)
	30%	(743,988)	(263,796)	(1,669,191)	(3,074,585)	(4,479,980)
	25%	(1,587,491)	(811,681)	(3,348,182)	(5,884,683)	(8,421,184)
Monthly per Subscriber Fees Paid by Management Partner	$ 13.00	640,882	(398,435)	(485,234)	(572,034)	(658,834)
	$ 13.50	792,316	228,745	619,624	1,020,275	1,430,942
	$ 14.00	943,750	855,925	1,734,443	2,634,925	3,557,918
	$ 14.50	1,095,184	1,483,105	2,849,263	4,249,575	5,684,895
	$ 15.00	1,246,618	2,110,284	3,964,082	5,864,225	7,811,871
Pole Attachment-Power Fees (% of Market Rates)	100%	943,750	855,925	1,734,443	2,634,925	3,557,918
	50%	1,298,182	1,573,650	2,824,543	4,106,709	5,420,929
	0%	1,652,614	2,291,374	3,914,643	5,578,494	7,283,941
Consumer Connection Fees (% of Installation Costs)	100%	2,836,675	6,802,598	7,829,783	8,882,648	9,961,835
	50%	943,750	855,925	1,734,443	2,634,925	3,557,918
	0%	(949,175)	(5,067,019)	(4,209,899)	(3,352,778)	(2,495,658)

As seen in the above table in the 5 year life of a 5 percent market share nets $4 million, a 50 cent increase in the monthly subscriber fee nets $2 million, a $8 decrease in the monthly pole attachment fee nets $2 million, and a $75 one-time subscriber connection fee nets $6.5 million. Please note that the pole attachment fee net savings are not dependant upon market share.

Table 7-7: Sensitivity Analysis: Low-Density WAP Approach

Assumption		End of Year Cash Balance (Cummulative $) 1	2	3	4	5
Residential Market Share	45%	(1,703,789)	1,468,868	(1,413,489)	(4,332,568)	(7,251,646)
	40%	(2,568,879)	311,155	(3,780,369)	(7,879,672)	(11,978,975)
	35%	(3,433,780)	(846,432)	(6,125,820)	(11,405,207)	(16,684,595)
	30%	(4,298,869)	(2,004,313)	(8,464,093)	(14,923,873)	(21,383,653)
	25%	(5,163,571)	(3,161,900)	(10,801,765)	(18,441,629)	(26,081,494)
Monthly per Subscriber Fees Paid by Management Partner	$ 13.00	(2,871,747)	(935,633)	(5,978,856)	(11,022,079)	(16,065,302)
	$ 13.50	(2,720,313)	(312,239)	(4,883,502)	(9,454,765)	(14,026,028)
	$ 14.00	(2,568,879)	311,155	(3,780,369)	(7,879,672)	(11,978,975)
	$ 14.50	(2,417,445)	934,549	(2,669,430)	(6,296,773)	(9,924,116)
	$ 15.00	(2,266,011)	1,557,943	(1,558,492)	(4,713,874)	(7,869,257)
Pole Attachment-Power Fees (% of Market Rates)	100%	(2,568,879)	311,155	(3,780,369)	(7,879,672)	(11,978,975)
	50%	(1,909,935)	1,629,043	(1,770,590)	(5,210,949)	(8,651,308)
	0%	(1,250,991)	2,946,931	239,189	(2,536,246)	(5,317,661)
Consumer Connection Fees (% of Installation Costs)	100%	(2,026,404)	1,951,555	(2,098,959)	(6,198,262)	(10,297,565)
	50%	(2,568,879)	311,155	(3,780,369)	(7,879,672)	(11,978,975)
	0%	(3,111,354)	(1,329,245)	(5,428,548)	(9,527,851)	(13,627,154)

As seen in the above table in the 5 year life of a 5 percent market share nets $4.7 million, a 50 cent increase in the monthly subscriber fee nets $2 million, a $8 decrease in the monthly pole attachment fee nets $3.3 million, and a $75 one-time subscriber connection fee nets $1.7 million. Please note that the pole attachment fee net savings are not dependant upon market share. The impact of the customer charge is lower in the high-density WAP approach since the majority of consumer will not require an external installation.

Understanding the above sensitivities is important when encouraging a potential private provider to deploy a City-wide WiFi network.

7.3.2 Tucson Service and Market Assumptions

CTC's methodology in developing the analysis was to apply the St. Louis Park model assumptions to Tucson. In addition we based projected market shares on the market research during this study and compared the low-density and high-density WAP conceptual designs presented in Section 5.

The Internet services offered in St. Louis Park include:

- 1 Mbps symmetrical service for $25 per month, including the CPE lease.
- 2 Mbps symmetrical services for $35 per moth including the CPE lease.
- 128 Kbps symmetrical services for $20 per month, including the CPE lease.

Regardless of the services subscribed to, the management partner pays the City $14 per month per subscription. Any add-on product revenues such as web-hosing and VoIP are the management partners.

Residences

Approximately 195,000 occupied households are located in the City of Tucson. Today, approximately 87 percent of all households acquire an Internet service. Based upon the market research, we project that up to 40 percent of Internet users or 34.8 percent of all households will subscribe to a Tucson WiFi offering.

Businesses

We estimate that there are 27,000 businesses in Tucson. The anticipated market for the wireless services are the smaller business and specialty users. For example, while it makes no sense for Raytheon to consider use of the service for its Internet connection, they may be interested in maintaining roamer passes for use by customer and suppliers visiting their facilities.

Today, approximately 93 percent of all businesses have Internet access. Based upon the market research, we project that up to 43 percent of Internet users or 40 percent of all businesses will subscribe to a Tucson WiFi offering.

Please note that above residential and business market share estimates are ceilings. In the analysis summary, we show the impact of reduced market share projections.

7.3.3 Financing Assumptions

7.3.3.1 Financing: Low-Density WAP Approach

The total capital requirements are estimated to be $40.8 million for the first two years. This includes:

- A $30.4 million short-term bond to cover implementation costs, including core network equipment and other miscellaneous implementation costs. All of this equipment is depreciated over five years. This bond is therefore paid off over five years at an interest rate of 5 percent.
- A $ 416,000 long-term bond to cover fiber extensions. All of the fiber extensions are depreciated over 20 years. This bond is therefore paid off over 20 years at an interest rate of 5 percent.
- A $10 million loan. This loan is issued in year 2 to finance the CPE additions. The loan will also be issued at an interest rate of 5 percent and will be paid off over five years.

We assume that issuance costs are equal to 1.0 percent of the principal borrowed on the short-term and long-term bonds. No interest reserve or debt service reserve is required.

Interest earned on excess cash is assumed to be 2.5 percent of the previous year's ending cash balance.

7.3.3.2 Financing: High-Density WAP Approach

The total capital requirements are estimated to be $ 56 million. This includes:

- A $42.5 million short-term bond to cover implementation costs, including core network equipment and other miscellaneous implementation costs. All of this equipment is depreciated over five years. This bond is therefore paid off over five years at an interest rate of 5 percent.
- A $416,000 long-term bond to cover fiber extensions. All of the fiber extensions are depreciated over 20 years. This bond is therefore paid off over 20 years at an interest rate of 5 percent.
- A $13 million loan. This additional loan is issued in year 2 to finance the CPE additions. The internal loan will also be issued at an interest rate of 5 percent and will be paid off over five years.

We assume that issuance costs are equal to 1.0 percent of the principal borrowed on the short-term and long-term bonds. No interest reserve or debt service reserve is required.

Interest earned on excess cash is assumed to be 2.5 percent of the previous year's ending cash balance.

7.3.4 Implementation Cost Assumptions

Implementation costs have been divided into three categories:

Fiber: Extensions required to be added to connect to the point-to-multipoint radio base station that backhaul traffic from WAPs designated as gateways.

Network Equipment: Network equipment includes WAPs, media converters and repeaters, routers, switches, servers and necessary software to build the wireless network. We have based the initial cost estimate using the Tropos costs presented in Section 5.

Customer Premises Equipment: Customer Premises Equipment (CPE) includes all equipment required by end-users to connect to the wireless network.

7.3.4.1 Implementation: Low-Density WAP Approach

The total implementation cost obligations to Tucson for the low-density WAP approach is estimated at $18.7 million for the wireless network, $456,000 for fiber extensions, and backup upgrades, and $475,000 for project management.

This is in addition to the CPE costs. The CPE costs are estimated at $150 per subscriber for equipment and $150 per subscriber for installation.

7.3.4.2 Implementation: High-Density WAP Approach

The total implementation cost obligations to Tucson for the high-density WAP approach is estimated at $18.7 million for the wireless network, $456,000 for fiber extensions, and backup upgrades, and $475,000 for project management.

This is in addition to the CPE costs. The CPE costs are estimated at $125 per subscriber for equipment and $150 per installation for subscribers receiving the 2 Mbps service and 10 percent of the remaining subscribers.

7.3.5 Expense Assumptions

7.3.5.1 Staffing Expenses

Given the breakdown of responsibilities between Tucson and the management partner, Tucson will need to add additional staff or allocate staff resources to the new business venture. The staff allocations and/or additions are shown in Table 7-8.

Table 7-8: Staff Allocations and/or Additions

	Year 1	Year 2	Years 3 to 5
Broadband Service Manager	1	1	1
Broadband Technician	1	1	1
Customer Service Representative	3	3	3
Total	5	5	5

The labor cost used in the analysis is $80,000 for the Manager, $50,000 for the technician, and $40,000 for each Customer Service Representative. In addition, we added 47 percent overhead to these costs.

7.3.5.2 Operation and Maintenance Expenses

7.3.5.2.1 Operation & Maintenance Expenses: Low-Density WAP Approach

Years 1 and 5 operating and maintenance expenses are presented in Table 7-9.

Table 7-9: Operating and Maintenance Expenses: Low-Density WAP Approach

Year	1	2	3	4	5
Annual Fixed Operating Expense					
Insurance	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000
Contingency	50,000	50,000	50,000	50,000	50,000
Fiber Maintenance	29,160	29,160	29,160	29,160	29,160
Vendor Maintenance Contracts	-	10,000	110,000	110,000	110,000
Interconnect Fee	60,000	120,000	120,000	120,000	120,000
Tree Trimming-Ground Clearing-Facilities	48,000	24,000	24,000	24,000	24,000
Legal & Consulting Fees	30,000	24,000	24,000	24,000	24,000
Start-up Costs	100,000	-	-	-	-
Marketing (Incremental Support)	50,000	50,000	25,000	25,000	25,000
Annual Variable Operating Expense					
Professional Installation	3,785,850	8,012,850	-	-	-
Total	$ 4,203,010	$ 8,370,010	$ 432,160	$ 432,160	$ 432,160

In addition to the above expenses annual pole attachment and energy fees are estimated at $709,000 and annual labor expenses are estimated at $367,500 (see Table 7-8).

7.3.5.2.2 Operation & Maintenance Expenses: High-Density WAP Approach

Years 1 and 5 operating and maintenance expenses are presented in Table 7-10.

Table 7-10: Operating and Maintenance Expenses: High-Density WAP Approach

Year	1	2	3	4	5
Annual Fixed Operating Expense					
Insurance	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000
Contingency	50,000	50,000	50,000	50,000	50,000
Fiber Maintenance	29,160	29,160	29,160	29,160	29,160
Vendor Maintenance Contracts	-	10,000	110,000	110,000	110,000
Interconnect Fee	60,000	120,000	120,000	120,000	120,000
Tree Trimming-Ground Clearing-Facilities	48,000	24,000	24,000	24,000	24,000
Legal & Consulting Fees	30,000	24,000	24,000	24,000	24,000
Start-up Costs	100,000	-	-	-	-
Marketing (Incremental Support)	50,000	50,000	25,000	25,000	25,000
Annual Variable Operating Expense					
Professional Installation	1,084,950	2,195,850	-	-	-
Total	$ 1,502,110	$ 2,553,010	$ 432,160	$ 432,160	$ 432,160

In addition to the above expenses annual pole attachment and energy fees are estimated at $1,317,888 and annual labor expenses are estimated at $367,500 (see Table 7-8).

7.3.5.3 Summary of Expenses Assumptions

Key annual operation and maintenance assumptions include:

1. Salaries and benefits are based on market wages. See Table 7-8 for the list of projected staffing allocation. Benefits and office expenses are estimated at 47 percent of the base salary.
2. Insurance is estimated to be $50,000 in years 1 through 5.
3. Contingency is estimated to be $50,000 in years 1 through 5.
4. Wireless network maintenance fees are performed by the management partner.
5. Fiber maintenance fees are assumed to be $25,000 annually, plus 1 percent of installed cost.
6. Vendor maintenance contracts are executed with the vendors. It is estimated these will total $110,000 per year
7. Interconnect fees for Internet access is $60,000 in year 1, and $220,000 thereafter.
8. Legal fees are estimated to be $50,000 in year 1 and year 2, and then reduced to $25,000 in years 3 through 5.
9. Start-up costs are assumed to be $110,000 in year 1.
10. Incremental marketing and promotional expenses are estimated to be $50,000 in year 1 and year 2, and $25,000 in years 3 through 5. This is addition to expenses covered by the Management Partner.

11. Bad debts are a Management Partner expense.
12. Pole attachment and power fees are estimated at market rates, the annual Pole attachment and power fees are $709,000 for the low-density WAP approach and $1,317,888 for the high-density WAP approach.
13. Inflation and salary cost increases were not used in analysis as it is assumed that cost increases will be passed on to customers in the form of increased prices.

A complete summary of all assumptions and projected financial statements[43] are included in Appendix G for the low-density WAP approach and in Appendix H for the high-density WAP approach.

7.3.6 Income Statements

7.3.6.1 Income Statement: Low-Density WAP Approach

Years 1 and 5 projected cash flows are presented in Table 7-11.

Table 7-11: Projected Income: Low-Density WAP Approach

	Year	1	2	3	4	5
a. Revenues						
Internet		$ 4,240,152	$ 13,214,880	$ 13,214,880	$ 13,214,880	$ 13,214,880
Ancillary Revenues		1,892,925	4,006,425	-	-	-
	Total	$ 6,133,077	$ 17,221,305	$ 13,214,880	$ 13,214,880	$ 13,214,880
b. Operating Costs						
Labor Expense		$ 367,500	$ 367,500	$ 367,500	$ 367,500	$ 367,500
Operation and Maintenance Expenses		4,203,010	8,370,010	432,160	432,160	432,160
Pole Attachment Expense		708,864	708,864	708,864	708,864	708,864
Depreciation		4,515,914	6,118,484	6,306,069	6,493,653	6,681,238
	Total	$ 9,795,288	$ 15,564,858	$ 7,814,593	$ 8,002,177	$ 8,189,762
c. Operating Income		$ (3,662,211)	$ 1,656,447	$ 5,400,287	$ 5,212,703	$ 5,025,118
d. Non-Operating Income						
Interest Income		$ -	$ 23,594	$ 21,398	$ 43,361	$ 65,873
Interest Expense (ST Bond)		(1,519,421)	(1,244,444)	(955,718)	(652,556)	(334,236)
Interest Expense (LT Bond)		(20,800)	(20,800)	(20,119)	(19,404)	(18,653)
Interest Expense (Loan 2)		-	(500,000)	(383,994)	(262,188)	(134,291)
	Total	$ (1,540,221)	$ (1,741,650)	$ (1,338,433)	$ (890,787)	$ (421,307)
e. Net Income		$ (5,202,432)	$ (85,203)	$ 4,061,854	$ 4,321,916	$ 4,603,811

[43] Including the Income Statement, Cash Flow Statement, Capital Additions, Bond and Loan Repayment Schedules, Revenues, and Expenses.

7.3.6.2 Income Statement: Low-Density WAP Approach

Years 1 and 5 projected cash flows are presented in Table 7-10.

Table 7-12: Projected Income: High-Density WAP Approach

	Year	1	2	3	4	5
a. Revenues						
Internet		$ 4,240,152	$ 13,214,880	$ 13,214,880	$ 13,214,880	$ 13,214,880
Ancillary Revenues		542,475	1,097,925	-	-	-
	Total	$ 4,782,627	$ 14,312,805	$ 13,214,880	$ 13,214,880	$ 13,214,880
b. Operating Costs						
Labor Expense		$ 367,500	$ 367,500	$ 367,500	$ 367,500	$ 367,500
Operation and Maintenance Expenses		1,502,110	2,553,010	432,160	432,160	432,160
Pole Attachment Expense		1,317,888	1,317,888	1,317,888	1,317,888	1,317,888
Depreciation		7,205,320	8,540,795	8,869,160	9,197,524	9,525,889
	Total	$ 10,392,818	$ 12,779,193	$ 10,986,708	$ 11,315,072	$ 11,643,437
c. Operating Income		$ (5,610,191)	$ 1,533,612	$ 2,228,172	$ 1,899,808	$ 1,571,443
d. Non-Operating Income						
Interest Income		$ -	$ -	$ 7,779	$ -	$ -
Interest Expense (ST Bond)		(2,124,999)	(1,740,427)	(1,336,628)	(912,638)	(467,449)
Interest Expense (LT Bond)		(20,800)	(20,800)	(20,119)	(19,404)	(18,653)
Interest Expense (Loan 2)		-	(650,000)	(499,192)	(340,844)	(174,579)
	Total	$ (2,145,799)	$ (2,411,227)	$ (1,848,160)	$ (1,272,886)	$ (660,680)
e. Net Income		$ (7,755,989)	$ (877,615)	$ 380,012	$ 626,922	$ 910,763

7.3.7 Cash Flow Statements

7.3.7.1 Cash Flow Statement: Low-Density WAP Approach

Years 1 and 5 projected cash flows are presented in Table 7-13.

Table 7-13: Projected Cash Flow: Low-Density WAP Approach

Year	1	2	3	4	5
a. Net Income	$ (5,202,432)	$ (85,203)	$ 4,061,854	$ 4,321,916	$ 4,603,811
b. Cash Outflows					
Financing	(308,044)	-	-	-	-
Capital Expenditures	(23,366,570)	(8,012,850)	(975,736)	(975,736)	(975,736)
Total	$ (23,674,615)	$ (8,012,850)	$ (975,736)	$ (975,736)	$ (975,736)
c. Cash Inflows					
ST Bond Proceeds	30,388,420	-	-	-	-
LT Bond Proceeds	416,000	-	-	-	-
Internal Loan Proceeds	-	10,000,000	-	-	-
Total	$ 30,804,420	$ 10,000,000	$ -	$ -	$ -
d. Total Cash Outflows and Inflows	$ 7,129,806	$ 1,987,150	$ (975,736)	$ (975,736)	$ (975,736)
e. Non-Cash Expenses - Depreciation	$ 4,515,914	$ 6,118,484	$ 6,306,069	$ 6,493,653	$ 6,681,238
f. Adjustments					
Proceeds from Additional Cash Flows (ST Bond)	$ (30,388,420)	$ -	$ -	$ -	$ -
Proceeds from Additional Cash Flows (LT Bond)	(416,000)	-	-	-	-
Proceeds from Additional Cash Flows (Loan)	-	-	-	-	-
Total	$ (30,804,420)	$ -	$ -	$ -	$ -
g. Adjusted Available Net Revenue	$ (24,361,133)	$ 8,020,431	$ 9,392,187	$ 9,839,833	$ 10,309,313
h. Principal Payments on Debt					
ST Bond Principal	$ 5,499,538	$ 5,774,515	$ 6,063,241	$ 6,366,403	$ 6,684,723
LT Bond Principal	-	13,622	14,303	15,018	15,769
Loan Principal (Loan 2)	-	2,320,118	2,436,124	2,557,930	2,685,827
Total	$ 5,499,538	$ 8,108,255	$ 8,513,668	$ 8,939,352	$ 9,386,319
i. Net Cash	$ 943,750	$ (87,825)	$ 878,519	$ 900,482	$ 922,994
Cash Balance					
Unrestricted Cash Balance	$ 943,750	$ 855,925	$ 1,734,443	$ 2,634,925	$ 3,557,918
Debt Service Reserve	$ -	$ -	$ -	$ -	$ -
Total Cash Balance	$ 943,750	$ 855,925	$ 1,734,443	$ 2,634,925	$ 3,557,918

7.3.7.2 Cash Flow Statement: Low-Density WAP Approach

Years 1 and 5 projected cash flows are presented in Table 7-14.

Table 7-14: Projected Cash Flow: High-Density WAP Approach

	Year	1	2	3	4	5
a. Net Income		$ (7,755,989)	$ (877,615)	$ 380,012	$ 626,922	$ 910,763
b. Cash Outflows						
Financing		(429,160)	-	-	-	-
Capital Expenditures		(36,813,599)	(6,677,375)	(1,679,636)	(1,679,636)	(1,679,636)
	Total	$ (37,242,759)	$ (6,677,375)	$ (1,679,636)	$ (1,679,636)	$ (1,679,636)
c. Cash Inflows						
ST Bond Proceeds		42,499,974	-	-	-	-
LT Bond Proceeds		416,000	-	-	-	-
Internal Loan Proceeds		-	13,000,000	-	-	-
	Total	$ 42,915,974	$ 13,000,000	$ -	$ -	$ -
d. Total Cash Outflows and Inflows		$ 5,673,215	$ 6,322,625	$ (1,679,636)	$ (1,679,636)	$ (1,679,636)
e. Non-Cash Expenses - Depreciation		$ 7,205,320	$ 8,540,795	$ 8,869,160	$ 9,197,524	$ 9,525,889
f. Adjustments						
Proceeds from Additional Cash Flows (ST Bond)		$ (42,499,974)	$ -	$ -	$ -	$ -
Proceeds from Additional Cash Flows (LT Bond)		(416,000)	-	-	-	-
Proceeds from Additional Cash Flows (Loan)		-	-	-	-	-
	Total	$ (42,915,974)	$ -	$ -	$ -	$ -
g. Adjusted Available Net Revenue		$ (37,793,428)	$ 13,985,805	$ 7,569,536	$ 8,144,810	$ 8,757,015
h. Principal Payments on Debt						
ST Bond Principal		$ 7,691,424	$ 8,075,995	$ 8,479,795	$ 8,903,785	$ 9,348,974
LT Bond Principal		-	13,622	14,303	15,018	15,769
Loan Principal (Loan 2)		-	3,016,154	3,166,962	3,325,310	3,491,575
	Total	$ 7,691,424	$ 11,105,771	$ 11,661,060	$ 12,244,113	$ 12,856,318
i. Net Cash		$ (2,568,879)	$ 2,880,033	$ (4,091,524)	$ (4,099,303)	$ (4,099,303)
Cash Balance						
Unrestricted Cash Balance		$ (2,568,879)	$ 311,155	$ (3,780,369)	$ (7,879,672)	$ (11,978,975)
Debt Service Reserve		$ -	$ -	$ -	$ -	$ -
	Total Cash Balance	$ (2,568,879)	$ 311,155	$ (3,780,369)	$ (7,879,672)	$ (11,978,975)

7.4 Tempe, AZ Example

Another example of a municipal wireless deployment is Tempe, AZ. Unlike the St. Louis Park model presented in Section 7.3, the Tempe model did not require an investment by the City – either for network ownership or being an anchor tenant. The bait for MobilePro was cost avoidance- for pole attachment and energy fees worth approximately $180,000 per year. At first this expense might not seem substantial, however assuming MobilePro was able to capture 30 percent of households with a $30 per month service, $180,000 represents 2.5 percent of all revenues (higher at lower market shares) – enough to make or break a business case.

In April of 2005, the City Council of Tempe awarded MobilePro Corporation a five year contract for City-wide wireless broadband services. The network, named WAZ Tempe™, was completed in February 2006. MobilePro contracted with Strix Systems equipment (WiFi equipment) and Pronto Networks services (User authentication software and help desk) to construct and support the network.

Mobile did not limit themselves to the Tempe city limits. The neighboring communities of Chandler and Gilbert have contracted with MobilePro to join their wireless network footprint. Collectively MobilePros' network has a 187 square mile footprint.[44]

A website[45] has been set up to educate residents and to offer information on the services offerings and prices. There are multiple plans available as illustrated in Table 7-15 and Table 7-16:[46]

Table 7-15: Outdoor Roaming WiFi Services

Speed	Equipment-Setup Fee	Cost
Up to 1 Mbps symmetrical	None	$4.95 per hour
Up to 1 Mbps symmetrical	None	$9.95 per day
Up to 1 Mbps symmetrical	None	$19.95 per week
Up to 1.5 Mbps symmetrical	None	$12.95 per month (first 3 months) $24.95 per month (after first 3 months)

Table 7-16: Residential and Outdoor Roaming WiFi Services

Speed	Equipment-Setup Fee	Cost
Up to 2 Mbps symmetrical	$69.95 one-time charge for wireless gateway to enable in-home/residential service.	$12.95 per month (first 3 months) $29.95 per month (after first 3 months)

MobilePro's wireless network covers the entire community of Tempe and they allow free access to City of Tempe services and Arizona State University (ASU). If users want access to other web pages, they must obtain one of the subscriptions outlined in the above tables. No digital inclusion programs or assistance is included in the agreement.

The agreement between MobilePro and the City also creates a second "virtual" municipal network on the same infrastructure as the public network. In return for this network for municipal use, the City allows limited use of the city-owned street light infrastructure and existing fiber backhaul. The city does not subsidize or pay for any part of the network

[44] City of Tempe – Wireless Internet Access Website, http://www.tempe.gov/wifi/, accessed March 14, 2007.
[45] www.waztempe.com
[46] WAZ Tempe Website, http://www.waztempe.com/service/, accessed March 7 and March 14, 2007.

including installation or maintenance. The city plans to use the 4.9 GHz spectrum for public safety communications.[47]

In our conversation with Dave Heck,[48] Deputy Manager of Information Technology for the City of Tempe, he indicated that while the municipal network was completed in 2006, it took about 12 months of optimizing and refining the network to work out all of the issues. He reports that it is just within the last month that the network is finally working well. The network needed an additional 500 WAPs added from the original 400 WAPs to improve the signal quality and the consumer experience. The original deployment was a at a WAP density of 10 per square mile vs. the 22.5 WAPs per square mile after the upgrade. The upgraded density is similar to the low-density estimate presented in this Section. CTC's experience suggests that depending upon housing construction in Tempe and given the WAP density of 22.5 per square mile, some consumers may experience marginal service, and coverage may not be ubiquitous unless consumers locate their CPE outdoors.

As part of the agreement with MobilePro, the City has 1,500 subscriber licenses for the network to be used as needed. Mr. Heck also reports that the city is starting to deploy its own applications on the municipal network that include rolling service out to police officers in their squad cars. This required upgrading over 300 laptop computers in the squad cars to enable them to work on the network. Seamless communications for these laptops while in motion in the squad cars continues to be an issue.

Because the city does not own or operate the network, it does not receive reports from MobilePro on subscribers or usage. Mr. Heck did report that complaints to the city from the downtown merchant area have decreased with the increased number of WAPs.

[47] City of Tempe – Wireless Internet Access Website, http://www.tempe.gov/wifi/, accessed March 14, 2007.

[48] CTC staff conversation with Dave Heck, Deputy Manager of Information Technology, City of Tempe, March 14, 2007.

Appendix A: Residential Frequencies and Crosstabs

Appendix B: Business Frequencies and Crosstabs

Appendix C: Wireless Technologies

Appendix D: Tucson Hot Spots

Appendix E: Interview Summaries

Appendix F: Tucson Connectivity Providers

Appendix G: Cost-Benefit Analysis Low-Density WAP Approach

Appendix H: Cost-Benefit Analysis High-Density WAP Approach

Appendix I: Estimated Tucson Costs to Support a Private WiFi Deployment