INNOVATING INTERNET CONNECTIVITY IN THE ATLANTA WESTSIDE COMMUNITIES

Smith, Aviva B

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EMBEDDED PERVASIVE LAB

Immediate access to a well-established internet connection has become a requirement in participating in many circles of modern society. Most of us rely on our Wi-Fi connected devices to work in our professional career fields, complete academic assignments, participate in social media, and remain abreast of relevant local and global events, etc. Those who live in mid- to high- income areas usually have little trouble finding means of accessing free Wi-Fi connection. However, those who live in lower-income communities typically have more limited options for finding stable, cheap Wi-Fi. (Anderson & Kumar, 2017)

This trend is evidence that a new division between members of varying income brackets has been created – one that shows a marked difference in the ease with which members of populations can access tools required to carry on their daily routines. Such tasks include searching for jobs (Smith, 2019); researching, completing, and submitting homework (Anderson & Perrin, 2018); and receiving updates on major changes to their environment or community (Dixon, 2017). This number of homes without internet compared to the number of homes with internet is the internet-connectivity ratio. While national gap between the internet-connectivity ratios of zip codes with differing median incomes – which we will hence forth refer to as the national "digital divide" - has gradually narrowed over the last few years, finding a means of consistently connecting to the internet remains a concern for millions across the country (Anderson & Kumar, 2017). The Westside communities of Atlanta are an example of a cluster of primarily low-median income neighborhoods affected by the digital divide.

To determine whether the Westside could be classified as a "low-median income neighborhood", we examined public data records collected by the U.S. Census Bureau that

showed the average household median income for zip codes in the Westside neighborhood. By comparing the average household median income of all the zip codes in the Westside with the national average household median income of the United States, we could determine whether the Westside can be statistically classified as a low-median income neighborhood.

According to a survey distributed from 2013 to 2017 by the U.S. Census Bureau, the data illustrates the average household median income of all zip codes in the Westside $52,828. That is approximately $8,000 less than the national average household median income of $61,372 (U.S. Census, 2018), putting the Westside well into the low-median income category and validating our hypothesis.

Following this analysis, we looked at another census record for the Westside that showed the ratio of the number of homes in a given zip code that did not have access to broadband internet to the total number of homes in the zip code. We observed that as the ratio of the number of households without access to broadband internet decreased, the average household median income of the zip code would increase.

Using this knowledge, we made the graph pictured in Figure 1. The vertical axis tracks the ratio of homes in a zip code that do not have broadband internet, while the horizontal axis tracks the average household median income for that zip code. What we determined fell in line with our hypothesis: as the average household median income of a zip code increases, the ratio of households without internet steadily decreases, as illustrated by the downward slope of the line.

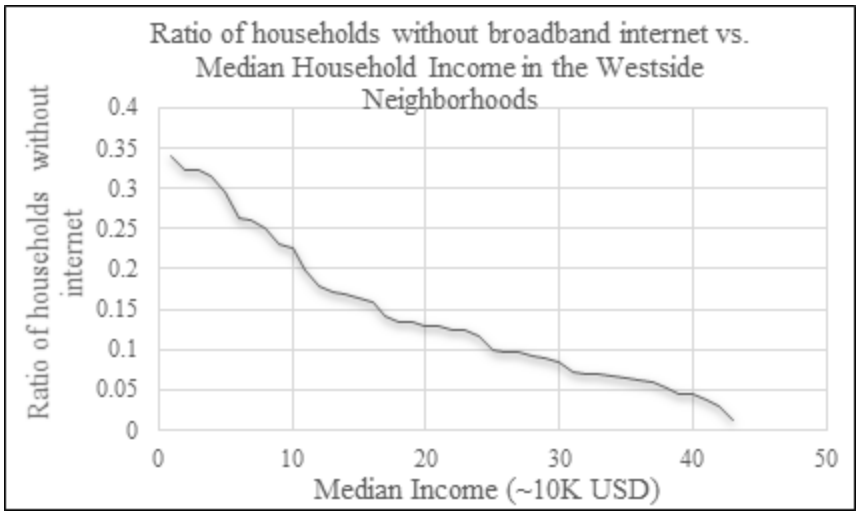

Figure 1. Strongly negative correlation between no internet access and higher income zip codes in Atlanta's Westside.(U.S. Census 2017)

Following this preliminary analysis, we attended two Neighborhood Planning Unit (NPU) meetings of NPU L - which encompasses the streets of English Avenue and Vine City - where we learned of the concerns of those who live in surrounding area. Based upon the announcements given by individual community members as well as companies in the area, it seems many updates are shared by word of mouth, possibly implying that digital communication may be less of option.

The poor access to Internet already exacerbates many residents' precarious situation brought on in part by the recent rising cost of housing caused by rampant gentrification (Dixon, 2017). As part of the ~~gentrification~~ infrastructure development, the implementation of the new extensions to the Atlanta Beltline have raised the cost of the living in the Westside and surrounding neighborhoods. While the intension of the recent construction was meant to make the area safer and more navigable by foot, many of the pre-construction residents have been driven out of the increasingly expensive district. For those who already have limited access to the internet, it remains a challenge to stay up to date with the Westside's evolution. In a 2017

interview about the impact of the beltline on Westside residents, southwest Atlanta Councilwoman Joyce Sheperd said, "***If you are not Internet savvy, you have no idea that the Beltline is coming**,"* in conjunction with other comments about how Westside residents have not been receiving regular updates on the construction and its aftermath (Stafford, 2017).

At the beginning of the project, we intended to analyze the possibilities of collecting and evaluating data showing resident engagement online. The study was designed to investigate how the community members primarily use the internet, what are their current means of internet access, and what are some practical solutions that can be applied to solve the issue of internet connectivity in the Westside. Due to safety restrictions put in place to restrict the spread of COVID-19, for the entirety of 2020, we were unable to do our own data collection. However, we were able to make logical conjectures about the state of internet access in the area due to previous studies which have investigated similar issues in other places. To provide a background on how these similar studies have handled the topic, three papers will be covered which expound on how citizens of several developing countries handle frequent failures in internet connection; internet access restricted by the nation's governing policy; (Morshed et. al., 2017) internet service that is rationed on a weekly basis (Dye et. al., 2018); and how to establish stable, accessible internet in remote regions (Heimerl et.al., 2013). After covering the research methods and approaches taken to complete these past studies, we will examine how currently implemented technologies are designed to solve the connectivity issues faced by those in various environments and circumstances.

By analyzing the flaws and successes of currently implemented networks and system designs, it will be more possible to mold a system suitable meet the internet connectivity demands of residents in urban environments in the U.S. (Heimerl et.al., 2013). To conclude, we

will analyze the relevance of the data collected, draw conclusions about the severity of Westside internet connectivity issues, and discuss the design of solutions that could be feasibly implemented.

LITERATURE REVIEW

The establishment of widely accessible public internet connection has been an area of focus in human and computer interaction (HCI) research across the globe. Between the goals of making internet available in even the most rural communities (Dye et al., 2018) to assuring that internet is still accessible in times of power shortages or electricity crises (Morshed et al., 2017), there have been many theoretical proposals and practical implementations intent on resolving this issue. However, amid the United States' charge to expand the network of reliable internet service available to all, finding stable and fast internet connection remains a concern for many living in low-income urban environments across the country. (Anderson & Kumar, 2019). Studies published by research centers have shown a very clear, positive correlation between income and access to broadband internet, showing a marked gap in how individuals from differing income brackets can get the most out of their online resources (Anderson & Kumar, 2019). For one, the digital age has ushered in a period in which internet is a requirement to carryout day to day task such as searching for jobs (Smith, 2019), submitting homework (Anderson & Perrin, 2018), and staying up to date with the developments in one's surroundings (Stafford, 2017). Furthermore, national newspapers have published articles illustrating that inflated statistics about internet speeds released by internet service providers has further obscured visibility of this issue (Ramachandran & Rizzo, 2019).

Hence, while internet connectivity in urban environments has been regarded as a topic worthy of coverage in HCI, it still requires further investigation to collect enough data to better

grasp the pertinent details of the situation. To facilitate learning more about this topic, our research focused on studying internet connectivity in the Atlanta Westside communities.

Digital Divide

In two separate studies conducted by the by Pew Research Center (PRC), experts claim that children living in households with an annual income less than $30,000 were often faced with the absence of high-speed internet, or a computer or other device through which they could complete and submit homework assignments. The “homework gap”, as dubbed in the article by Anderson and Kumar, suggests that while there has been an uptick in the adoption of broadband internet by many low-income households, the spread still remains too slow to accommodate the needs of the many who require constant internet access, such as in the homework case mentioned above. Furthermore, it was also reported that limited access to devices has resulted in many members of the lower-income brackets using their phones to carry out task typically done on a device with a larger screen. This evidence does bolster the claim of Anderson’s and Kumar’s study which said that while the adoption of broad-band internet and smartphone use has increased substantially between 2015 and 2019, there still remains a gap in the enabling of all U.S. internet users to have substantial access to the web (Anderson & Kumar, 2019).

In the second study conducted by the PRC, further emphasis was placed on examining the correlation between the educational divide, ethnicity, and income. Anderson and Perrin concluded that the educational gap between children from minority households and children from Caucasian households belonging to the same median income bracket, is further exacerbated by the lack of broadband internet subscription in the households of low-income Black and Hispanic families (Anderson & Perrin, 2018).

As PRC did not include ~~the~~ more specifics of the geography from where the data was

taken and sample size could be unrepresentative, the methodology is not necessarily the best for covering how to conduct similar experiments. However, both articles offer insight into the current state of internet connectivity as reported in their studies, and they offer further break down into the wealth brackets that are also central to our study. (Anderson & Kumar, 2019) (Anderson & Perrin, 2018).

International Cases in Connectivity

In a study presented at the 2018 CHI conference held in Quebec, Canada, it was reported that in Cuba, due to strict government restrictions on 24/7 public access to the internet, an underground network of off-line and rationed data is shared between individuals and across communities. These offline networks, which are frequently updated and have access packets distributed weekly are known as “El Paquete Semanal”, are used to gain access to content that cannot be viewed on government monitored networks. This study does emphasize that human social infrastructure shapes how people choose to access the desired content and through what means they attain this goal (Dye et al., 2018). In a similar study (whose research team also included Dye and Kumar) conducted in Bangladesh, the intersection of politics, resource rationing, social infrastructure, and internet connectivity was expounded upon. Following a ban of social media and other non-sanctioned online content in the country, the Bangladesh government began sponsoring programs encouraging its people to incorporate the internet more into their daily lives, as the push was in part due to a drive to modernize more rural parts of the country. Their plan somewhat worked, as internet usage on government-maintained servers has skyrocketed since the program began. However, persistent users still try to circumvent non-neutral networks to access non-powers by communicating with parties in other countries to share

illegal content through these side channel, without risking being identified on government networks (Morshed et al., 2017).

The issues faced in the urban U.S. communities covered in this research are markedly different from those faced in developing countries. For one, the rationing and subscription systems implemented in Cuba and Bangladesh as covered in the aforementioned studies is done for a much larger portion of those country's respective populations, as many people cannot afford broadband internet at all. In the United States, while greater portion of the overall population has access to the internet, for those living in low-income environments who cannot afford internet, the cost is somewhat higher. Participation in U.S. in society often requires or is simplified by usage of resources accessible only through the internet. These tools include online job boards, homework submission portals and educational tools, and these days, everyday task such as grocery shopping. This cycle is self-defeating, as those in search of more high-paying jobs may not have access to the necessary online tools required to find these jobs (Morshed et al., 2017) (Dye et al., 2018).

This relates to our study as one of its facets requires that we learn what content members of the Westside typically use the internet for and whether their internet speed affects their ability to find what they are searching for. While the collection of data and statistics shapes the quality and validity of our study's claims, interviews with Westside community members have also provided us with insight into the needs of such communities to better pinpoint the exact parameters of the issue.

Gentrification

More specific to Westside is the recent changes in the housing cost and infrastructure bought about by the construction of the Atlanta Beltline. While the intention of the project was to foster more convenient paths on which one could navigate Atlanta on foot or by bike, there has been much controversy stemming from the fact that many of the those who lived there before the Beltline's construction have been drive out by the gentrification done in the area (Gravel, 1998). While communities have welcomed some of the steps to reduce crime, provide better trash management, and the increase in safe, walkable streets that have been recently added, especially in the areas surrounding the Mercedes Benz stadium, the Beltline has introduced much controversy (Dixon, 2017).

As discussed in a recent documentary exploring the stadium construction and its impact on the Westside populace, *The Home Team*, many of those that lived in the area before the stadium was built have seen little improvement in safety, cleanliness, and economic sustainability of the neighborhoods that exist nearby. In fact, during a conversation had with one of the NPU L meetings attended as part of this study, the interviewee said that while the cost of internet access as increased with the influx of usage bought upon those visiting the stadium and the surrounding area, the quality of service has not changed. Hence, while the focus of this study is on the quality of the digital environment of the Westside, the gentrification of the region must be accounted for the Westside denizens' digital struggles are intertwined with changes to the physical environment.

In the recent months, the Westside, like many cities across the world, has been impacted by complications of the Coronavirus Pandemic. As of the second week of April 2020, over 6.6 million jobs and counting were lost as a result of the quarantines and closures done as part of the security measures taken to preserve health of millions across the country (Invanova, 2020).

Many news mediums have noted that while this economic downturn could affect the U.S. job market, many of those impacted most directly are those who work blue collar and manual labor-intensive jobs – occupations often held by those in lower income brackets, a category into which many Westside zip codes' median incomes fall under. Furthermore, most of these jobs are done outside of the home and require face to face contact with customers, both of which have been shut down as a result of the Coronavirus, leading to many of these individuals being laid off or being unable to work. For those that can work at home, the digital divide has become more pronounced as households with stable internet connectivity are less impacted by the policies enforcing working from home than households with less stable internet connectivity (Scheiber, 2020).

Summary

Internet Connectivity is a global issue through which we studied only a tiny slice of it through the lens of the Westside Community. While urban environments across the U.S. vary, we can determine some factors that have resulted in this unusual socio-economic and technological gap. Through this study, we hoped to gain a better understanding of how urban residents access and use the internet in order to gain insight into how better technical solutions can be applied to urban internet connectivity. While there exist projects such as monkeybrains.net ISP in San Francisco and Red Hook Wi-fi in New York that have been previously established to get a handle on the issue of affordable wi-fi among those living in their respective densely inhabited urban regions, such initiatives are yet to expand their reach nationally and globally. Progress on this topic will require multiple parties investigating and sharing their findings among the community of Human-Computer Interaction experts working to solve this issue.

METHODOLOGY

In the spring and summer semesters of 2020, we began learning the concerns of the Westside residents by attending the monthly Neighborhood Planning Unit (NPU) meetings for the English Ave. and Vine City neighborhoods. While listening to the meetings' presenters, we determined that interpersonal communication and social media were the quickest means of distributing new information among local social networks; company owners and leaders who would be willing to be interviewed; places where we could perform IRB-approvable data collection; and survey questions that would be most effective for learning the community needs.

Through our investigation, we also found community leaders who helped us tweak our hypothesis to better focus the scope of our study. For example, Mother Mamie Moore, the head of the BelovedCommunity and other service projects, encouraged us to connect with Georgia Tech professors who have done previous work in the community, such as Professor Christopher Le Dantec in the School of Literature, Media, and Communication, and Professor Elizabeth DiSalvo in the School of Interactive Computing. She also gave us insight on the impact of the beltline and gentrification; and what changes would have a noticeable positive impact on the quality of life of those in the neighborhood. After speaking to a resident from English Avenue, we also found that people often relied on their neighbors' internet service to fill online forms and submit important documents as they did not have sufficient broadband service at home. Other resources we utilized included the Georgia Tech and Georgia State University archives to examine records about the communities' structural and socioeconomic evolution, so we had a preliminary background about long-term issues faced by Westside residents. While our plans were impacted by the nationwide closures and quarantine procedures, we have since adapted to

the circumstances by meeting with contacts familiar with the area through phone calls, conference platforms, and emailing.

During the summer of 2020, much progress was made in discovering and contacting new leads. I spoke with the assistant coordinator of the Street Smart Youth Project (SSYP), Tamica Moon, and learned how SSYP is a service initiative focused on raising the quality of life of the Westside youth and young adults. She told us of a semi-successful plan that distributed routers to some of the students in the nearby public schools while Xfinity offers free WiFi to some qualifying families. Although the student spent less time in class, they were able to assess the virtual tutoring offered by SSYP and complete assignments from home. Given that the concerns of the educational well-being of youth around the world has become a prominent issue at the forefront of many news outlets, SSYP's program illustrates that internet has become a necessity for accessing education in a post-COVID world.

After we used her input to better the scope of our study and informed her of adjustment of our project's approach, Ms. Moore referred us to SSYP. Since they had already made strides in completing both of their missions listed above and continued to rapidly expand their outreach through the grants and investments of employees, volunteers, and donors, they were an optimal candidate to investigate how our research could be practically implemented. By connecting with this well-established program, we hoped to be able to either find a means to connect and learn more from participating individuals or find another avenue through which our research can offer a positive impact.

Circling back to existing avenues offered through the university, I reached out to the Georgia Tech Constellation Center for Equity in Computing. As a department within the College of Computing that is focused on encouraging and supporting parents and students from

underserved communities around Atlanta in their pursuit of an education and career in the STEM field, the Constellation Center already has programs, funding, and a network through which they fulfill their goals. By connecting with the Constellation Center, I hoped to find contacts who could give us further insight into technical programs and infrastructures that already have impacted the Westside and where our research can continue to contribute. The Center was responsive and recommended that I speak with one of Constellation Fellows, Lian Diaz. The Center's Fellows not only have first-hand experience teaching computer science in low-income districts, but also use their knowledge to design effective curricula to better prepare K-12 students for computing-based careers before they arrive at college. Since the Fellows have both the classroom experience and technical expertise to explain the state of the Westside education system, I hoped their insight could add depth to our understanding of technical factors involved in the Westside's situation.

During our conversation, Lian mentioned that several companies based in the Atlanta area or with branches in Atlanta were offering several months of free WiFi access to Atlanta families who made below a certain household income. While the details of how this long promotion would last, and what income brackets qualified was not available, in 2020, the Georgia Broadband Deployment Initiative compiled a list of service providers that were offering free or low-cost broadband internet access from mobile phones. The list of providers included AT&T, Comcast, Verizon, and the Georgia Telecommunications Association (Georgia Broadband Deployment Initiative, 2020). However, as part of the ongoing mission of the Constellation Center, fellows and teachers partnered schools were vouching for schools to issue to students' devices, hotspots, and other online infrastructure to be able to complete assignments from the safety of home. Around that time, the Atlanta Public Schools superintendent announced

that public schools would continue with digital learning for at least the first 9-weeks of the 2020-2021 academic year. In effort to meet the inevitable demand, counties such as Dekalb and Fulton also issued hotspots and devices to students in need. With so many students lacking the necessary tools, it was difficult for the counties to service every student in need (Dalton, 2020).

IMPLEMENTATION

Having developed a better understanding of the Westside's situation from listening to the concerns of the residences and meeting with those who had done previously well-received research with community, we explored prototyping a possible solution by setting up a Local Area Network (LAN). The purpose of our network was to set up an instance of a Jitisi server, a video conferencing service that would allow users to join a meeting without connecting to internet. If the project were to be successful, not only would it step towards validating our research goals, but the residences would be able to see immediate, tangible benefit from our work – another goal which ties into the purpose of starting this project in the first place.

To figure out how to configure the LAN, we collaborated with College of Computing Professor Ashutosh Dhekne, an expert in wireless networking, who advised us on how to configure a server using the Jitsi Meeting application. The idea of the prototype was to deploy an instance of a Jitsi server on a LAN. Clients that are connected to a WiFi access point and have permission to access the LAN could then join a Jitsi meeting being hosted over the LAN without having to be connected to the internet. Unlike more popular video conferencing software such as Bluejeans or Zoom, the Jitsi server can be configured to allow users to get limited access to services that would otherwise require internet.

To make this possible, the domain name of the Jitsi server that we set up was mapped to the IP address of the computer where the server was configured, as shown in Figure 2.

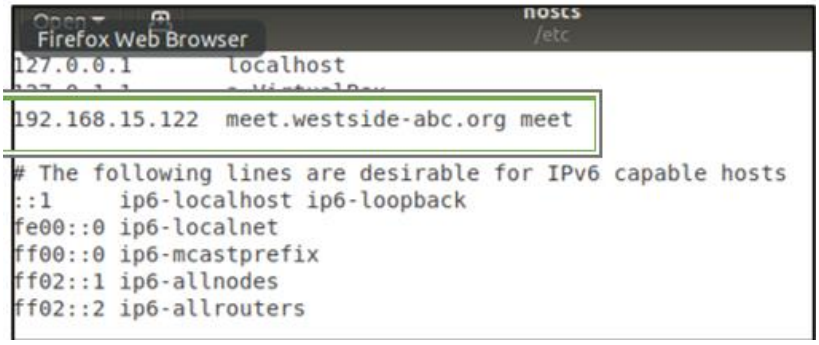

Figure 2. Virtual machine's hosts file being configured to recognize the domain name of the Jitsi server.

This mapping in the server's host file[1] allowed only devices with the same mapping in their own host files to access the video meeting room. To update their host file, users could use the administrator permission on their own client devices to access the file and add the mapping.

However, every time the IP address of the machine hosting the Jitsi server gets updated, the mapping of the IP address to the domain must also be updated in the host file. In turn, the users of the client devices must also update the mapping in host file on their own device in order to access the LAN. Since the IP address of the server device will change every time the server joins the network, this constant updating of the host file would become tedious.

However, if the research team were to purchase and reserve this domain name, it would become unnecessary to make these constant changes to the host file on both the server and the client devices. Users could then access the meeting room by typing the URL into their device's internet browser, much like accessing a webpage over the internet.

RESULTS

Using the instructions provided on the Jitsi Meeting website, we were able to initialize a prototype network by configuring a Virtual Machine my host machine to act as a server on my

[1] A host file is a file on a computer that maps the IP address of a computer to the host name of the computer

home's LAN. To confirm the success of the network configuration, we stored domain name for the Jitsi server and mapped it to the ip address of the Virtual Machine.

Once the server was established, my host machine, smartphone, and another Virtual Machine running on my host machine where able to successfully connect to meeting room. The success of the prototype demonstrated that an experimental LAN could be set up to allow permitted users to join a very small subnet of the internet to access tools that raise their quality of life.

During the experiment, it took much troubleshooting and tweaking of the Virtual Machines settings to set up the server and make it visible to all clients that intended to join. In the future, a lighter-weight platform such as the open-source container software Docker, might be more ideal to run the next level prototype given that it can be configured to carry out the same functions as the Virtual Machine while could while reducing memory storage demanded from the host machine. Given how Jitsi does have instructions on configuring a meeting server on Docker, it may be the next step so making a more consistent prototype of lab to use.

CONCLUSION

Based upon previous research, it is already known that a social and economic divide is further exacerbated by the difference in afford, stable internet service available in different areas. However, the current state of this research does not provide enough evidence to conclusively prove that this is the case for the Westside. Furthermore, the impact of COVID-19 has changed the state of employment statistics, demographics, and residents' priorities of the Westside Community. Until we collect more recent information, we will be unable to further progress with this study.

With the work done so far, we have formed a more solid basis on what the scope of our

project should be. We have learned of some of the key initiatives that have driven progress behind increasing the quality of life and educational opportunities of the local youth. By observing what is already in place, we have found where work still needs to be done to continue the progress, as well as possible mediums which could benefit from the implementation of a technical prototype. Furthermore, we have been able to craft a survey that has evolved to focus not just on the question of what and why community members are facing challenges in internet service, but what they feel would meet their demands and the medium that would make it easiest for them to access.

Moving forward, we can continue the project by following with the leads covered in the discussion section. Furthermore, there is much we have learned and can still learn from the success of projects in other regions, such as the Red Hook initiative in New York City and Monkey Brains in San Francisco. In addition to all mentioned above, there is the possibility of reaching out to both the initiatives to get some insight on how they collected necessary data to support their thesis and discuss what strides they have made so far. Since there are more options to hopefully carry on with the project, it may be possible to expand our breadth of knowledge of internet connectivity until face-to-face interaction becomes a more viable prospect.

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