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An investigation into the competitiveness of the telecommunications industry in New York City

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Progress Report One

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Abstract

As workplaces go fully-remote to avert the pandemic, satisfying the need for accessible, fast, and reliable Internet access has become a paramount goal for the success of modern cities, especially New York City. To achieve this goal of improved connectivity, not just during a pandemic, the Department of Information Technology & Telecommunications of New York City (DoITT) is seeking to quantify the effects that a competitive telecommunications industry can have on internet service accessibility and pricing for New Yorkers. This project seeks to find out if there is a correlation between the number of internet providers, and better accessibility and pricing of internet service. If so, the minimum number of providers needed to achieve that desired market state. We will use the latest demographic, current network coverage, and pricing data from the Census Bureau, Federal Communications Commission (FCC), New York City, and Internet Service Providers (ISPs) respectively. Geospatial and machine learning techniques will then be applied to obtain insights that can help DoITT achieve its stated goals of an optimal telecommunications market.

Introduction

The telecommunication industry plays a fundamental role in connecting individuals, businesses, and government. It is also a regulated industry. In particular, as an industry, its wired home broadband service is extremely costly for the average consumer with the result that approximately 9% of Americans lack high-speed broadband internet access in their homes (Talbot, Hessekiel, and Kehl, 2018).

The FCC defines a wired home broadband service as an “Internet access connection providing speeds of at least 25Mbps download and 3Mbps upload.” (Talbot *et al.*, 2018, p.4) Further, Talbot *et al.* (2018) argue that future investments in telecommunication networks will likely take the form of fiber networks due to their “exceptionally high capacity, versatility, and durability”. In other words, broadband refers to high-speed internet access whereas a fiber network is a facilitating transmission technology, much like digital subscriber lines (DSL), cable modems, satellites, and wireless transmitters (US Congressional Research Service, 2019).

A cellular network or mobile network is a communication network where the last link is wireless. The network is distributed over land areas called "cells", each served by at least one fixed location transceiver, but more normally, three cell sites or base transceiver stations. These base stations provide the cell with the network coverage which can be used for transmission of voice, data, and other types of content. A cell typically uses a different set of frequencies from neighbouring cells, to avoid interference and provide guaranteed service quality within each cell (Miao, Zander, Sung, and Slimane, 2016).

The Telecommunications Act of 1996 charges the FCC to “foster competition and maximize consumer benefits of broadband access.” (Government Accountability Office [GAO] as cited in Palmer, 2015, p.67). During the Obama administration, the Executive Office of the President

(2015) authored a report that argues for greater competition within urban broadband markets in order to lower prices and improve service delivery.

On the other hand, Brake and Atkinson (2019) suggest that it is not the absolute number of competitors in an urban market that matters. Increased competition as measured by the number ISPs or the Herfindahl-Hirschman Index (HHI) is neither a universal panacea nor the ideal solution. Instead, one needs to understand the individual market structure of urban broadband, mobile, and WiFi networks. Broadband networks are infrastructure with high fixed capital costs that are subject to rapid technological change. As a result, an oligopolistic market structure with a few big firms reaping efficiencies accrued from scale is the norm. Smaller companies are neither able to surmount the barriers to entry nor enjoy the economies of scale, necessitating subsidies to stay afloat.

DoITT regulates and oversees the installation of telecommunication infrastructure and service provision in the five boroughs. This suggests that firms own the infrastructure and networks. Market fragmentation among several providers can reduce the amount of revenue generated, affecting the ability of network providers to either sustain their service, or invest in the latest technology. Oligopolistic firms can be better suited to doing so.

This places the state of the telecommunications industry squarely in the public interest. Fundamentally, DoITT believes that New York City is better served through greater levels of competition between different ISPs. This is reflected in the city's Internet Master Plan (The New York City Mayor's Office of the Chief Technology Officer [NYC CTO], 2020). However, as argued above, it is not about the absolute number of providers and level of competition. Instead, it should be about "policy levers that can be used to produce superior outcomes" (FCC, 2010, p. 62). The public interest can therefore be further distilled into the following: availability of service providers in direct competition, service quality improvements over time, and price levels.

Problem Statement

For the purpose of this capstone project, DoITT has charged the team with investigating the degree of competition between ISPs. More specifically, what does competition look like on the ground? How many service providers are there within a particular spatial boundary, such as a Neighborhood Tabulation Area (NTA) or Census tract? What is the quality of the internet service provided, as measured by speed? How much are these providers charging subscribers? What is the optimal number of service providers that will result in a desirable market rate for these types of internet services?

Deliverables

DoITT, as communicated during the initial project meeting, expects the team to deliver data visualizations that illustrate the current level of internet service provision in the city. This might include the geographical disparities in service provision and competitive pressures in different

NTAs, for example, and the availability of classes of service plans. On top of the visualizations, an analysis paper outlining our findings is also required. The last deliverable will be a website to host our research, findings, and visualizations.

Data Sources and Methods

Proprietary and open data sources will be utilized in this project. Open data repositories are instrumental in providing geospatial datasets such as the degree of adoption of the Internet Master Plan at various geo-spatial scales such as NTAs, Census tracts, and Assembly Districts. At the federal level, the FCC also provides data on the degree of service provision at the Census block level through Form 477 mobile and broadband deployment data shapefile. However, the latest FCC data dates back to June 2019. The geospatial nature of these datasets require corresponding data handling methods such as joining with other datasets such as the TIGER Census block shapefile produced by the United States Census Bureau. Viewshed analysis can also be conducted to determine the effective coverage area of newly installed cellular towers. The locations of which can be gleaned from the Internet Master Plan Adoption dataset. Some of these more complex geospatial analytical techniques may well have to be performed outside of Jupyter notebooks using specialized software such as QGIS and ESRI's ArcGIS. The latter of which has been made free for all students up until August 31, 2020.

At this point of the project, the team remains in the exploratory data analysis stage. The team projects that of geospatial analytical methods will be required to visualize the spatial distribution of services. Machine learning, both supervised and unsupervised, might be utilized to identify patterns within the datasets to answer the research questions. For example, what are some of the common characteristics or predictors that can be used to predict the number of ISPs or the growth of cellular infrastructure in a given NTA? With what accuracy can this be achieved? Finally, microeconomic market-specific analysis will also be performed to determine the level of competitiveness as measured by the Herfindahl-Hirschman Index of market concentration and price-elasticity of demand.

Research Risks, Limitations, and Mitigation

A key risk in this project is the risk of data obsoletion and its attendant impact on the quality and relevance of the analyses generated. Data sources are constantly updated and reviewed. This is especially crucial because the 2020 Decennial Census is expected to result in sweeping changes in the boundaries of Census tracts, and blocks, as well as other political geographical units. As much as it is possible, our data analyses will reflect this by shifting from locally-stored data from a previous instance to updated sources that rely on Socrates API calls and the constant updating of these sources by the relevant agencies.

Another point of issue is the granularity of data with respect to ISP access within the same census block. Currently even if one building within a census block is served by a different ISP than the rest of the block, the FCC data would count two ISPs as available within the same block even though, clearly, true accessibility on the ground is different. We risk misclassifying neighborhoods as being highly competitive when in fact they may be as monopolistic as areas with one service provider. To mitigate this risk we will need to include datasets about the extent of access to other internet infrastructure, like fiber, to get a better sense of internet accessibility. But largely we will have to note that our datasets, for privacy reasons, will not be accurate in smaller areas beyond the census block.

Team Roles and Timeline

At the recommendation of the project sponsor, each member of the team was assigned a particular type of telecommunication network to look into. The team has also decided to each focus on a particular type of analytical method based on our individual competencies. The breakdown is as follows:

- Wesley Chioh: Broadband Networks with Fiber focus | Geospatial Analysis and Visualization
- Yichen Liu: Mobile Networks | Machine Learning and Econometric Analysis
- Erik Lopez: Broadband Networks | Website/Tech Tasks
- Ziyu Yan: WiFi Networks | Econometric Analysis

With this distribution of workload in mind, the team proposes the following capstone research timeline.

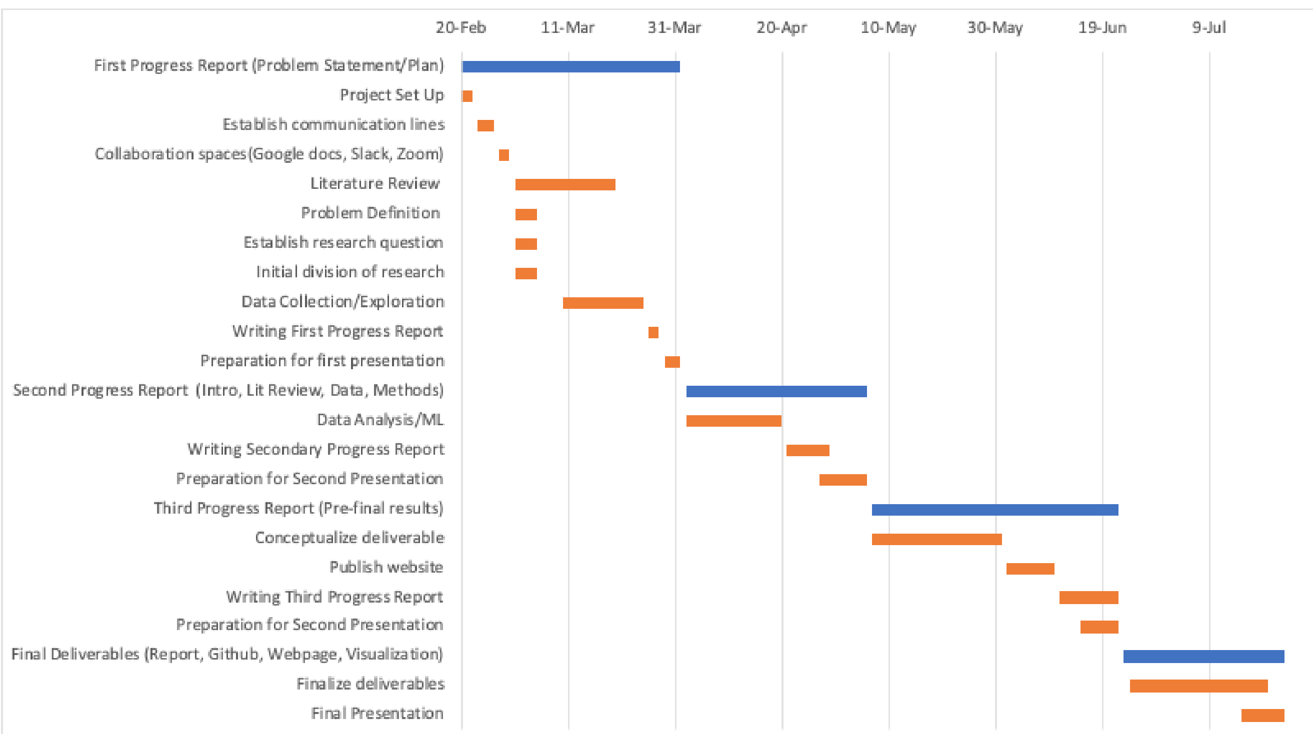

Figure 1: Gantt Chart highlighting key research milestones.

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