

Measurement based performance analysis of 3G and 4G LTE network

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Declaration

We hereby declare that the work which is being presented in the thesis entitled “Measurement based performance analysis of 3G and 4G LTE network” is submitted to Indian Institute of Information Technology Kalyani in partial fulfillment for the award of the degree of **Bachelor of Technology** in Computer Science and Engineering during the period from July, 2019 to November, 2019 under the supervision of **Dr. Dalia Nandi**, ECE Department, Indian Institute of Information Technology Kalyani, West Bengal 741235, India, does not contain any classified information.

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This is to certify that the above statement made by the candidate is correct to best of my knowledge.

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TABLE of CONTENTS

Chapters	Page
1. Chapter1: Introduction	5
2. Chapter 2: Objective and Methodology	6
2.1. Objective	
2.2. Methodology	
2.3. Linear Regression	
3. Chapter 3:Preparation of Data	7
3.1. Mobile Application Development	
3.2. CSV file	
4. Chapter 4:Data Preprocessing & Analysis	8-10
4.1. Preprocessing	
4.2. Graphs and plots	
4.3. Detailed Analysis	
5. Chapter 5: Future Goals & Aspects	12
6. Chapter 6: Conclusion	13
7. References and Bibliography	14

Aim

The aim of this project is to present a multidimensional performance analysis of mobile 3G and 4G networks of rural morphology in India. The Mobile Network performance analysis is carried out based on measurement data obtained through drive tests (DT) conducted in rural areas located in West Bengal, namely Kalyani. The measurement data pertains to the performance of three national mobile network operators (MNOs), namely Reliance Jio and Airtel, in rural areas. The Mobile Network performance measurement data was collected between October and November using modified Redmi Note 5 smartphone handsets.

Chapter 1: Introduction

The society's increased reliance on Mobile networks has led to big challenges for service providers in terms of provisioning uninterrupted coverage, providing high network performance, and achieving high user quality of experience (QoE) . These challenges are motivating the Mobile network stakeholders in the academia and industry to understand the gap between the performance of current technologies and the users' ever increasing demands and expectations. A thorough understanding of such gap helps service providers to further enhance the capabilities of their mobile networks by designing new technologies that provide new applications and services, and be able to cope with the growth in traffic volume with a wide variety of user devices.

This study aims to understand the actual user Mobile network experience in rural area of India. Having this knowledge allows relevant bodies and agencies to layout plans for sustaining or even refining the current Mobile Network services in rural area of India, especially when the mobile traffics are forecasted to increase exponentially in the near future. In addition, this can also help consumers to check the differences between 3G, 4G and 5G networks. understand the performance benefits of 4G over 3G and to identify performance differences between different mobile operator's networks. Also, this study will be able to contribute significantly to planning 5G networks efficiently. Our measurements covers one MBB service i.e web browsing through 2 distinctive platforms: Google chrome and Mozilla Firefox.

Chapter 2: Objectives and Methodology

1. Objective

The main objective of this study/project is to make a predictive model for the dimensions of mobile network which will help the users many folds. We have divided the tasks keep this objective in mind i.e data analysis and machine learning. The analysis is done in a single location i.e Kalyani, West Bengal, India. The data is being collected in real time and processed on the basis of the analysis required.

2. Methodology

Our test methodology has been designed to measure performance metrics relevant to the consumer experience of using mobile broadband. To ensure that each network was tested on an equal basis, our test processes were designed with the following assumptions and settings:

- (i) Each network was tested concurrently to ensure that environmental conditions were the same for each service operator.
- (ii) Identical handsets were used for each network.
- (iii) Undue contention was avoided by testing networks in parallel and ensuring that no concurrent tests were run on the same network.

We collected our data using a mobile application developed by us, namely a Speedtest app which can store the network speed. These two applications are selected due to the following reasons:

- (iv) The Speediest app allows customised test sets, close to the consumer experience of Mobile broadband access. These data sets are then saved locally into the test device.
- (v) The test app itself requires no modification of the handsets.
- (vi) The test apps are set to continuously run the test in cycle, which make it suitable and convenient as there is less interaction required between tester and the phones.

3. Linear Regression

Linear Regression is a linear approach to modelling the relationship between a scalar response (or dependent variable) and one or more explanatory variables(or independent variables).In

linear regression, the relationships are modelled using linear predictor functions whose unknown model parameters are estimated from the data. Linear regression was the first type of regression analysis to be studied rigorously, and to be used extensively in practical applications.^[4] This is because models which depend linearly on their unknown parameters are easier to fit than models which are non-linearly related to their parameters and because the statistical properties of the resulting estimators are easier to determine.

Chapter 3: Preparation of Data

1. Development of the mobile application

The data of different operators has been collected through a mobile application developed by us, named as SpeedTest. The basic functionality of this app is that it check the number of web cycles required to upload and download a 17MB photo through various platforms depending upon the user. Various modules such as TelephonyManager, CellInfo(Gsm/LTE), CellSignalStrength etc. For storing the history, we have used SQLite i.e the local storage of the cellphone. The application is made entirely in Java. There is an option to retrieve the data stored in local storage to a .csv file whenever required. This .csv file can be used further for analysis and predictions.

2. CSV files

a)What

A CSV is a comma-separated values file, which allows data to be saved in a tabular format. CSVs look like a garden-variety spreadsheet but with a .csv extension. CSV files can be used with most any spreadsheet program, such as Microsoft Excel or Google Spreadsheets. They differ from other spreadsheet file types because you can only have a single sheet in a file, they can not save cell, column, or row. Also, you cannot not save formulas in this format.

b) Why

These files serve a number of different business purposes. They help companies export a high volume of data to a more concentrated database, for instance.

They also serve two other primary business functions:

- CSV files are plain-text files, making them easier for the website developer to create
- Since they're plain text, they're easier to import into a spreadsheet or another storage database, regardless of the specific software you're using
- To better organise large amounts of data

Chapter 4: Data Preprocessing & Analysis

1. Preprocessing

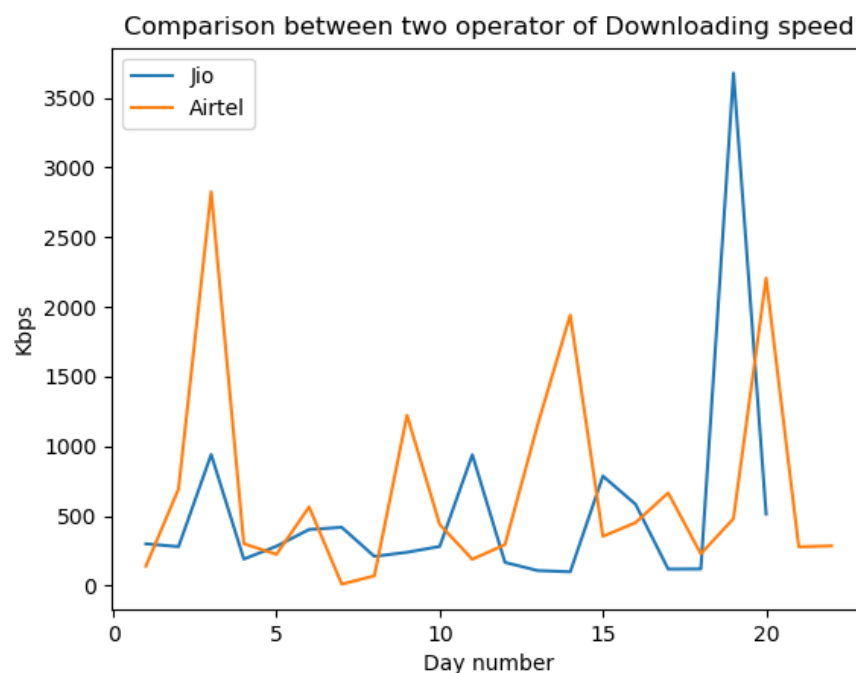
We have collected data for the whole month of October. For every 15minutes, the application wakes up and does a single web cycle i.e upload and download speed through the default web platform due to which we used two different devices of the same model. The preprocessing steps are:

- 1) Average of the intervals i.e 15mins for each day into a single value. Discarded last few days due to improper collection of values in proper intervals.
- 2) Usage of Regular Expressions to recover the values from the text of the csv files.
- 3) Separation of the files on the basis of:
 - a) Operator names
 - b) Operations performed i.e upload, download etc.
 - c) On the basis of platforms that is used to perform the operations.
 - d) On the basis of network type i.e 3G, 4G etc.

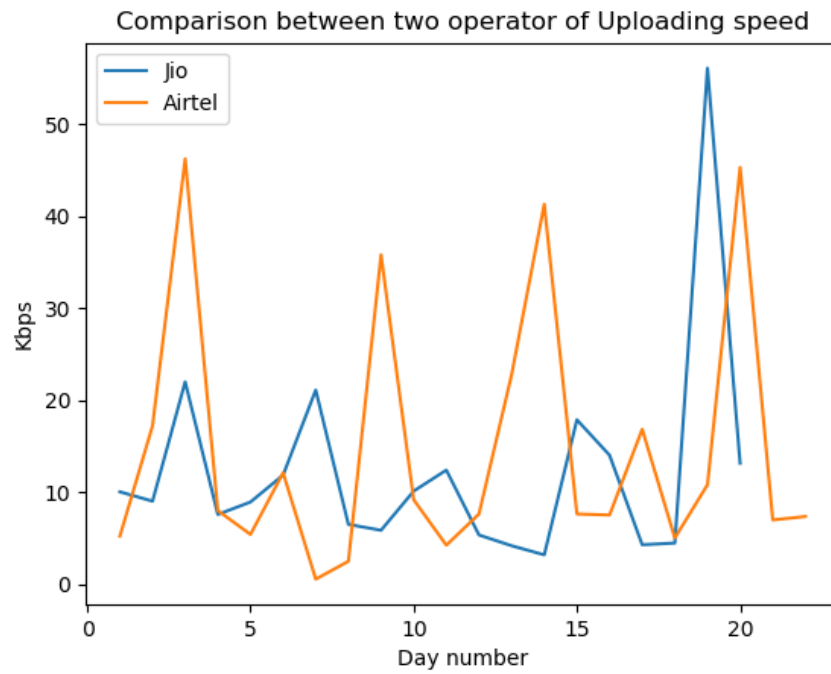
2. Analysis

Various analysis has been done throughout the process.

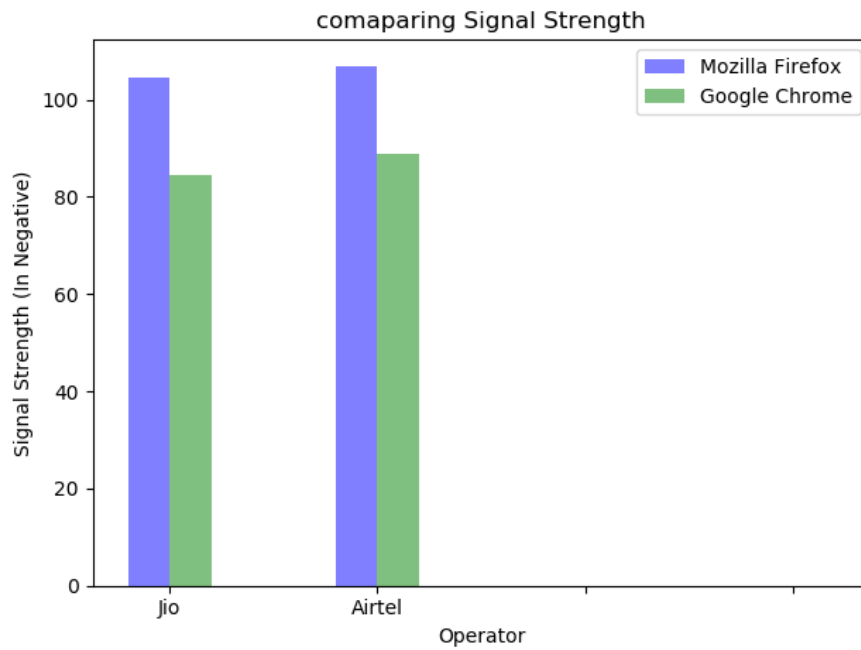
1. Comparison of download speeds in 4G between 2 operators i.e Airtel and Jio.



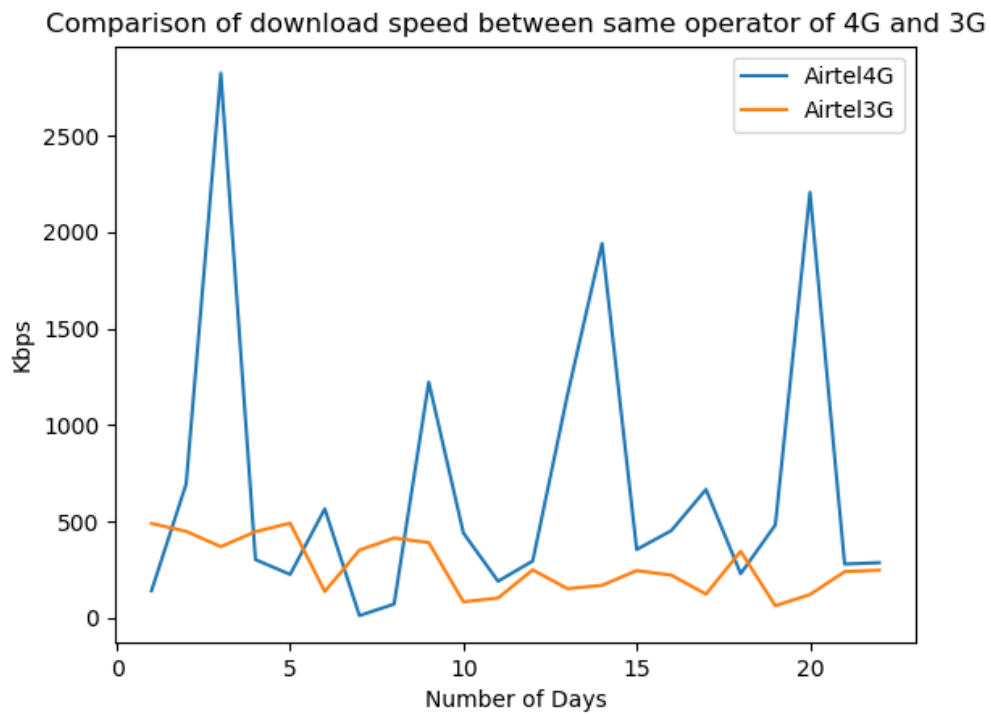
2. Comparison of upload speeds in 4G between 2 operators i.e Airtel and Jio.



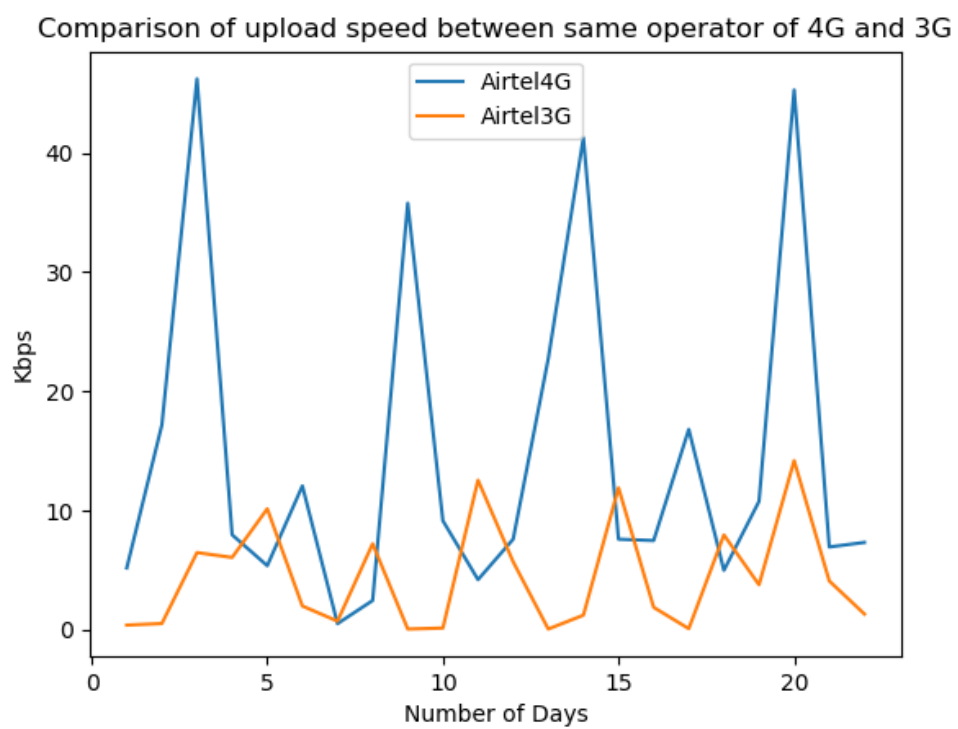
3. Comparison of Signal strengths in 2 platforms using different operators.



4. Comparison of download speeds in 3G and 4G using a single operator.



5. Comparison of upload speeds in 3G and 4G using a single operator



3. Detailed analysis

From the graphs 1 and 2:

- 1) Nothing as such can be predicted as such from the Graph 1 and Graph 2. In some days, Jio performs better than Airtel while in other days, Airtel performs better.
- 2) To get a clear picture on this, we scrapped the weather data to compare and learn more. The days in which Jio performs better are bright and sunny days i.e clear sky and no hovering of clouds and vice-versa.

From graph 3:

- 1) According to the analysis, Google Chrome performs better in both the network operators. Here it is measured in Signal strength which is measured in negative i.e less negative, better performance in number of web access cycles.
- 2) While in the graph, it can be seen that Jio is performing better altogether in average in the range of 22-25 days by which it can be inferred that Jio has better performance than Airtel in web platforms.

From Graph 4 and Graph 5:

- 1) It can be seen how 4G has evolved. It shows a way above performance than 3G. In every aspects, 4G beats 3G in terms of speed, signal strength etc.
- 2) It can be seen that for a day or two, 3G performs better than 4G. This might be an operator's issue as no other reason can be inferred from the plot.

Chapter 5: Future Goals and Aspects

The future goals are as follows:

- 1) The main goal is to make a predictive model which can predict the dimensions of the network such as speed, connectivity for the next few hours/minutes. The analysis done above will help us achieve this goal.
- 2) A notification feature will be added to the model which will notify the users about the dimensions of the network according to which the user can change his/her schedule.
- 3) Other factors relating to the consumer experience of using mobile services such as price, traffic management policies, data allowances, customer service, billing etc. can also be considered.
- 4) Analysis of mobile broadband services delivered to other devices, the performance of mobile virtual network operators (MNVOs) may be examined in future.

Chapter 6: Conclusion

The present work has been carried out to measure the mobile broadband and to produce a statistically robust dataset that treats each operator on a fair and equivalent basis. This is to compare 4G and 3G networks as a whole, and to be able to compare the performance of each network, on 3G and on 4G. The data are collected through drive a mobile application conducted in the Kalyani, West Bengal, India where two MNOs in rural morphology are selected for conducting the experiments. Measurement data are collected using a proprietary testing application, MBB explorer for web browsing services. Two metrics parameters, namely network signal strength and speed are considered in this research. Our results show that, on average, 4G networks performed much better than 3G networks throughout across all the measurement areas considered in this research. These observations were found consistent across all mobile operators. This is unsurprising because we would expect consumers to experience a noticeable improvement in using a mobile broadband service over a 4G network as compared to a 3G network.

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