Performance Modeling – EEX5362
Mini project deliverable 1

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System Description

Spotify is one of the most popular online music streaming platforms, providing users access to a vast library of songs, podcasts, and playlists. It operates on a client–server architecture. That means the Spotify mobile or desktop client interacts with cloud-based backend servers to request, stream, and manage audio content. When a user selects a song, the client sends a request to Spotify's servers, which respond by delivering the audio data in small packets that are buffered and played in real time.

The performance of Spotify's streaming experience depends on several factors, including network bandwidth, server latency, caching mechanisms, and device processing speed. High network latency or unstable connections can cause playback interruptions, longer start delays, and degraded audio quality.

This project focuses on evaluating Spotify's streaming performance from the user's perspective. The goal is to analyze how varying network types (Wi-Fi, 4G, 3G) and speeds affect playback responsiveness and buffering behavior. By collecting and analyzing playback data such as start delay, buffer count, and total buffering time, the project aims to identify performance bottlenecks and suggest strategies—such as improved pre-buffering or adaptive bitrate adjustments—to enhance the overall streaming experience.

Performance Objectives

The primary objective of this project is to evaluate and model the performance of Spotify's music streaming system from an end-user perspective under varying network conditions. The study aims to identify key factors that influence the user experience during playback and determine how performance can be optimized for smoother and more reliable streaming.

The specific performance objectives are as follows:

1. To measure and minimize playback start delay — evaluating how long it takes for audio to begin after a user presses play, under different network speeds and types.
2. To assess buffering frequency and duration — analyzing how often playback interruptions occur and how much time is lost due to buffering.
3. To determine the impact of network conditions on performance — comparing streaming behavior across Wi-Fi, 4G, and 3G networks to understand how bandwidth and stability affect playback quality.
4. To identify performance bottlenecks — investigating conditions (e.g., peak hours, slow networks) where latency or buffering significantly increases.
5. To propose possible improvements — recommending strategies such as adaptive bitrate streaming, smarter caching, or predictive buffering to enhance system responsiveness and user satisfaction.

By achieving these objectives, the project provides insights into how streaming performance varies with environmental and technical factors, helping to model Spotify's behavior as a dynamic, real-world system influenced by network and user conditions.

Data Collection Methodology

Since Spotify's backend performance data is private, this project uses client-side performance observations**.** The student manually collected measurements while streaming songs under different network conditions. For each playback test, the following data was recorded:

- Timestamp / Date – the date and time of the test.
- Song Name / Track ID – the song played during the test.
- User ID (anonymized**)** – for privacy, a unique identifier was assigned to each user.(Used different divices and Spotify accounts)
- Device Type – the device used for streaming (Android/iOS/computer like wise).
- App Version – the version of the Spotify app.
- Network Type – Wi-Fi, 4G, 3G, or other network types.
- Network Speed (Mbps) – measured using Speedtest.net while streaming.
- RTT / Ping (ms) – network latency measured via ping commands in Termux.
- ISP / Network Provider – the internet service provider used for the test.
- Region / City – location where the test was performed.
- Time of Day – Morning, Afternoon, Evening, or Night.
- Song Duration (s) – length of the song in seconds.
- Start Delay (s) – time between pressing play and audio playback starting.
- Buffer Count – number of buffering interruptions during playback.
- Total Buffer Time (s) – total duration of buffering events.
- Notes – any observations or anomalies during the test (e.g., brief network issues, app freezes).

Data was collected for 7- 10 songs across different network types and times of day. This dataset will be analyzed to identify factors influencing performance, such as network speed, latency, and time of day, and to propose potential improvements in streaming efficiency and user experience.

Git Repository for the dataset- TishaSachi/Performance-Modelling-Mini-Project