5G-MAG - A user interface for metrics and consumption reports

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***Abstract*—As media consumption continues to grow, ensuring seamless content delivery and maintaining an exceptional user experience becomes increasingly vital. The 5G-MAG Reference Tools development program supports the implementation and interoperability of 5G Media technologies through a set of common open software reference tools. This project specifically focuses on developing a web user interface to visualize Quality of Experience (QoE) Metrics Reports and Consumption Reports generated by the Media Streaming Client and sent to the Application Function within the 5G Media Streaming architecture. This report explores the project's motivation, implementation, evaluation, and conclusions, emphasizing the importance of managing QoE metrics and consumption reports in the dynamic landscape of 5G media technologies.**

***Index Terms*—5G Media Streaming, Quality of Experience (QoE), Consumption Reports, Media Streaming Client, Application Function, 5G-MAG Reference Tools, User Experience, Web User Interface, Interoperability, Media Technologies.**

I. Introduction

The advent of 5G technology signifies a substantial advancement in the field of media streaming. Boasting high bandwidth, low latency, and enhanced connectivity, 5G technology facilitates superior media experiences. The 5G Media Streaming architecture capitalizes on these attributes to deliver high-quality video and audio content with minimal delay, thereby enabling real-time streaming and interaction. This architecture includes several critical components: User Equipment (UE) equipped with a 5G Media Client, an Application Function (AF) for control and management, and an Application Server (AS) that hosts the media content. Additionally, network functions such as the Network Exposure Function (NEF) and Policy Control Function (PCF) ensure seamless policy management and resource exposure. The integration of these components within the 5G ecosystem highlights both the complexity and transformative potential of 5G Media Technologies in revolutionizing media consumption [1].

II. 5G Media Technologies

The evolution of 5G media technologies is set to redefine how media content is delivered and consumed. With unprecedented speed and reliability, 5G technology is essential for applications that require real-time data transmission, such as live video streaming, virtual reality, and augmented reality [2]. The high bandwidth of 5G networks enables the transmission of large volumes of data at significantly higher speeds compared to previous generations of mobile networks. Additionally, the low latency of 5G ensures minimal delay, which is crucial for interactive applications and high-quality media streaming [1].

A key component of 5G media technology is the 5G Media Streaming architecture, designed to optimize media delivery over 5G networks. This architecture includes:

- **User Equipment (UE)**: Houses a 5G Media Client responsible for handling media streams.
- **Application Function (AF)**: Provides control and management functionalities, ensuring efficient and effective media content delivery.
- **Application Server (AS)**: Hosts the media content and interacts directly with the UE for content delivery.
- **Network Functions**: Includes the Network Exposure Function (NEF) and Policy Control Function (PCF), which play vital roles in policy management and resource allocation, ensuring the network meets the demands of high-quality media streaming.

The 5G-MAG Reference Tools program is an initiative focused on developing open software tools to support the implementation and interoperability of 5G media technologies. Coordinated by Fraunhofer FOKUS, the program aims to create reference tools that adhere to the standards set by the 3rd Generation Partnership Project (3GPP) for 5G media streaming. These tools are designed to facilitate the deployment of 5G media technologies by providing a common framework that developers and service providers can use to build and integrate their solutions [3].

III. 5G-MAG: A User Interface for Metrics and Consumption Reports Use Case

The 5G-MAG Reference Tools program addresses the need for robust solutions to manage and visualize Quality of Experience (QoE) metrics and consumption reports within the 5G media streaming architecture. The primary goal of this project is to develop a web user interface that effectively visualizes these metrics and reports. This interface aims to enhance the understanding of user behavior and network performance, facilitating the delivery of superior media experiences over 5G networks.

[1] 5G Media Action Group, "5G-MAG Reference Tools," https://www.5g-mag.com/reference-tools, accessed: 2024.07.27

To address these challenges, we propose the development of the 5G-MAG user interface, designed to manage QoE metrics and consumption reports effectively within the 5G Media Streaming framework. Our approach involves creating a web-based interface using HTML, CSS, and JavaScript, ensuring accessibility, ease of implementation, and flexibility for customization.

The web user interface developed in this project serves as a comprehensive visualization tool for QoE metrics and consumption reports. It provides users with a detailed view of streaming performance, helping them identify patterns and issues that may affect the user experience. By offering interactive charts and real-time data visualization, the interface allows users to explore specific metrics and gain actionable insights. Our proposed solution focuses on three main points:

- **Dashboard Interface**: We are creating an easily accessible interface that visualizes QoE metrics and consumption reports, enabling users to monitor and analyze key metrics related to media content delivered over 5G networks.
- **Actionable Insights**: This dashboard will provide users with insights into streaming performance through interactive charts, featuring functionalities such as zooming in and out of the displayed data.
- **Data Sharing**: Users will also have the capability to download and share the visualization of reports with third parties if needed.

By developing this web user interface, the project aims to offer a powerful tool that enhances the management and visualization of QoE metrics and consumption reports, ultimately contributing to better media experiences over 5G networks.

IV. Implementation Details

A. Understanding the 5G Media Streaming Architecture

Our initial step involved an in-depth study of the 5G Media Streaming architecture. We focused on understanding the roles and interactions of the User Equipment (UE), Application Function (AF), Application Server (AS), and network functions such as the Network Exposure Function (NEF) and Policy Control Function (PCF). This foundational knowledge was essential for developing a user interface capable of accurately visualizing the metrics and reports generated within this architecture (see Figure 1).

B. Setting up the project

To create a robust web interface for visualizing Quality of Experience (QoE) metrics and consumption reports within the 5G media streaming architecture, we opted to use Next.js for our project implementation. Next.js was chosen due to its efficiency in handling fast implementations and its seamless integration with React. The framework's ability to render both on the server and client side enhances performance and SEO, which is crucial for delivering a responsive and accessible user experience. Our fully functional Next.js application is currently deployed and accessible via the provided link,

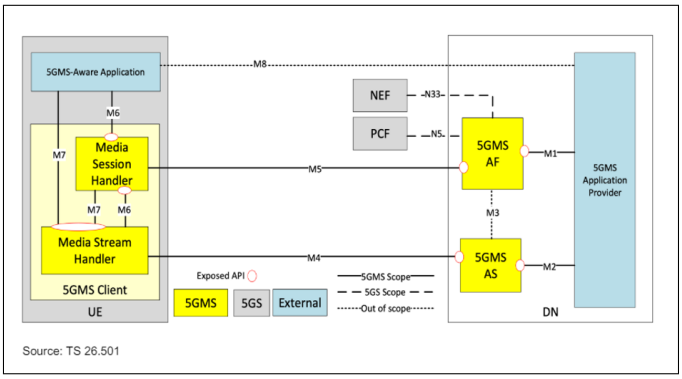

Fig. 1. 5G Media Streaming Architecture

demonstrating its reliability and performance in a real-world environment [2].

React.js, the foundation upon which Next.js is built, was another pivotal choice for our project. React's component-based architecture allows for reusable and maintainable code, which is essential for the dynamic nature of our web interface. This structure facilitates the development of interactive and responsive user interfaces, making it ideal for our needs. The combination of Next.js and React.js provides a powerful toolkit for building modern web applications, enabling us to efficiently manage state and props within our components, ensuring a smooth user experience as users interact with the interface [3].

To visualize the QoE metrics and consumption reports, we integrated the ApexCharts library into our application. ApexCharts was selected for its comprehensive documentation and ease of integration with React, allowing us to create interactive and visually appealing charts. The library supports a wide range of chart types and provides advanced features such as zooming, panning, and real-time updates, which are crucial for analyzing streaming performance data. By utilizing ApexCharts, we were able to display the JSON data graphically, offering users actionable insights into streaming performance through an intuitive and interactive dashboard [4].

Initially, to ensure our application could handle real data seamlessly, we populated it with mock data in JSON format. This mock data was served using an Express mock server, provided by our mentor, which allowed us to simulate real-world data scenarios and verify the functionality of our interface. This approach enabled us to design and test the full application, ensuring that all features were operational and ready for deployment. The mock data setup not only facilitated thorough testing but also provided a clear framework for integrating actual data streams, ensuring the system's robustness and scalability.

[2]Vercel, "Next.js - The React Framework for Production," https://nextjs.org/docs, accessed: 2023.07.27.

[3]Meta, "React - A JavaScript library for building user interfaces," https://reactjs.org/, accessed: 2023.07.27.

[4]ApexCharts - "Modern Interactive Open-source Charts," https://apexcharts.com/docs/react-charts/, accessed: 2023.07.27.

C. Application Architecture

1) Home Page: The home screen of our 5G Media Streaming Dashboard provides a user-friendly interface that summarizes the core functionalities of the application. It prominently features four main sections:

- **QoE Metrics**: View Quality of Experience (QoE) metrics to understand the performance and quality of media streaming.
- **Consumption Reports**: Analyze consumption reports to gain insights into user engagement and media consumption patterns.
- **M8 Information**: Access M8 information connected to our mock Express server for detailed service data.
- **Service Access Information**: Get detailed service access information provided by our mock Express server for deeper analysis.

Each section is designed to guide users towards specific data visualizations and insights. This layout ensures that users can easily navigate and access crucial information regarding the performance and consumption of media content over 5G networks, with a clear emphasis on data visualization and actionable insights.(see Figure 2).

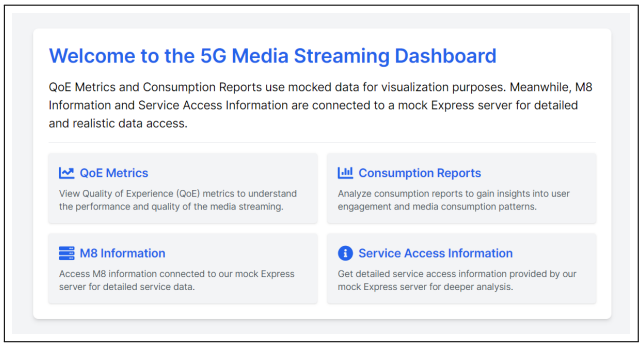

Fig. 2. Home Page

2) QoE Reports Page: The QoE Reports page of our 5G Media Streaming Dashboard provides an intuitive interface for visualizing various Quality of Experience (QoE) metrics. This page features three main charts: QoE Over Time, Latency Over Time, and Bitrate Over Time, which display important performance indicators of the media streaming experience.

Users have the option to select different data sources via a dropdown filter. This allows for flexibility in analyzing various datasets and understanding the impact of different data sources on streaming quality. Additionally, users can combine data sources based on the timestamp to correlate and compare metrics from different time periods or sources, enabling a comprehensive analysis of the streaming performance.

Each chart on this page is interactive, offering functionalities such as zooming and panning to explore the data in detail. For example, the QoE Over Time chart visualizes buffering duration and playback quality, the Latency Over Time chart shows latency trends, and the Bitrate Over Time chart displays video and audio bitrates over time. This rich set of features empowers users to gain actionable insights and identify patterns that affect the user experience (see Figure 3).

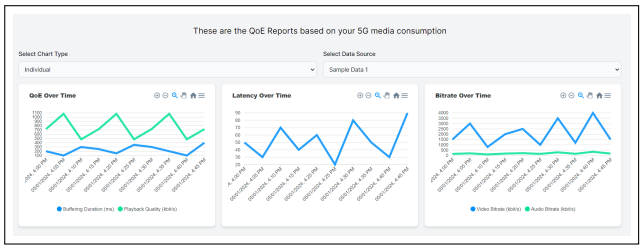

Fig. 3. QoE Reports Page

3) Consumption Reports Page: The Consumption Reports page of our 5G Media Streaming Dashboard provides a comprehensive view of user interaction with media content. This page features three main charts: Interaction Count Per Content, User Engagement Over Time, and Viewing Duration per Content. These charts offer detailed insights into how users interact with media content, their engagement levels over time, and the duration of content viewing.

Users can filter the data by selecting different data sources through a dropdown menu. This functionality allows for flexible analysis of various datasets, facilitating a deeper understanding of user behavior across different data sources. Additionally, users have the capability to combine data sources based on the timestamp, enabling the correlation and comparison of metrics from different time periods or sources, which aids in a more holistic analysis of media consumption patterns.

The charts on this page are interactive, providing features such as zooming and panning for detailed data exploration. The Interaction Count Per Content chart displays the frequency of interactions with different content pieces, the User Engagement Over Time chart shows engagement trends, and the Viewing Duration per Content chart visualizes how long each content piece was viewed. This interactive and detailed presentation empowers users to identify trends and patterns in media consumption, driving better decision-making for content delivery strategies (see Figure 4).

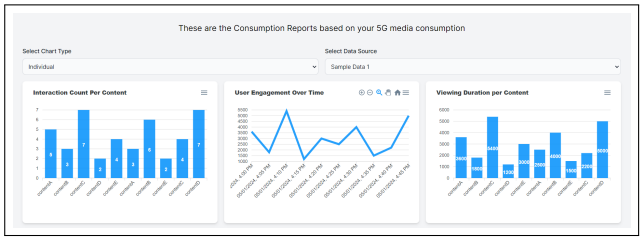

Fig. 4. Consumption Reports Page

4) M8 Information Page: The M8 Information page of our 5G Media Streaming Dashboard provides detailed service data collected in JSON format by the Express mock server. This page displays a list of services, each associated with a session ID, allowing users to view specific details for each service.

This layout ensures that users can easily access detailed information about each service, facilitating a deeper under-

standing of the data collected and its relevance to the overall media streaming performance. The JSON format data collected by the Express mock server provides a structured and efficient way to manage and display these details (see Figure 5).

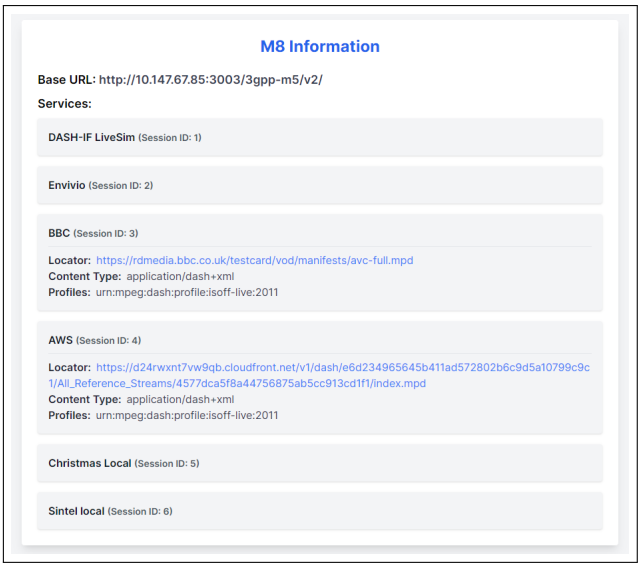

Fig. 5. M8 Information Page

5) Service Access Information Page: The Service Access Information page of our 5G Media Streaming Dashboard provides comprehensive details about provisioning sessions, streaming access, and client reporting configurations. This data is collected in JSON format by the Express mock server, ensuring structured and efficient data management.

This layout ensures that users can easily access and understand detailed information about each provisioning session and reporting configuration. The use of JSON format for data collection by the Express mock server provides a consistent and reliable method for managing these details (see Figure 6).

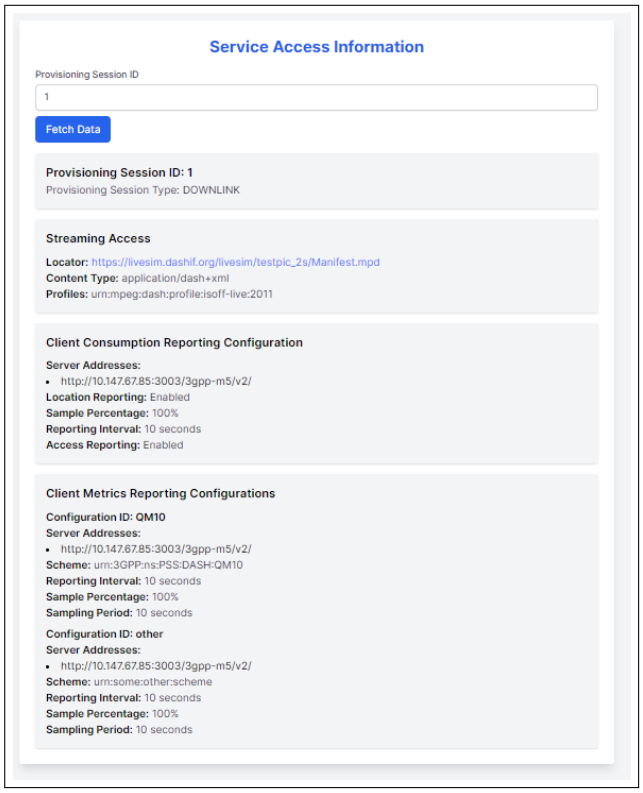

Fig. 6. Service Access Information Page

V. Evaluation of Current Implementation

The current implementation of the 5G Media Streaming Dashboard has been evaluated based on several key criteria: functionality, performance, usability, and scalability. This section presents an analysis of these aspects, highlighting the strengths and areas for improvement in our implementation.

A. Functionality

The dashboard successfully integrates and visualizes QoE metrics, consumption reports, M8 information, and service access information. The use of interactive charts and real-time data visualization allows users to gain actionable insights into media streaming performance. The ability to filter and combine data sources based on timestamps enhances the analytical capabilities of the dashboard, providing a comprehensive view of the data.

B. Performance

The performance of the dashboard has been evaluated under various conditions to ensure its reliability and responsiveness. The use of Next.js and React.js has proven effective in delivering a fast and efficient user experience. The charts rendered using ApexCharts load quickly and interact smoothly, even with large datasets. However, continuous monitoring and optimization are required to maintain performance as the volume of data and number of concurrent users increase.

C. Usability

User feedback indicates that the dashboard is intuitive and easy to navigate. The clear layout and interactive elements help users quickly access the information they need. The inclusion of detailed service information and configurable reporting settings adds to the usability, making the dashboard a valuable tool for network administrators and service providers. Future iterations could benefit from additional user testing to further refine the user interface and address any usability issues.

D. Scalability

The current implementation demonstrates good scalability, with the ability to handle multiple data sources and large volumes of streaming data. The use of an Express mock server for data collection and JSON format for data management ensures that the system can be easily extended to accommodate additional services and metrics. However, as the system scales,

it will be important to implement more robust data management and storage solutions to handle the increased load.

E. Areas for Improvement

While the current implementation meets many of its objectives, there are several areas where improvements could be made:

- **Enhanced Data Integration**: Integrating live data sources and providing more real-time data updates would increase the dashboard's value.
- **Advanced Analytics**: Incorporating advanced analytics and machine learning algorithms could provide deeper insights and predictive analytics.
- **User Customization**: Allowing users to customize the dashboard layout and select specific metrics to display could improve usability and relevance.
- **Security**: Implementing robust security measures to protect data and ensure privacy is crucial as the system handles more sensitive information.

Overall, the current implementation of the 5G Media Streaming Dashboard is a strong foundation for managing and visualizing QoE metrics, consumption reports, and service information. By addressing the identified areas for improvement, the system can be further enhanced to meet the evolving needs of media streaming services in the 5G era.

VI. Future Work and Potential Improvements

As we look to the future, several enhancements and expansions are planned for the 5G Media Streaming Dashboard to further increase its utility and performance. Key areas of focus include:

A. Reading from XML Reports

Currently, the system handles data in JSON format. One significant improvement would be to enable the reading and processing of XML reports. This enhancement would involve setting up an end-to-end connection with the server, as outlined in the tutorial available at https://5g-mag.github.io/Getting-Started/pages/5g-media-streaming/tutorials/end-to-end.html. This will allow the dashboard to support a broader range of data formats and provide more comprehensive insights.

B. Live Data Integration

Integrating live data sources to provide real-time updates will be a crucial step in improving the dashboard's effectiveness. This will ensure that users have access to the most current information, enabling more timely and informed decision-making.

C. Advanced Analytics and Machine Learning

Incorporating advanced analytics and machine learning algorithms can offer deeper insights and predictive analytics. These capabilities will help in identifying trends, forecasting future performance, and making data-driven decisions to optimize media streaming quality.

D. User Customization and Interface Enhancements

Allowing users to customize the dashboard layout and select specific metrics to display will improve the user experience and relevance of the data presented. Additional user testing and feedback will be essential in guiding these enhancements.

E. Scalability and Data Management

As the system scales, implementing more robust data management and storage solutions will be necessary to handle increased loads. This includes optimizing database performance, improving data retrieval times, and ensuring data integrity.

F. Security Enhancements

Enhancing the security measures to protect data and ensure privacy is vital as the dashboard handles more sensitive information. This includes implementing encryption, access controls, and regular security audits to safeguard user data.

By addressing these areas, the 5G Media Streaming Dashboard can continue to evolve and provide even greater value to its users, supporting the growing demands of media consumers and ensuring the seamless delivery of high-quality content.

VII. Conclusion

Our project effectively addresses the challenges associated with managing QoE metrics and consumption reports within the 5G media streaming architecture. By developing a user-friendly web interface, we have provided a robust solution that enhances the understanding of user behavior and network performance. This project highlights the importance of effective data management and visualization in the evolving landscape of 5G media technologies, paving the way for future innovations in media streaming.

The development and deployment of this interface demonstrate the significant potential of open software tools in supporting the implementation and interoperability of 5G media technologies. As we move forward, continued advancements in these tools and standards will be crucial in meeting the growing demands of media consumers and ensuring the seamless delivery of high-quality content.

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