

NOC/CSOC: Real-Time Video Stream Monitoring System for Network and Cybersecurity Operations

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Problem Statement

Web application that enables the user to configurable the Dispaly consisting of multiple video streams. Faciliates video stream multiplexing and other options to enable monitoring for Network Operations Center and Cybersecurity Operations Center.

Project Objective

- Develop a secure, scalable, and modular video stream monitoring system.
- Stream video using HTTP Live Streaming (HLS) with FFmpeg and Node-Media-Server.
- Implement real-time analytics visualization with Elasticsearch, Kibana and Grafana.
- Enable role-based authentication and control through JWT.

INTRODUCTION

- The proposed system offers real-time video monitoring through browser-based dashboards.
- Uses technologies to ingest, convert, and stream RTMP feeds as HLS-compatible streams.
- Designed to cater to the operational needs of security control room and modular integration.

SYSTEM ARCHITECTURE OVERVIEW

- **Backend:** Handles streaming, authentication, analytics collection.
- **Frontend:** Role-based dashboards with 6-frame video displays.
- **External Tools:** Analytics and visualization with FFmpeg, Elasticsearch, Kibana and Grafana.

Backend Architecture

- Server: Node.js + Express
- Streaming Pipeline:
 - RTMP ingestion using Node-Media-Server
 - FFmpeg transcodes it into HLS
- Authentication Layer:
 - JSON Web Tokens for session control
 - Passwords securely hashed with bcrypt
- Analytics Integration:
 - FFprobe collects stream metrics
 - Elasticsearch stores the metrics

Frontend Architecture

- Built with HTML, CSS, JavaScript
- Admin Dashboard:
 - 6 video frames representing different zones
 - Timeline for simulated playback
 - Interface for approving new clients
- Client Dashboard:
 - Read-only access post approval
 - Video streaming using HLS.js

External Integrations

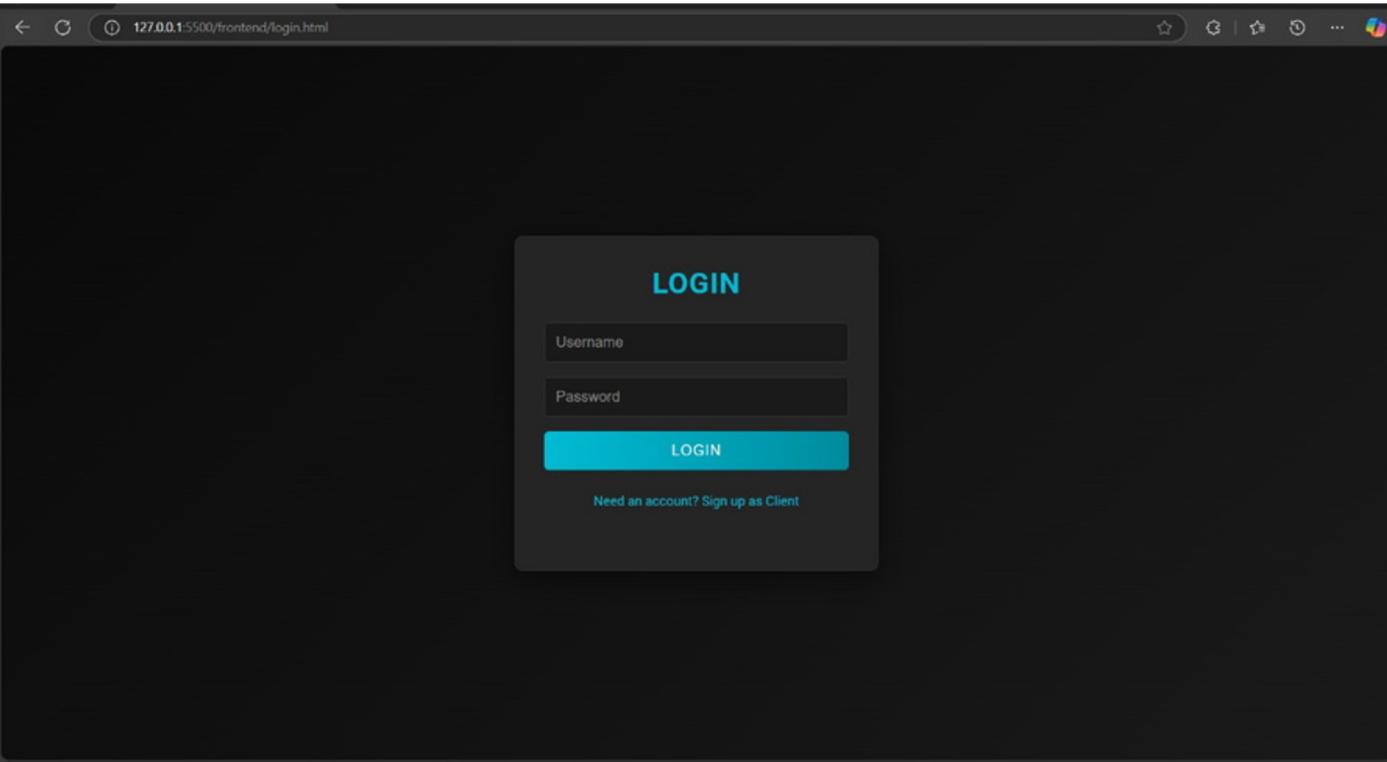
- FFmpeg: Converts live RTMP into browser-playable HLS.
- Elasticsearch: Collects and indexes metrics like FPS, bitrate, etc.
- Kibana & Grafana: Real-time analytics dashboards.
- Explored Integrations:
 - Firebase, Splunk, WebRTC (not finalized due to complexity/incompatibility)

IMPLEMENTATION DETAILS

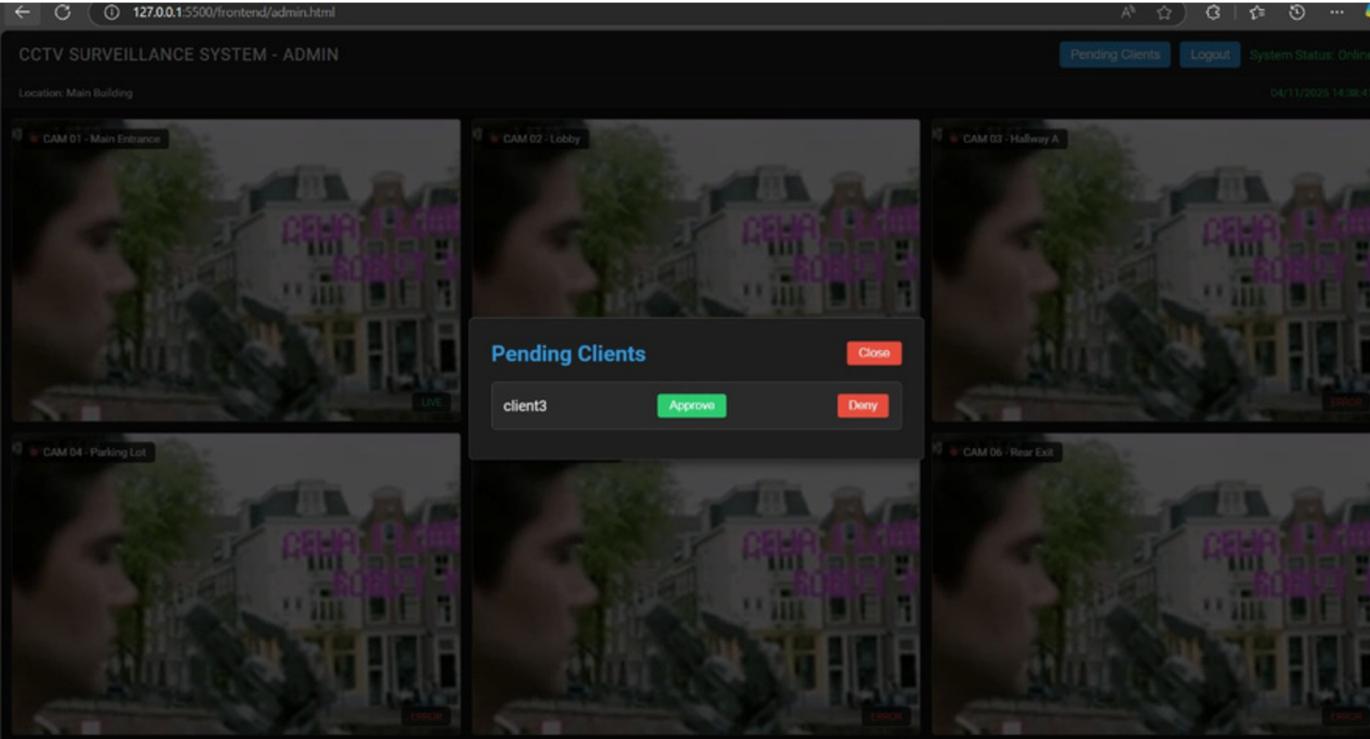
- Video streams are accessed via the browser using HLS.js.
- System periodically records frame rate, latency, bitrate into Elasticsearch.
- Dashboards offer live status visibility.

Web Application

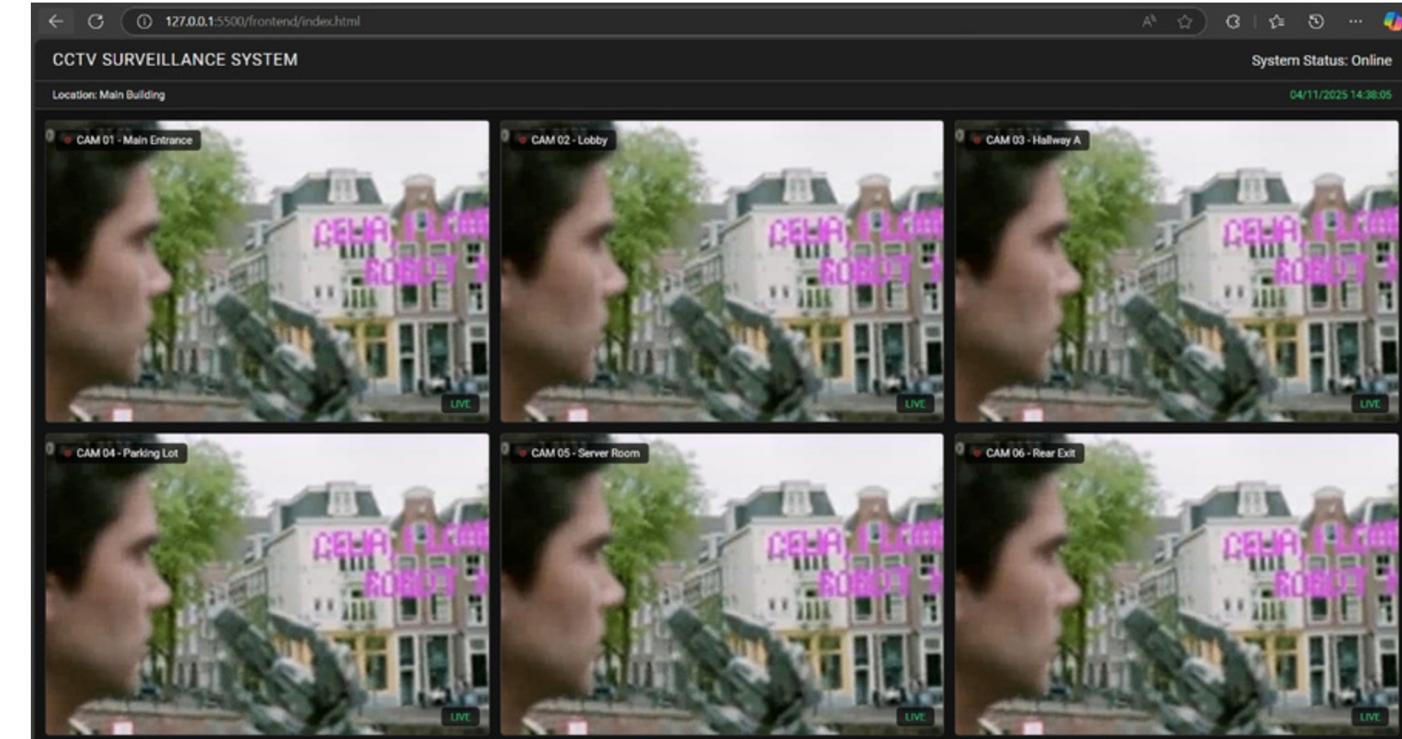
Login



Admin

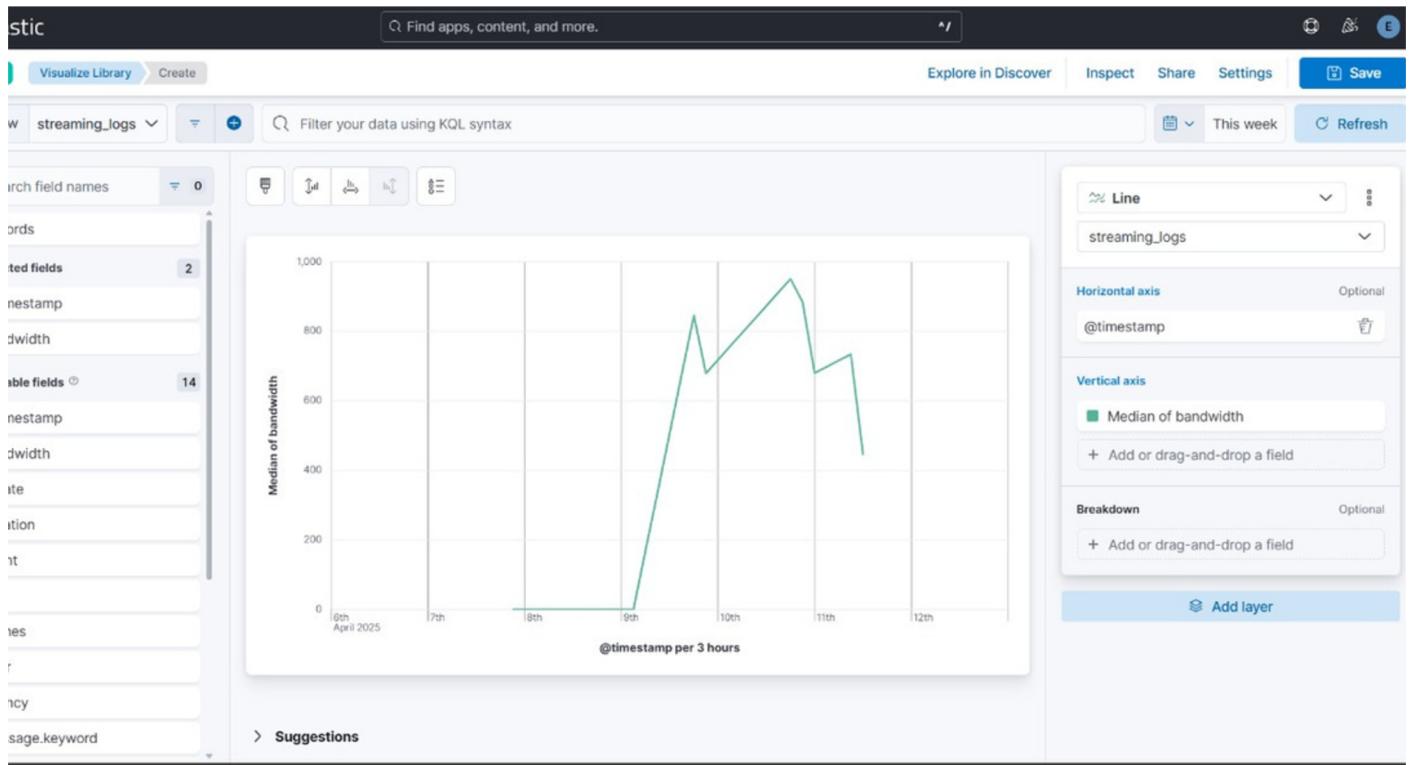


Client

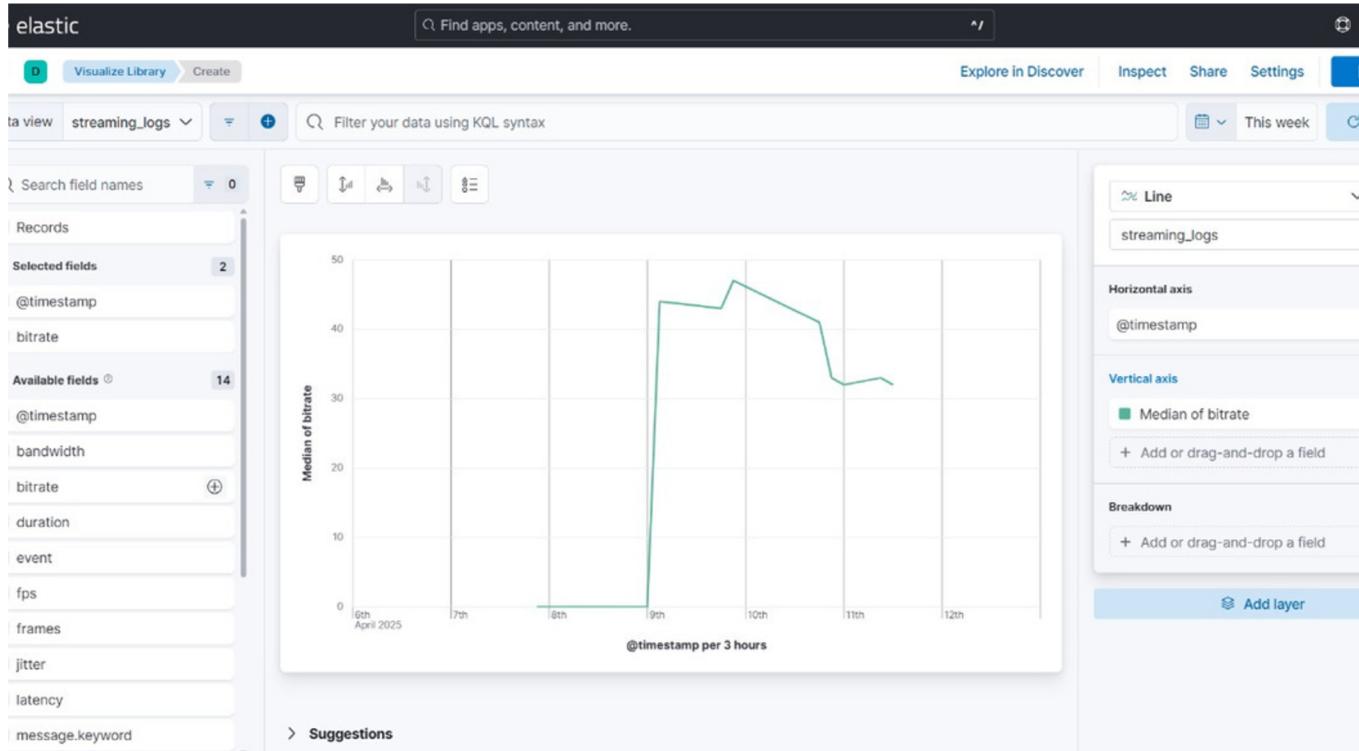


Kibana Dashboard

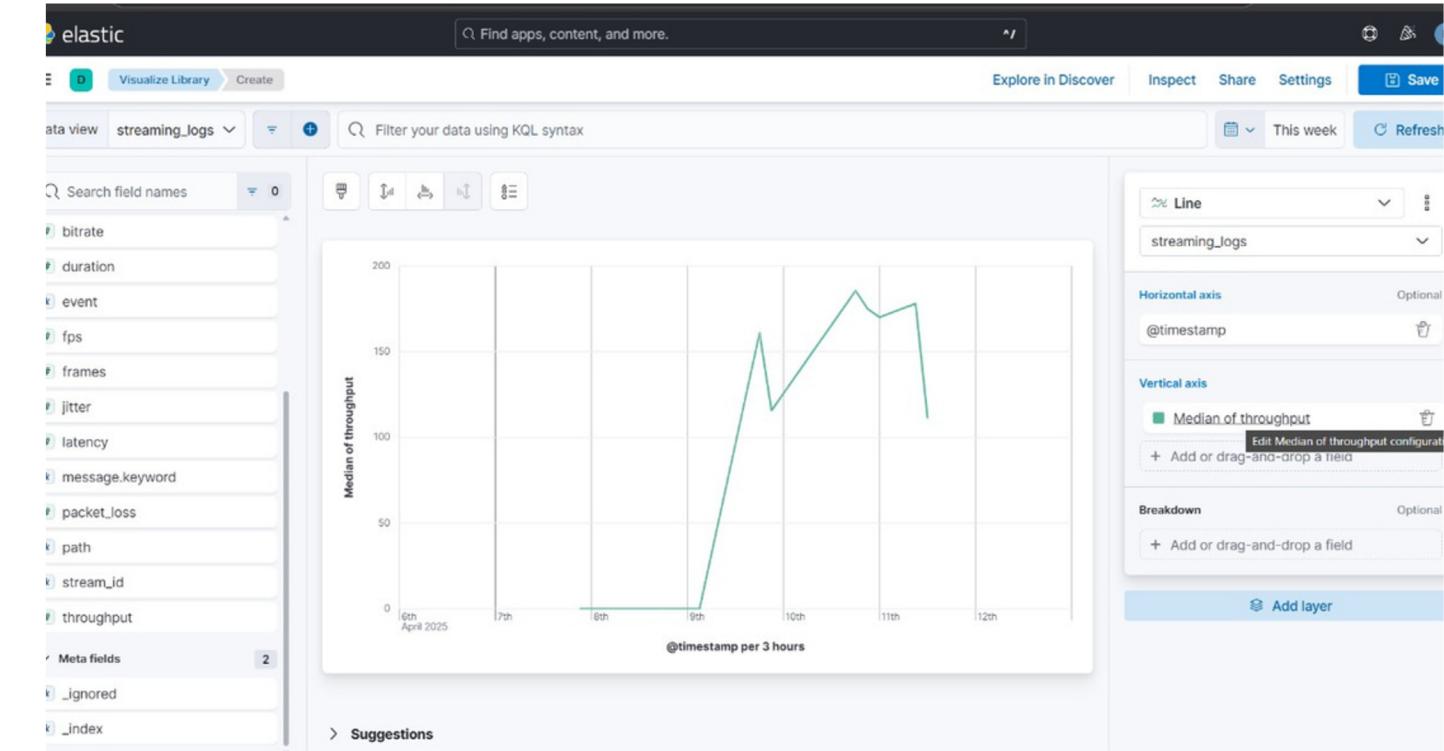
Bandwidth



Bitrate

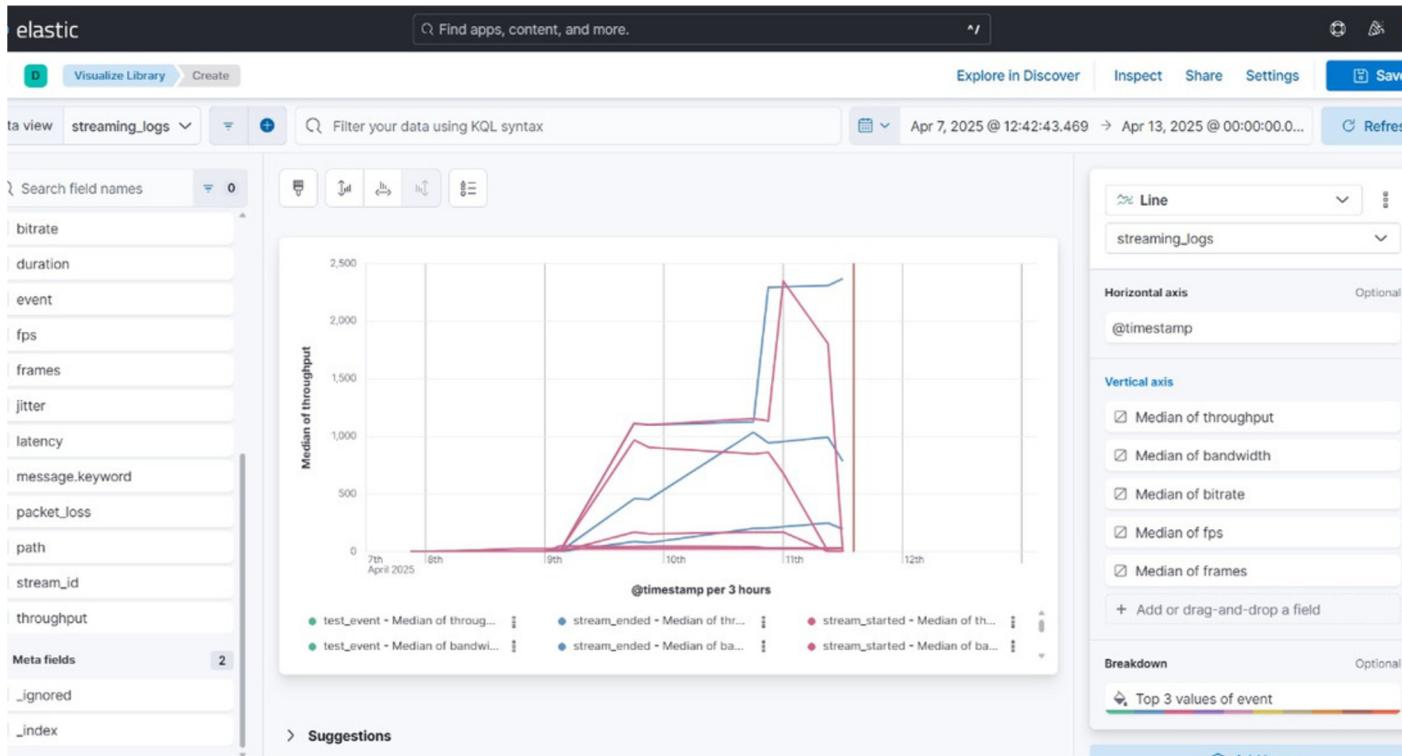
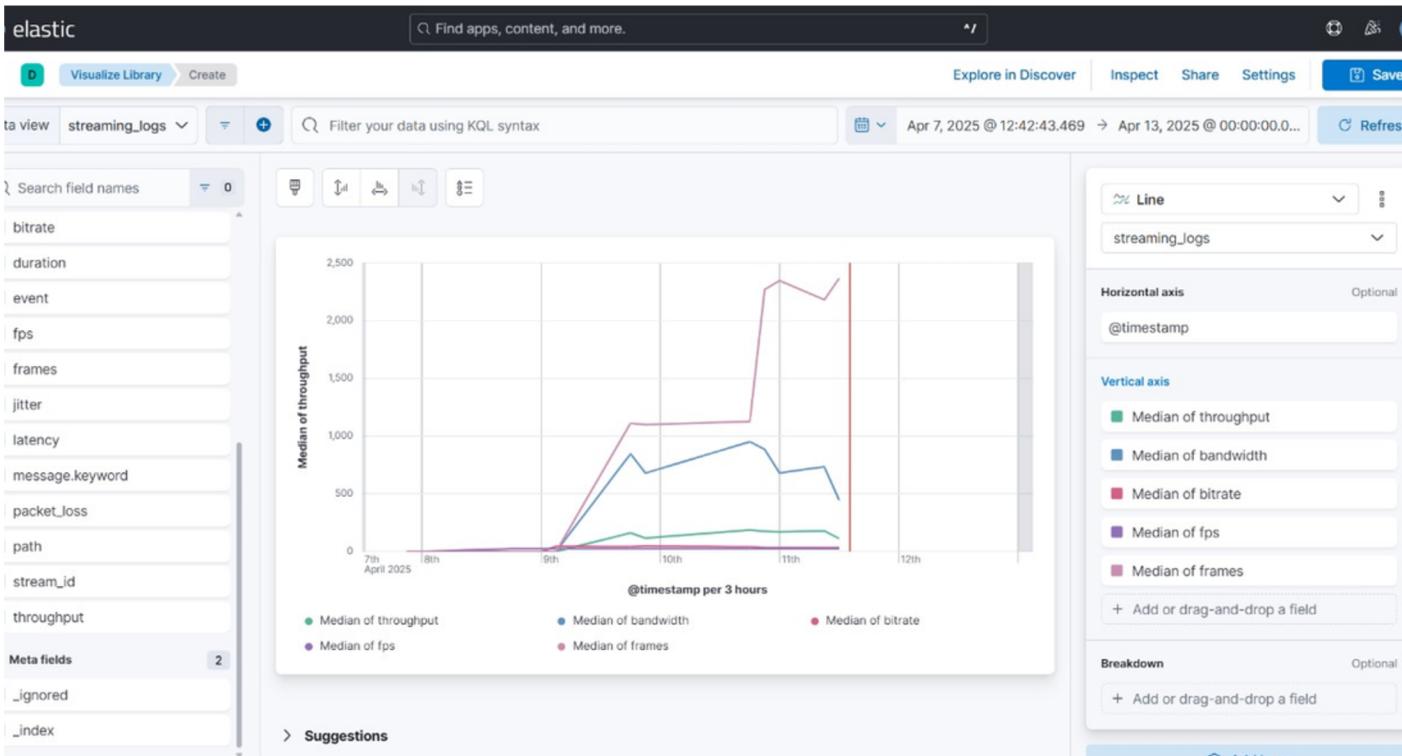
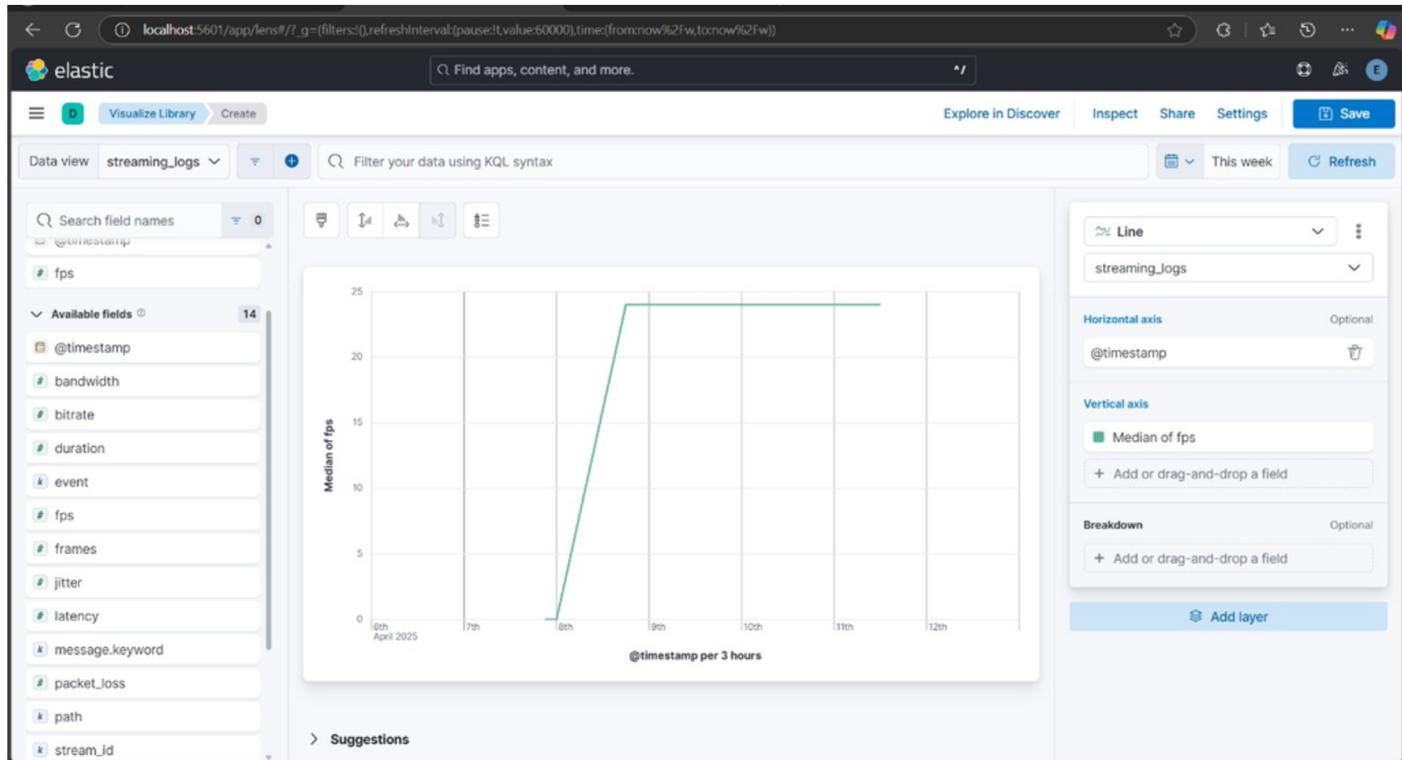
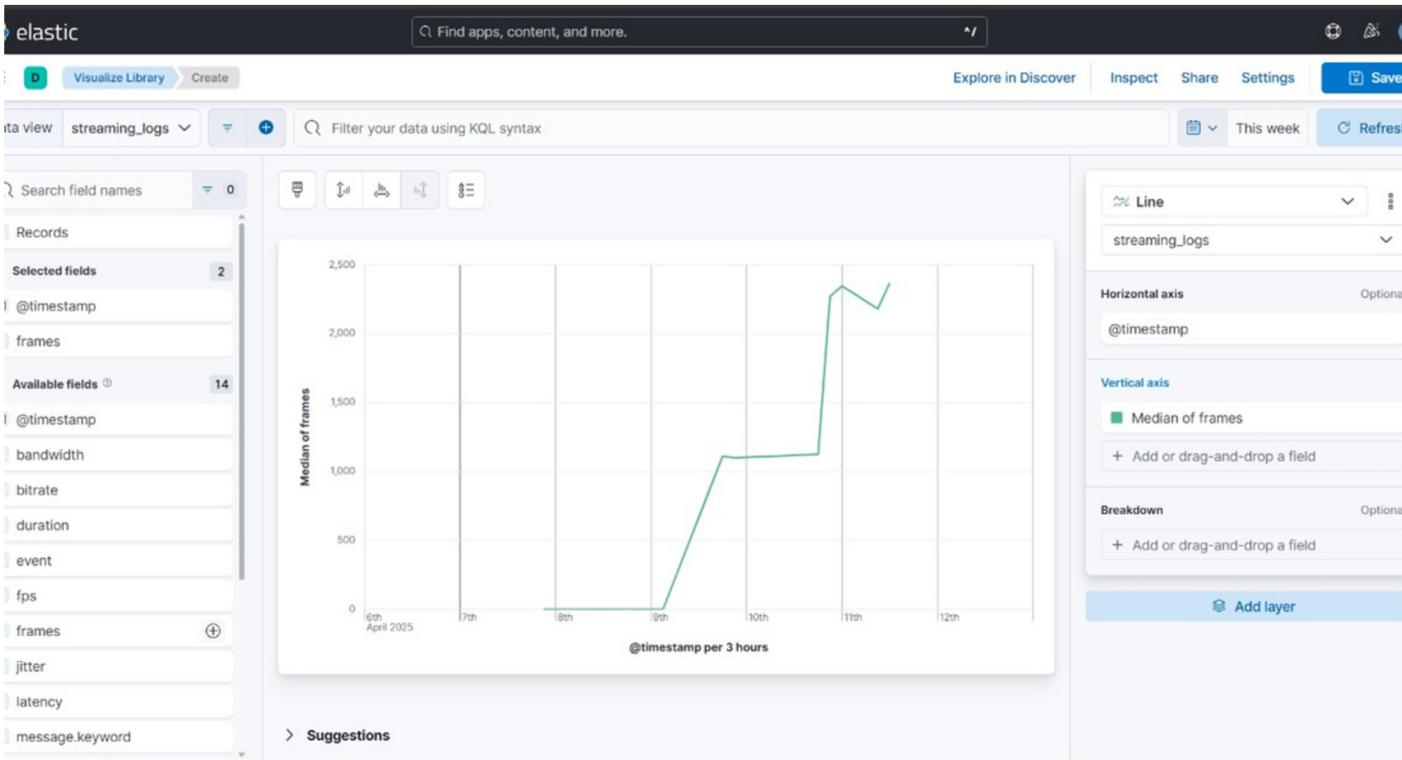


Throughput



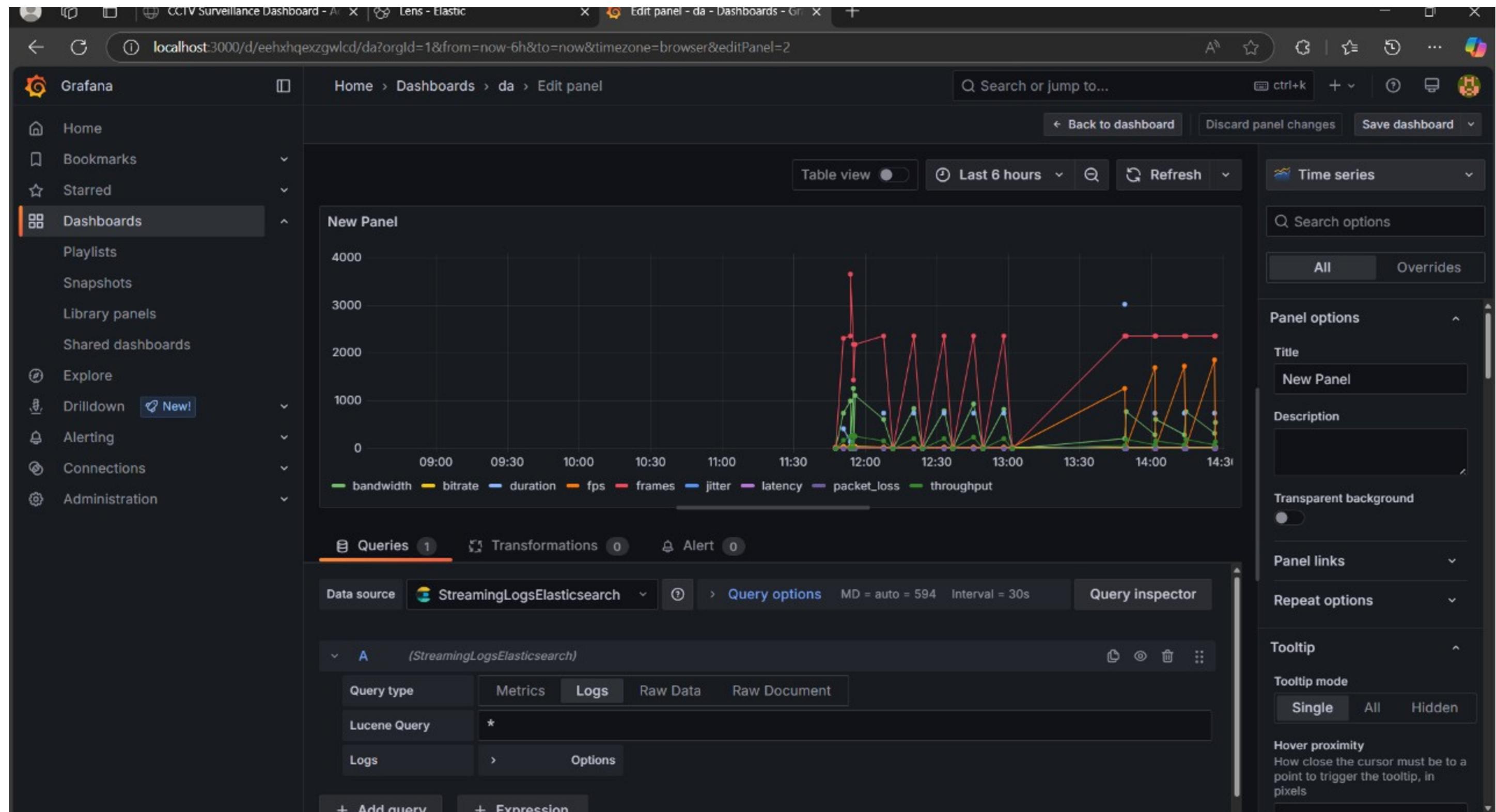
Kibana Dashboard

Frames



FPS

Grafana Dashboard



JWT Dashboard

```
or: /live/stream/index937.ts, Static path: E:\IITGN\practise\NOC-CSOC\backend\me
or: /approve-client, Static path: E:\IITGN\practise\NOC-CSOC\backend\media\live
or: /pending-clients, Static path: E:\IITGN\practise\NOC-CSOC\backend\media\live
or: /login, Static path: E:\IITGN\practise\NOC-CSOC\backend\media\live
empt: { username: 'client4', password: '118736' }
cessful, token generated for: client4
or: /live/stream/index.m3u8, Static path: E:\IITGN\practise\NOC-CSOC\backend\me
or: /live/stream/index934.ts, Static path: E:\IITGN\practise\NOC-CSOC\backend\me
or: /live/stream/index.m3u8, Static path: E:\IITGN\practise\NOC-CSOC\backend\me
or: /live/stream/index934.ts, Static path: E:\IITGN\practise\NOC-CSOC\backend\me
```

CHALLENGES AND ATTEMPTED INTEGRATIONS

- **Firebase Authentication:** Introduced latency, prompting a shift to JWT.
- **Multi-Stream Support:** Limited to a single stream due to NMS configuration issues and high processing power.
- **Threat Detection:** A machine learning model for crowd counting was tested but not deployed due to performance constraints.
- **WebRTC and MediaSoup:** Explored for low-latency streaming but incompatible with the HLS setup.
- **Splunk:** Attempted for advanced analytics but not completed due to setup complexities.
- **Stream Recording:** Hindered by storage limitations

FUTURE WORK

- Enable unique streams for each video frame.
- Integrate optimized threat detection models (e.g., YOLOv5).
- Add support for stream recording with archival storage.
- Explore WebRTC as a low-latency alternative.
- Finalize Splunk integration for broader observability.

Conclusion

- NOC/CSOC is a reliable and scalable base for operational surveillance.
- Real-time stream monitoring, secure access, and analytics are successfully implemented.
- Future improvements will elevate the system to real-world production-level readiness.

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