LAN Collaboration Suite Architecture for Secure Local Networks

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Abstract—This paper presents the architecture of a standalone, server-based LAN collaboration suite designed for secure, offline, multi-user communication. The system supports real-time audio, video, chat, file transfer, and screen sharing over both TCP and UDP protocols, using a hub-and-spoke model optimized for low latency and resilience.

I. INTRODUCTION

The proposed LAN Collaboration Suite is engineered to function entirely within a Local Area Network (LAN) without reliance on external internet connectivity. A centralized server manages client connections, media relaying, data synchronization, and health diagnostics. Each client runs an embedded Python runtime along with a browser-based UI, providing seamless interaction through local WebSockets and HTTP.

II. SYSTEM OVERVIEW

The system adopts a client-server architecture where clients connect to a centralized coordination server that handles all services including presence, control messages, and media streaming.
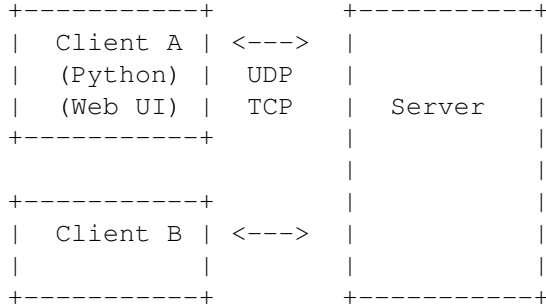
```
+-----------+             +-----------+
| Client A  | <--->       |           |
| (Python)  |  UDP        |           |
| (Web UI)  |  TCP        |  Server   |
+-----------+             |           |
                          |           |
+-----------+             |           |
| Client B  | <--->       |           |
|           |             |           |
+-----------+             +-----------+
```

Fig. 1. Hub-and-Spoke LAN Architecture

III. COMMUNICATION CHANNELS

Table **??** summarizes the protocols and transports used.

IV. CORE MODULES

A. Session Core

Manages client authentication, presence tracking, heartbeat monitoring, and graceful shutdown control.

TABLE I
COMMUNICATION CHANNEL OVERVIEW

Feature	Transport	Direction	Notes
Audio Conferencing	UDP	Client-Server	Low latency PCM with Opus codec
Video Conferencing	UDP	Client-Server	JPEG/VP8 streams with timestamps
Screen Sharing	TCP	Presenter to Viewers	Reliable PNG frame delivery
Chat	TCP	Bidirectional	JSON structured messages
File Transfer	TCP	Bidirectional	Chunked and resumable
Control Signalling	TCP	Bidirectional	Session presence, reactions, hand raise
Latency Probe	UDP	Bidirectional	Echo-based RTT measurement
UI Bridge	WebSocket	Localhost	Browser to Client Daemon

B. Chat Service

Ensures reliable, ordered message synchronization across participants using TCP.

C. Screen Sharing Module

Provides presenter arbitration and adaptive frame-rate sharing over TCP.

D. Media Mixer

Handles real-time audio mixing and video frame relaying using per-client UDP sockets.

V. TECHNOLOGY STACK

- Python 3.10+ for cross-platform runtime
- AsyncIO for high-concurrency networking
- FastAPI + Uvicorn for embedded web services
- PyAV, OpenCV, and NumPy for real-time media handling
- Jinja2 and Vanilla JS for dynamic user interface rendering

VI. SECURITY AND RESILIENCE

- Protected by network firewalls and access control lists
- Latency telemetry and heartbeat monitoring for health diagnostics

- Exponential reconnection logic ensures uninterrupted service

VII. Conclusion

The LAN Collaboration Suite delivers an integrated, secure, and resilient communication platform optimized for local networks. Its modular architecture ensures scalability for classrooms, corporate environments, and disaster recovery operations.