TSG

TSG LAB AG — USE CASE 4

Live Concert Audio NFT & Smart Contract Lifecycle

From Microphone to Marketplace — Capturing, Tokenizing, and Monetizing Live Musical Performances

AUDIO NFT | SMART CONTRACTS | ROYALTY SPLITS | LIVE MUSIC | AI MASTERING

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01 Executive Summary

> TSG Lab AG's Live Concert Audio NFT platform connects professional audio equipment directly to a blockchain-powered capture and minting pipeline. From the moment an artist takes the stage, audio is captured in studio-grade quality, cryptographically timestamped, and streamed to a real-time minting engine generating unique Audio NFTs managed by autonomous smart contracts.

Live music is ephemeral — yet the global live music market (USD 32+ billion) and the rapidly expanding music NFT ecosystem remain disconnected. Smart contracts govern the entire lifecycle: automated royalty splits between artists, producers, venues, and collaborators; time-locked exclusivity windows for VIP ticket holders; Dutch auction pricing for limited editions; and perpetual secondary market royalty enforcement. Artists retain sovereign control over their creative output from stage to sale.

02 Business Challenge

- **Ephemeral Value Destruction:** Live performances generate no persistent digital asset — the economic value of the moment dissipates when the final note fades.
- **Complex Rights Management:** Music rights involve multiple stakeholders (artist, songwriter, producer, label, publisher, venue). Manual royalty accounting is slow, error-prone, and frequently disputed.
- **Bootleg & Unauthorized Recording:** Audience-captured recordings circulate freely, generating zero revenue for artists while diluting brand value.
- **Fan Engagement Limitations:** Existing models (merchandise, streaming) offer no unique, verifiable connection to a specific live experience.
- **Revenue Concentration:** Streaming platforms capture the majority of digital music revenue; artists receive USD 0.003–0.005 per stream, while live performances leave no digital monetization trail.
- **Ticketing Disconnection:** Concert tickets expire at the door with no persistent digital value or connection to performance content.

03 Technical Solution

Audio Capture Layer — IoT-Enabled Professional Equipment

Microphone Integration: Digital microphones (Shure Axient Digital, Sennheiser Digital 6000) with firmware extensions embed cryptographic timestamps and device identity signatures into audio stream metadata.

Mixing Console Bridge: A hardware bridge device connects to the console's digital output (Dante/AES67, MADI) and captures multi-track or stereo mix in uncompressed formats (WAV, 48kHz/24-bit+).

Edge Processing Unit: A ruggedized rack-mount edge server handles real-time audio fingerprinting (Chromaprint), automatic song boundary detection, and continuous Merkle tree construction for integrity verification.

Minting & Processing Pipeline

Audio blocks are hashed in 10-second windows forming a Merkle chain, enabling post-hoc verification of any segment. An AI-powered mastering engine (CNN trained on professionally mastered live recordings) produces three quality tiers (Standard, HD, Audiophile). NFTs are minted as ERC-721 tokens with rich metadata: artist, venue, setlist, song boundaries, audio fingerprints, mastering tier, and edition number.

Smart Contract Lifecycle

PerformanceRegistry.sol — Root attestation for all NFTs derived from each performance.
AudioNFT.sol (ERC-721 + ERC-2981) — Core NFT with royalty enforcement and token-gated access.
RoyaltySplitter.sol — Programmable revenue distribution across all stakeholders per pre-agreed splits.
AuctionEngine.sol — English, Dutch, and fixed-price mechanisms with anti-sniping protections.
FanAccess.sol — Time-locked and condition-gated access: VIP ticket holders get 48-hour exclusive access before public sale.

04 Implementation Approach

Phase	Activities	Duration
Phase 1: Audio Equipment Integration	Shure/Sennheiser firmware extensions, bridge device prototyping, Dante/AES67 integration	8–10 weeks
Phase 2: Capture & Processing	Real-time audio hashing engine, ML song boundary detection, AI mastering pipeline, IPFS integration	8–10 weeks
Phase 3: Smart Contract Dev	All five contracts, formal verification, testnet deployment, security audit	8–10 weeks
Phase 4: Artist & Venue Dashboard	Performance registration, NFT edition config, royalty management, real-time analytics	6–8 weeks

Phase 5: Fan Marketplace	Consumer marketplace with audio preview, auction participation, token-gated playback, mobile app	6–8 weeks
Phase 6: Pilot Concerts	5–10 live performances across diverse genres and venue sizes, end-to-end validation	6–8 weeks

05 Technology Stack

Layer	Technologies
Audio Capture	Shure Axient Digital, Sennheiser Digital 6000, Dante/AES67, MADI, custom bridge (ARM Cortex-A72)
Audio Processing	FFmpeg, LibROSA, Chromaprint/AcoustID, custom CNN mastering model (PyTorch), FLAC/AAC encoding
Edge Computing	NVIDIA Jetson Orin (ML inference), Docker containers, MQTT for telemetry
Blockchain	Ethereum Mainnet (1/1 editions), Polygon PoS (open editions), Solana (real-time hashing attestations)
Token Standards	ERC-721 (Audio NFTs), ERC-2981 (royalties), ERC-1155 (multi-edition packs), ERC-4907 (time-limited access)
Smart Contracts	Solidity 0.8.x, Anchor/Rust (Solana), Chainlink Automation, Chainlink VRF (fair random distribution)
Storage	IPFS, Filecoin (pinning), Arweave (permanent archival), custom CDN for streaming
Marketplace	Next.js, Tailwind CSS, Howler.js (audio playback), ethers.js, WalletConnect, Web3Auth

06 Key Features & Capabilities

✔**Live-to-Chain Capture** — Professional audio feeds cryptographically timestamped at the source, with an unbroken integrity chain from microphone to NFT.

✔**AI-Powered Mastering** — Automated engine produces three quality tiers, enabling immediate release without manual post-production delays.

✔**Flexible Edition Strategy** — 1/1 unique masters, limited editions (e.g., 100 copies), open editions (time-limited minting), and individual song segments.

✔**Programmable Royalty Splits** — Smart contracts enforce pre-agreed revenue distribution across all stakeholders — automatically, transparently, and irrevocably.

✔**Multi-Mechanism Auctions** — English auctions for rare 1/1s, Dutch auctions for limited editions, fixed-price for open editions — all with anti-sniping protections.

✔**Token-Gated Playback** — NFT owners access high-fidelity streaming directly through their wallet — no separate subscription required.

✔**Ticket-to-NFT Bridge** — Concert ticket holders receive priority access windows and discounted minting for the performance they attended.

✔**Setlist-Aware Segmentation** — Automatic song boundary detection enables per-song NFT minting alongside full-concert editions.

07 Business Benefits & ROI

New Artist Revenue Stream

Direct-to-fan NFT sales generate 10–50x more revenue per listener than streaming platforms

Perpetual Royalty Income

Secondary market royalties (5–10%) create ongoing passive income from every resale in perpetuity

Fan Monetization

Concert attendees acquire verifiable digital memorabilia, increasing per-attendee revenue by 25–40%

Bootleg Displacement

Official high-quality recordings available immediately after the show eliminate unauthorized capture markets

Rights Transparency

On-chain royalty splits eliminate accounting disputes, reducing legal and administrative costs by 60–70%

Venue Revenue Share

Venues earn a programmatic share of audio NFT revenue, incentivizing live performance hosting

08 Use Case Scenarios

Intimate Jazz Club Performance

A renowned jazz quartet performs at a 200-seat club in Zurich. The 90-minute performance is recorded in multi-track, AI-mastered, and segmented into 12 tracks plus the full concert. The artist releases: 1 unique full-concert audiophile master (auctioned, starting at 5 ETH), 50 limited-edition full concerts (0.5 ETH each), and an open edition of individual tracks (0.05 ETH, 48-hour window). Revenue of 45+ ETH is distributed automatically: 70% artist, 10% producer, 10% venue, 10% platform.

Stadium Rock Concert

A headlining act performs before 60,000 fans. 10,000 limited-edition NFTs are released at USD 25 each via Dutch auction starting at USD 100 — with ticket QR codes unlocking a minting discount. Within 72 hours all 10,000 NFTs are sold, and secondary market trading generates a 7.5% royalty flowing back to the artist and collaborators on every resale.

Music Festival Multi-Stage Capture

A three-day European festival captures performances across 5 stages. Each artist's set is independently tokenized. A 'Festival Pass NFT' grants holders access to all recordings. Cross-artist collaboration recordings from surprise jam sessions are minted as ultra-rare 1/1 editions.

09 Security & Compliance

- **Audio Integrity Verification:** Merkle chain of audio hashes enables anyone to verify a recording is authentic and unaltered — essential for legal and licensing contexts.
- **Rights Management Compliance:** Smart contract royalty splits align with ASCAP, BMI, GEMA, SUISA frameworks and can satisfy label and publisher agreements.
- **Content Moderation:** AI-based audio analysis screens for unauthorized copyrighted material (e.g., cover songs without clearance) before minting.
- **Anti-Piracy Measures:** Audio watermarking embeds unique, inaudible identifiers in each NFT holder's stream, enabling forensic tracing of leaked content.
- **GDPR & Data Privacy:** Audience data is not captured; artist and venue data managed under GDPR with explicit consent frameworks.
- **Swiss IP Law Compliance:** Platform structured to comply with Swiss Federal Act on Copyright, ensuring NFT sales constitute legitimate licensing transactions.

10 Future Enhancements

Spatial Audio NFTs: Capture and mint in Dolby Atmos/Ambisonics formats for immersive playback on Apple Vision Pro and spatial audio headphones.

AI-Generated Remix Rights: NFT holders receive smart contract-granted permissions to create AI-assisted remixes, with derivative works automatically linked to the original and subject to royalty sharing.

Live Streaming with Real-Time Minting: Extend the platform to live-streamed concerts, enabling remote audiences to mint NFTs of specific moments during the performance.

Fan Governance DAOs: Concert communities as DAOs where NFT holders vote on setlists, encore selections, or charitable donations from performance revenue.

Cross-Platform Interoperability: Integration with Spotify, Apple Music, and Tidal to surface NFT-authenticated live recordings in mainstream streaming catalogs.