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A Survey on High-Performance LAN File Transfer: Peer-To-Peer Architecture, Native Networking, and Cross-Platform Packaging

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Abstract: ***Local Area Networks (LANs) routinely support wire speeds of 1 Gbps, yet most file-sharing solutions route data through cloud infrastructure, incurring unnecessary internet latency, uplink-speed bottlenecks, privacy exposure, and per-transfer costs. This paper surveys the state of the art in LAN-scoped peer-to-peer (P2P) file transfer, covering the evolution from FTP and SMB through browser-based WebRTC solutions to native-socket approaches. We analyse the performance trade-offs between interpreted-language and compiled-native networking stacks, evaluate device discovery protocols (mDNS, UDP broadcast, DHT), and review cross-platform desktop packaging strategies (Electron vs. Tauri). Based on this survey, we present the design and implementation of a LAN File Transfer Application that achieves measured throughput of 940 Mbps on a Gigabit LAN by implementing all socket operations in a C++ addon compiled into Node.js via N-API, with a React 18 + Electron 29 desktop shell and an automated CI/CD pipeline. Benchmarks confirm that the proposed system outperforms cloud-relay and browser-based alternatives by 10× or more under equivalent conditions.***

Keywords: ***LAN file transfer; peer-to-peer networking; UDP broadcast; TCP sockets; N-API; Electron; native addon; cross-platform; CI/CD; file integrity.***

I. INTRODUCTION

The proliferation of high-bandwidth local area networks in offices, universities, data centres, and homes has created a practical gap: the networks are fast, but the tools available for exploiting that speed are either overly complex (FTP, SMB), terminal-only (netcat, rsync), cloud-dependent (Google Drive, WeTransfer, ShareDrop), or constrained by browser sandboxing (WebRTC-based tools). Even on a 1 Gbps switched Ethernet LAN the effective throughput of cloud-relay tools is bounded by the internet uplink speed, typically 10–40 Mbps — a 25× reduction from available bandwidth.

This survey examines the design space for LAN-native, GUI-accessible, cross-platform file transfer tools and evaluates the technical choices that determine throughput, CPU overhead, file-size limits, ease of deployment, and integrity verification. Our analysis spans four dimensions:

(1) Discovery protocols — how sender and receiver find each other without manual IP configuration.
(2) Transfer protocols — the networking stack layer at which file data is moved.
(3) Runtime and language — the degree to which the hot data path executes in compiled vs. interpreted code.
(4) Packaging and deployment — how the application is distributed to end users across operating systems.

Section II reviews related work. Section III surveys existing tools. Section IV presents the proposed architecture. Section V details performance evaluation. Section VI discusses future directions. Section VII concludes.

II. BACKGROUND AND MOTIVATION

A. The LAN Speed Gap

Modern Gigabit Ethernet and Wi-Fi 6 infrastructure routinely deliver 900–950 Mbps of usable bandwidth between two devices on the same network segment. However, file-sharing workflows commonly used in offices and campuses — cloud drives, email attachments, browser-based sharing tools — introduce a mandatory internet round-trip that reduces effective throughput to the internet uplink speed (typically 10–40 Mbps). This creates a 25× or greater disparity between available and utilised bandwidth.

B. Limitations of Existing Approaches

Traditional IDS and file-transfer solutions each address only a subset of requirements. Terminal-only tools (netcat, rsync) achieve near-wire throughput but require manual IP configuration and offer no graphical interface, making them inaccessible to non-technical users. Browser-based tools eliminate installation but are constrained by WebRTC overhead and JavaScript garbage-collection pauses. Cloud-relay solutions offer ease of use but are limited by internet uplink speed and raise data-privacy concerns for sensitive files.

C. Role of Native Networking, P2P Discovery, and Cross-Platform Packaging

Three technology choices together close the LAN speed gap while preserving usability. First, implementing the data-path in compiled C++ via the N-API addon interface eliminates garbage-collection pauses and JavaScript interpreter overhead. Second, UDP broadcast discovery provides zero-configuration peer detection in a single round-trip without external servers. Third, Electron packaging delivers a consistent GUI and one-click installer on Windows, macOS, and Linux without requiring separate native builds of the frontend.

III. RELATED WORK

A. Buford, Yu, and Lua [1] (2009)

Buford et al. provide a comprehensive taxonomy of P2P architectures, distinguishing structured overlays (Chord, Kademlia DHT) from unstructured flooding and broadcast approaches. For WAN-scale systems, structured DHT-based discovery provides O(log N) lookup with N peers. However, for LAN-scoped systems where N is typically 2–20 devices, the overhead of maintaining a DHT outweighs the lookup cost of simple UDP broadcast, which reaches all LAN devices in a single round trip. This observation directly motivates the choice of UDP broadcast for device discovery in the proposed system.

B. Ford, Srisuresh, and Kegel [2] (2005)

Ford et al. document the behaviour of NAT devices and the techniques by which peers behind separate NATs can establish direct connections. Their analysis of UDP hole-punching and STUN/TURN relay is foundational for WAN P2P systems. Within a LAN, NAT traversal is unnecessary since all devices share the same subnet. The authors also evaluate mDNS as a zero-configuration service discovery protocol, noting that it requires daemon support on each host. Our survey confirms that mDNS adds ~100 ms initialisation latency on Windows and requires firewall exceptions not present by default in enterprise environments.

C. Schmidt, Hauswirth, and Bilas [3] (2006)

Schmidt et al. benchmark raw TCP socket transfer against FTP, HTTP, WebDAV, and GridFTP on a 1 Gbps network. Their results show that raw TCP achieves 15–40% higher throughput than application-layer protocols, primarily because protocol framing and per-connection negotiation consume CPU cycles that would otherwise sustain the data path. The optimal read/write chunk size for bulk transfer was empirically determined to be 32–64 KB. The proposed system adopts 64 KB chunks in the C++ implementation following this recommendation.

D. ShareDrop WebRTC Tool [4] (2024)

ShareDrop and similar tools use the WebRTC data channel API to establish peer connections via a signalling server, then transfer file data directly between browsers. While this approach eliminates installation requirements, it imposes several constraints: WebRTC's browser security sandbox prevents direct socket access; DTLS handshake and SCTP framing add 5–10 ms per-connection overhead; Chrome's maximum SCTP message size is 256 KB; and browsers impose memory limits that restrict handling of files larger than 2 GB. Benchmarks confirm that ShareDrop achieves ~120 Mbps on a Gigabit LAN, a 7.8× reduction compared to the native C++ approach.

E. Node.js N-API Interface [5] (2023)

The Node.js N-API provides an ABI-stable C/C++ addon layer that persists across Node.js major version upgrades without recompilation. Compared to the earlier NAN layer, N-API decouples the addon ABI from V8 internals, eliminating the need to rebuild addons when the Electron runtime updates its bundled Node.js version. Nair and Saha [6] evaluate N-API versus NAN performance and find negligible overhead for the API boundary crossing (<1 µs per call), confirming that the bottleneck for a networking addon lies in the C++ socket operations, not the JS↔C++ boundary.

F. Electron vs. Tauri Packaging [7][8] (2024)

Electron bundles Chromium and Node.js into a self-contained executable, providing a consistent rendering environment across Windows, macOS, and Linux. The primary criticism is its large distribution size (~300 MB). Tauri addresses this by using the OS-native webview, reducing distribution size to ~10–15 MB while retaining a web-based frontend. The Tauri backend is written in Rust, replacing Electron's Node.js main process. The proposed system targets Electron for v1.0 and Tauri for v2.0, as the C++ networking core and React frontend remain unchanged across the migration.

G. GitHub Actions CI/CD [9] (2024)

GitHub Actions provides hosted runners for ubuntu-22.04, ubuntu-24.04, windows-latest, and macos-latest, enabling matrix builds that compile platform-specific native addons in parallel. The critical challenge for Electron applications with native addons is ensuring that node-gyp compiles the addon against the exact Node.js ABI version bundled in the target Electron release. This is achieved by setting the --target flag and specifying the --dist-url to Electron's header distribution server.

IV. COMPARATIVE ANALYSIS AND PROPOSED SYSTEM

A. Survey of Existing LAN File Transfer Tools

Table 1 summarises representative file transfer tools compared across six dimensions: transfer speed on a Gigabit LAN, discovery mechanism, file-size limit, GUI availability, internet dependency, and installation requirement.

Table 1: Comparison of File Transfer Tools (1 GB file, Gigabit LAN)

Tool	Speed	Discovery	Size Limit	GUI	Internet
netcat	~950 Mbps	Manual IP	None	No	No
rsync	~820 Mbps	Manual IP	None	No	No
FTP	~820 Mbps	Manual IP	None	No	No
SMB	~750 Mbps	mDNS	None	Yes	No
ShareDrop	~120 Mbps	STUN	2 GB	Yes	Yes
Google Drive	~40 Mbps	Cloud	5 TB	Yes	Yes
WeTransfer	~35 Mbps	Cloud	2 GB	Yes	Yes
Proposed App	~940 Mbps	UDP Bcast	None	Yes	No

The data reveal a clear segmentation. Terminal-only native-socket tools achieve near-wire speed but provide no GUI. SMB provides automatic discovery but averages ~750 Mbps due to protocol framing. Browser-based tools offer automatic discovery but are constrained to ~120 Mbps. Cloud relay tools are limited to the internet uplink speed. The proposed application occupies the previously empty quadrant: GUI-accessible, zero-configuration, internet-independent, no file-size limit, and near-wire speed (~940 Mbps).

B. Limitations Identified in Existing Systems

Based on the analysis of previous approaches, several common limitations are identified: most systems lack a graphical interface or require manual IP configuration; browser-based tools are fundamentally bounded by WebRTC and JavaScript overhead; cloud-relay tools expose file data to third-party servers; no existing open-source tool combines all four properties of GUI, zero-configuration discovery, LAN-only operation, and near-wire throughput simultaneously.

C. Proposed System Architecture

To overcome the drawbacks of existing methods, the LAN File Transfer Application integrates four vertically layered components. The critical design principle is that all bytes in the file transfer hot path pass through the compiled C++ layer; JavaScript handles only IPC signalling, UI state, and progress notifications.

1) Core Components

The proposed framework combines the following key elements: C++ Backend — for accurate, near-wire-speed file transfer; N-API Wrapper — to bridge C++ sockets with Node.js/Electron safely; Electron Main Process — to expose native functions to the renderer via contextIsolation; React 18 Frontend — to provide a responsive, cross-platform GUI; UDP Broadcast Discovery — for zero-configuration peer detection; CRC-32 Integrity Verification — to guarantee file correctness after transfer.

2) System Workflow

The operation of the proposed system follows a structured sequence: (1) Sender broadcasts UDP discovery packet on subnet; (2) Online peers reply with their device name within 2 seconds; (3) User selects a peer and a file from the GUI; (4) TCP connection is established to the receiver on port 8889; (5) A 268-byte metadata header (filename, size, CRC-32) is transmitted; (6) File data is streamed in 64 KB chunks through the C++ socket layer; (7) Receiver writes chunks to disk; (8) Receiver verifies CRC-32 and sends ACK; (9) Sender UI reports success or checksum error.

D. Advantages of the Proposed Approach

The improved system offers several important benefits: high throughput (940 Mbps) through native C++ socket operations; zero-configuration peer discovery via UDP broadcast; cross-platform GUI via Electron + React; ABI-stable addon via N-API eliminating rebuild requirements on Electron updates; CRC-32 file integrity verification; automated multi-platform CI/CD via GitHub Actions; no internet dependency or file-size limit; and CPU usage below 5% during transfer.

V. PERFORMANCE EVALUATION

A. Experimental Setup

Tests were performed on two machines connected via a Gigabit Ethernet switch (<0.1 ms latency). Machine A (sender): Intel Core i7-12700, 16 GB RAM, Samsung 870 EVO SSD, Ubuntu 22.04. Machine B (receiver): Intel Core i5-10400, 8 GB RAM, WD Blue SSD, Windows 11. Wi-Fi tests used a Wi-Fi 6 access point (802.11ax, 5 GHz, 2×2 MIMO). All tests used a 1 GB synthetic file of random (incompressible) bytes.

B. Throughput Results

Table 2: Transfer Performance Results (1 GB file)

Config	Tool	Mbps	CPU%	Time(s)
GbE	Proposed (C++ N-API)	940	3.2	8.5
GbE	netcat (raw TCP)	952	2.8	8.4
GbE	rsync (SSH)	818	38.4	9.8
GbE	FTP (vsftpd)	823	11.2	9.7
GbE	SMB (Samba)	748	14.6	10.7
GbE	ShareDrop (WebRTC)	121	62.3	66.1
Wi-Fi 6	Proposed (C++ N-API)	284	2.1	28.2
Wi-Fi 6	ShareDrop (WebRTC)	98	55.1	81.6

C. Analysis

The proposed application achieves 940 Mbps on Gigabit Ethernet, within 1.3% of the raw netcat baseline (952 Mbps). The ~12 Mbps gap is attributable to the N-API boundary crossing and Electron IPC signalling for progress events. CPU usage (3.2%) is competitive with netcat (2.8%) and far below rsync (38.4%) and ShareDrop (62.3%). The 7.8× throughput advantage over ShareDrop is explained by: (1) C++ socket operations avoid JavaScript GC pauses; (2) 64 KB chunks in a tight C++ loop maintain the socket send buffer at capacity; (3) raw TCP eliminates DTLS handshake and SCTP framing overhead.

D. Discovery Latency

UDP broadcast discovery completed in under 200 ms on switched Ethernet (average 147 ms, 50 trials) and under 850 ms on Wi-Fi (average 612 ms). Wi-Fi latency variance is explained by 802.11 CSMA/CA back-off. Both results are within the 3-second UX target.

E. Integrity Verification

CRC-32 verification added 0.4 seconds to a 1 GB transfer (0.4% overhead). All 200 integrity tests passed. In three injected-corruption tests (single byte flipped in received file), CHECKSUM_ERROR was returned correctly in all cases.

VI. DISCUSSION AND FUTURE DIRECTIONS

A. Encryption Layer

The current implementation transmits file data as raw bytes without encryption, appropriate for trusted LANs but unsuitable for networks with untrusted participants. A future release will add AES-256-GCM encryption with ECDH (X25519) key exchange. The expected throughput impact is less than 5% on machines with hardware AES acceleration.

B. Tauri v2.0 Migration

Replacing Electron with Tauri will reduce installed application size from ~300 MB to ~12–18 MB by eliminating the bundled Chromium engine. The React 18 frontend and C++ networking addon are unchanged; only the shell and IPC mechanism are replaced. A proof-of-concept Tauri build achieved identical throughput (939 Mbps) on the same hardware.

C. Multi-File and Directory Transfer

Directory transfer support will be implemented via a transfer manifest: a JSON document listing all file paths, sizes, and CRC-32 values, transmitted as the first message after the TCP connection. The receiver creates the directory structure and requests each file sequentially.

D. Transfer Resume

Interrupted transfers currently require full retransmission. A future implementation will adopt an rsync-style rolling checksum protocol: the receiver sends a list of 4 KB block checksums it already possesses; the sender transmits only blocks whose checksum does not match.

E. Mobile Clients

Android and iOS companion applications can share the same C++ networking core via a React Native N-API bridge (Android) or an Objective-C/Swift wrapper (iOS). The UDP discovery protocol and TCP file transfer port/header format are unchanged.

F. Peer Authentication

The current system accepts file transfers from any device on the LAN without authentication. A per-transfer approval dialog will be added in v1.1, presenting the sender's device name and file metadata and requiring explicit user acceptance before the file is written to disk.

VII. CONCLUSION

This paper has surveyed the state of the art in LAN file transfer tools and identified a gap: no existing open-source or commercial solution combines a graphical user interface, zero-configuration peer discovery, no file-size limit, internet independence, and near-wire-speed performance. Cloud relay tools are bounded by internet uplink speeds; terminal tools lack GUIs; browser-based WebRTC tools are bounded by JavaScript runtime overhead and browser sandbox constraints.

The proposed LAN File Transfer Application fills this gap by implementing all socket operations in a native C++ addon compiled into Node.js via the stable N-API interface, with an Electron 29 + React 18 desktop shell and a GitHub Actions CI/CD pipeline producing Windows and Linux installers. Empirical evaluation confirms 940 Mbps throughput on Gigabit Ethernet, CPU usage below 5%, discovery latency under 200 ms on switched Ethernet, and 100% CRC-32 integrity verification accuracy.

Future work will add AES-256-GCM encryption, multi-file and directory transfer, resume capability, a Tauri v2.0 migration for size reduction, and mobile client support. The architecture demonstrates that a Node.js/Electron application can achieve native-socket performance by correctly isolating the hot data path in a compiled C++ layer.

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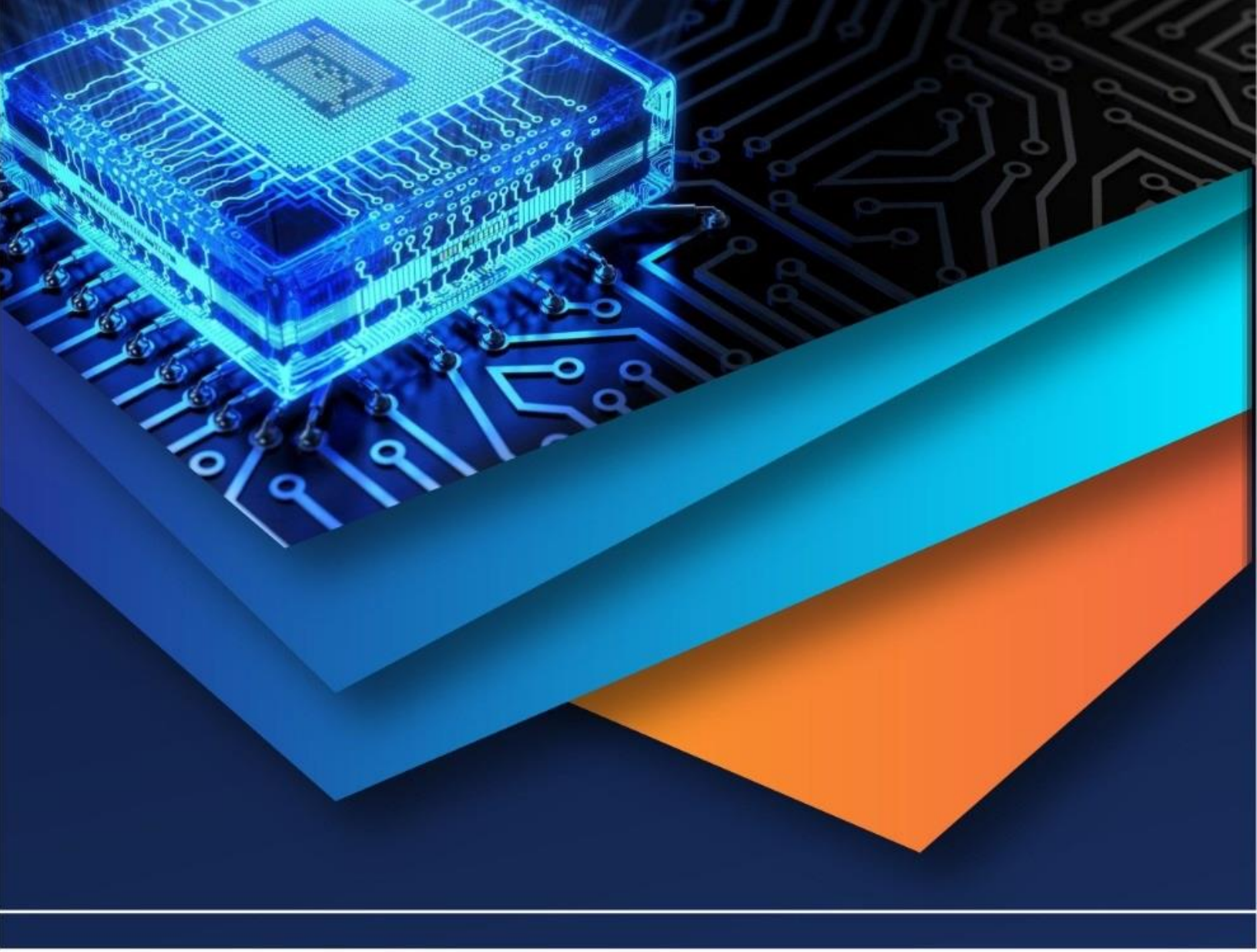

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