How BitTorrent Optimises Distributed Systems

Efficiency, Scalability, and Resilience in Modern File Sharing

1. Introduction

BitTorrent is a peer-to-peer (P2P) protocol for efficient file sharing by breaking files into pieces and distributing them among users.

2. How BitTorrent Works

- **Torrent Files:** Contain metadata and hashes.
- **Swarms:** Groups of peers sharing the file.
- **Seeders vs Leechers:** Uploaders vs Downloaders.
- **Piece-based Downloading:** File is split into parts.
- **Trackers and DHT:** Help locate peers.

3. Optimisations in BitTorrent

- **Parallel Downloads:** Multiple pieces from multiple peers.
- **Rarest First:** Ensures availability of all pieces.
- **Tit-for-Tat:** Rewards uploaders.
- **Choking/Unchoking:** Dynamically prioritizes peers.

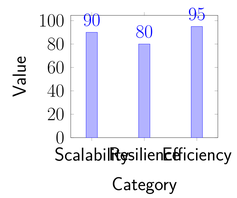
4. Performance Comparison

4.1 Scalability

Performance improves with more peers, unlike centralized systems.

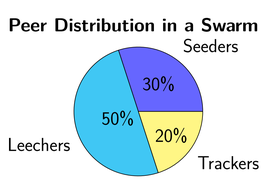
4.2 Resilience

Files are available even if some peers go offline.



5. Real-World Applications

- **Linux Distros:** Ubuntu, Fedora, Arch
- **Game Updates:** Used by Blizzard and Steam
- **Enterprise:** Facebook used it internally



6. Challenges and Limitations

- **NAT Traversal:** Connection issues across firewalls.
- **Initial Seeder Bottleneck:** Delays at startup.
- **Security:** File integrity requires verification.
- **Legal Issues:** Often associated with piracy.

Fun Fact: BitTorrent accounts for over 20% of global internet traffic during peak hours.

7. Conclusion

BitTorrent shows how P2P systems can outperform traditional models in scalability and efficiency. Future Web3 systems will likely build on similar architecture.

8. References

- Cohen, B. (2003). Incentives Build Robustness in BitTorrent.
- Norberg, A. (2008). BitTorrent Enhancement Proposals. `https://www.bittorrent.org/beps/bep_0003.html`
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