

# How BitTorrent Optimises Distributed Systems for Peer-to-Peer File Transfers

Eddie Liew c3259452 Tristan Neverov c3476555 Joshua Wagstaff c3524789 Lucas Newman c3500964 Leon Fardell CC10032

# What is BitTorrent?

BitTorrent is a peer-to-peer protocol and software for sending files over the internet, which allows users to send BitTorrent scales better than traditional client-server systems because each peer contributes bandwidth. Perfor- NAT Traversal and Connectivity large files over the internet by connecting multiple sources at the same time, rather than relying on a single mance improves as the swarm grows, making it ideal for large-scale distribution. It also offers resilience — if Peers located behind firewalls or NAT (Network Address Translation) routers often struggle to connect with server to do it instead [1].

# Why do we need it? Limitations of traditional file transfer

Traditional methods like email or FTP lack any security and have limited data sharing. This can lead to data inconsistency and redundancy. These methods also struggle with larger file sizes and complex data sharing. Other methods like using centralised servers, also introduce problems like single points of failure, potential data loss or corruption and many more [2].

# Importance of distributed systems and P2P architecture

Distributed systems are an essential part for today's modern computing needs, with their abilities such as enhanced scalability, fault tolerance and other factors that make them great for handling large-scale data transfer and processing. The P2P architecture allows our distributed systems to eliminate central authority by allowing nodes to function both as clients and servers, which then improves the systems resilience to faults as there no longer is a single point of failure. It also further improves scalability as new nodes are able to seamlessly be joined into the network [3].

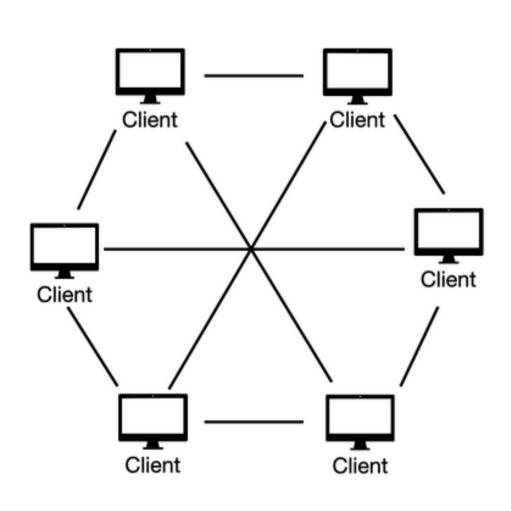


Diagram of P2P systems [4].

# **How BitTorrent Works**

Bittorrent works by locating other computers using the same software that have the file you wish to download. content being shared. Many reputable organizations use it for legitimate and efficient content distribution. These other computers are ordinary computers like your own that are known as peers. The process starts by finding a link for the file you want. Your bittorrent client software will then communicate with a tracker to find other computers running BitTorrent that have the complete file (known as seed computers) and those with Ethical Considerations of BitTorrent portions of the file, these are typically peers in the process of downloading said file. The tracker identifies the swarm, which is a group of connected computers that have all or a portion of the file and are also in the process of sending or receiving it. The tracker then helps trade pieces of the file you want with others in the swarm, you can also receive multiple pieces of the files at once [5].

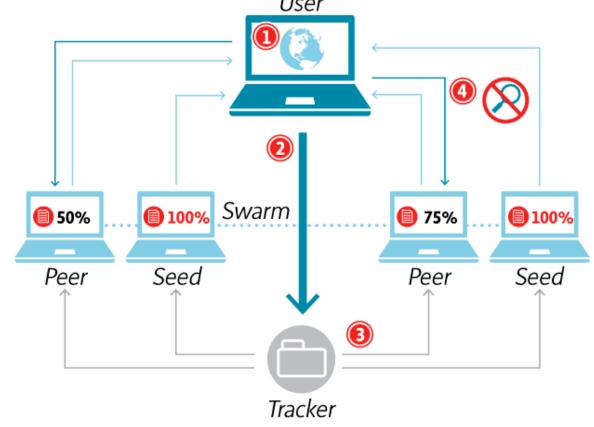
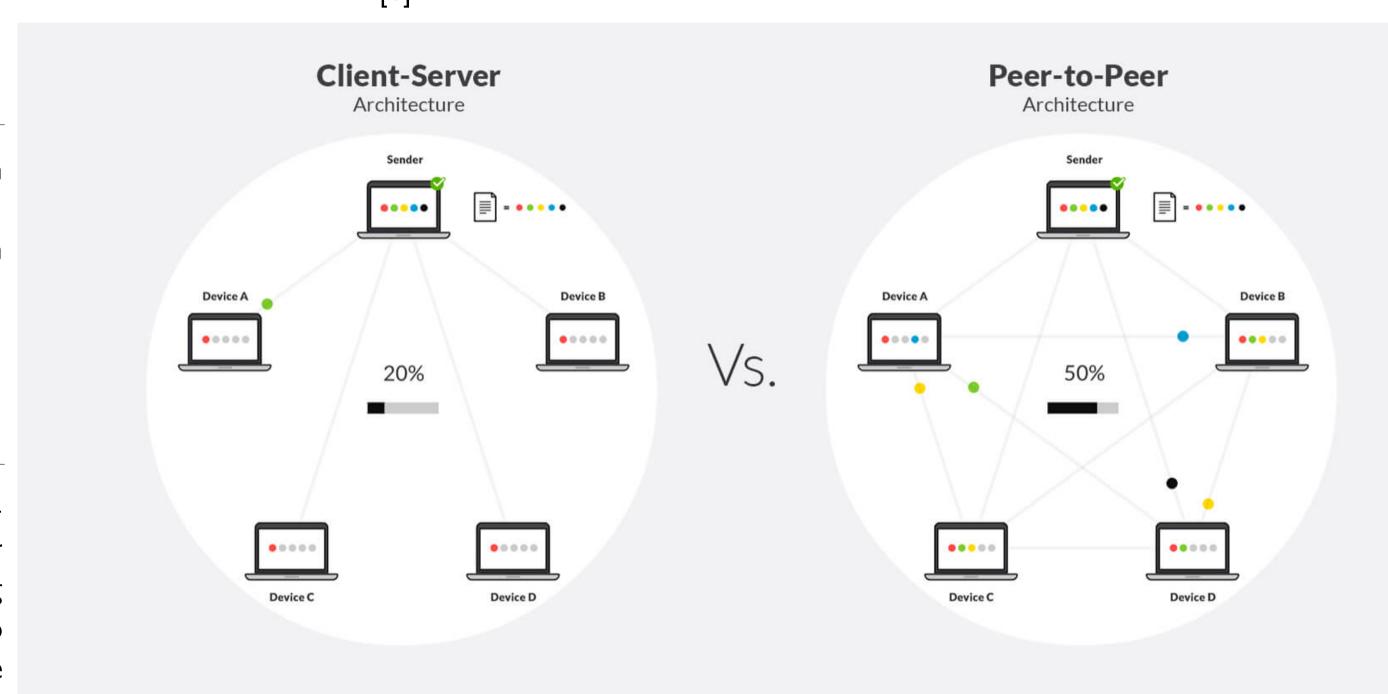


Diagram of how torrents work [5].

# **Performance Comparison**

one peer fails, others still maintain availability. In contrast, centralized servers present single points of failure other nodes in the swarm. This can reduce overall swarm efficiency and isolate nodes unless protocols like UPnP and bottlenecks under load [6].



Comparison of the client-server system vs peer-to-peer system [6].

# Real-World Applications

### **Open-Source Distribution**

BitTorrent is widely used by open-source communities to distribute large files. Linux distributions such as Ubuntu and Fedora rely on the protocol to share installation ISOs efficiently, minimizing server bandwidth and encouraging community participation through seeding [7].

### Gaming and Software Delivery

Companies like Blizzard Entertainment have leveraged BitTorrent to deliver large-scale game updates and patches to millions of users. The protocol helps manage high demand while maintaining fast and reliable distribution [7]. References

### **Enterprise Use**

Facebook previously employed a customized BitTorrent client to deploy code across its global data centers. This decentralized approach allowed faster and more resilient internal software rollouts [7].

### Legal vs. Illegal Use

Although often associated with piracy, BitTorrent itself is a legal protocol. Its legality depends entirely on the

### **Legality of the Protocol**

BitTorrent is a neutral and legal peer-to-peer file-sharing protocol. Its core functionality — breaking files into chunks and sharing them across a distributed network — is not inherently unethical. However, because BitTorrent enables users to share any type of file, it has become a common platform for distributing pirated content

### **Intellectual Property and Copyright Infringement**

One of the most significant ethical concerns involves the unauthorized distribution of copyrighted material such as music, movies, software, and academic texts. This not only violates intellectual property rights but also affects the livelihoods of content creators and industries dependent on legal distribution models [8].

### **User Responsibility**

The ethical burden falls heavily on the user. Just because content is available through BitTorrent does not mean it is legal to download or share. Users must verify the legality of the files they interact with. Failing to do so even unintentionally — may contribute to piracy and digital rights violations [8].

# **Challenges and Limitations**

or port forwarding are enabled.

#### Initial Seeder Bottleneck

At the beginning of a torrent's lifecycle, when only one seed exists, download speed is constrained by that single uploader's bandwidth. Until more peers join and begin sharing, file distribution remains slow and inefficient [9].

#### **Security and Data Integrity**

Without trusted sources or cryptographic verification, users may unknowingly download tampered or malicious files. Fake torrents, malware, and "poisoned" pieces are persistent risks that can undermine trust in the system.

### Lack of Incentives in Long-Term Seeding

Once users finish downloading, many leave the swarm without continuing to seed. This behavior leads to reduced availability over time, especially for older or niche files where long-term contributors are crucial [9].

# Bandwidth Throttling and ISP Restrictions

Some Internet Service Providers (ISPs) intentionally throttle or block BitTorrent traffic, viewing it as highbandwidth or suspicious. This degrades user experience and undermines the protocol's effectiveness in certain regions.

### **Conclusion**

BitTorrent demonstrates the power and potential of decentralized systems in solving modern data distribution challenges. By removing reliance on central servers, it offers improved scalability, resilience, and efficiency making it an enduring example of peer-to-peer innovation.

While it faces technical limitations and ethical concerns, its core protocol remains widely used for legitimate purposes, from distributing open-source software to enabling infrastructure within large enterprises.

Looking forward, BitTorrent's architectural principles continue to influence the design of decentralized technologies, including blockchain-based platforms and Web3 storage systems. It will play a major role in shaping the future of distributed computing.

[1] BitTorrent Inc. About bittorrent | creator of the world's leading p2p protocol. https://www.bittorrent.com/company/about-us/, n.d.

[2] HowStuffWorks. How bittorrent works. https://computer.howstuffworks.com/bittorrent2.htm, March 26 2005. Accessed 2025.

[3] Wikipedia contributors. Bittorrent. https://en.wikipedia.org/wiki/BitTorrent, April 12 2020. Accessed 2025.

[4] Understanding peer-to-peer architecture, n.d. Accessed: 2025-04-20.

[5] Globe Staff. Explainer: How torrents work, 2013. Accessed: 2025-04-20.

[6] Ittai Shamir. What's the difference between peer to peer and client server?, 2018. Accessed: 2025-04-20.

[7] M. A. Rafique, A. Khan, and A. Hanif. Academic torrents: A decentralized platform for academic data distribution. Journal of Grid Computing, 15(4):577–591,

[8] Jonathan A. Obar and Steven S. Wildman. Social media definition and the governance challenge: An introduction to the special issue. Telecommunications Policy, 39(9):745-750, 2015.

[9] Xiaoyong Ding and Xiaodong Zhang. An analysis of bittorrent performance in high-speed networks. IEEE Journal on Selected Areas in Communications, 23(1):96–107, 2005.