

Project Report by Group 7

Torrenting Time: A Deep Dive into BitTorrent's History and Global Impact

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1. Abstract: -

In the vast field of digital data exchange, the torrent has emerged as a revolutionary force that is changing the way we share and distribute data online. In essence, torrent is a peer-to-peer file-sharing method. By distributing the workload across a network of connected users, torrents alter the way we download files and facilitate collaboration in contrast to traditional methods that rely on centralized servers to host files.

We will start this review by going over the background of torrents and how the BitTorrent protocol optimizes large file downloads. Our project will also look at the social, cultural and ethical impacts of BitTorrent. We will also shine a spotlight on the ongoing efforts to improve torrent technology. By the end of this report, we hope to provide a deeper understanding of torrents and their impact on the digital world.

2. Introduction:-

2.1) History of torrents:-

The act of exchanging digital media files, including music, videos, games, software, and documents, over the internet for a variety of uses, including backup, education, enjoyment, and cooperation, is known as file sharing. How to efficiently transfer enormous files over the Internet without overloading the network or source server is one of the main technical issues. Conventional file-sharing techniques, like direct downloads, HTTP, FTP, and email attachments, depend on a central server to store and distribute files to clients. Numerous issues with this method include low download speeds and availability for clients, high bandwidth and storage costs for servers, vulnerability to server failures or attacks, complex and inefficient file-sharing systems, scalability issues, lack of built-in redundancy, and inadequate support for real-time operation. Peer-to-peer technology and customized file sharing are just a few examples of new solutions that must be investigated as technology advances in order to get over these obstacles and propel digital connectivity and collaboration into the era of safely and effectively.

Inception of bittorrent protocol 2001:-

File sharing has been more popular since 2000, particularly among users who wish to share large amounts of data—sharing big data is difficult and fraught with difficulties. Several data-sharing programs and systems, including Napster, Gnutella, eDonkey, and Kazaa, appeared during this time and competed in the market, but none of them were able to address issues with data sharing.

So BitTorrent was established in 2001 by 25-year-old unemployed college student Bram Cohen. He has worked for numerous Internet companies, including MojoNation, a peer-to-peer network for information sharing and providing users with encrypted data. Cohen wanted to make file sharing fast, reliable and scalable. SO using python as a programming language and with his company Rainberry , Inc He presented the protocol's idea at the inaugural CodeCon conference, which he co-founded with roommate Len Sassaman, and used free porn to attract beta testers and BitTorrent quickly gained popularity and attention, as it proved more efficient than other file sharing methods, especially for large file sizes. It had attracted interest and investment from companies and organizations as diverse as Facebook, Twitter, Wikipedia and the Internet Archive, who used it for distribution of software updates and data storage.

Launch of bittorrent client 2002:-

Cohen released the first BitTorrent client, a software application that uses the Torrent-based file sharing protocol, in 2002. This novel and convenient means of sending huge amounts of information, such as digital video and music files, via the Internet gained a lot of attention. This arrangement, however, raised certain legal and ethical concerns, because some shared content is legally protected and represents a breach of the original content creator's and export rights. Because users may download dangerous or unlawful files or disclose their IP addresses and personal information to other users or third parties, BitTorrent poses some security and privacy hazards.

Proliferation and popularity (2003-2005):-

During this time, BitTorrent gained traction and became the most widely used online method for exchanging huge files. Users can upload and download simultaneously during the performance process, which speeds up the procedure. Since it's easy to use BitTorrent to distribute information to a large audience without paying expensive bandwidth, legitimate content creators and publishers have also been drawn to the platform. Several instances of this include: Operating Systems for Linux: The main or backup method for distributing ISO images to several Linux distributions, including Fedora, Ubuntu, and Debian, is BitTorrent. Users can download files quickly and reliably thanks to this, which also lessens the strain on hardware and servers. For those who wish to download Linux using BitTorrent, several Linux websites also offer instructions and torrent links[1][2][3].

A month before the release of Star Wars Episode III: Revenge of the Sith, in 2005, the Star Wars world was the setting for the movie Star Wars: Revelations. The video's production and graphics, created by a group of volunteers on a \$15,000–\$20,000 budget, are excellent. After being made available for free on BitTorrent, the video was downloaded over 500,000 times in its first few weeks. The movie is regarded as one of the best fan films of all time and was highly welcomed by both critics and fans.[4][5][6]

Introduction of torrent search engine 2004:-

In 2004, websites that let users locate and store torrent files—files and folders with content intended for online sharing—first appeared as torrent search engines. Users can locate and download torrent files on the two most well-known websites, Suprnova and Pirate Bay, which also offer rating and review forums. Under the pseudonym Sloncek, Andrej Preston, a student from Slovenia, founded Suprnova. Although the website was initially created as a hobby, it soon became well-known and drew many users. [2] [3] It is well-known for its vast and varied collection of torrents, quick and dependable service, and easy-to-use interface. [2] However, it also had to handle a number of issues like cyberattacks, legal Server overloads and legal threats. [2] It voluntarily closed in December 2004 in response to a cease-and-desist notice from the Slovenian police.[2] The Swedish group Piratbyrå, or "Pirate Bureau," established The Pirate Bay in September 2003. [4] The website's initial owners are Gottfrid Svartholm and Fredrik Neij (also known as "anakata" and "TiAMO" respectively). Publisher and co-founder Peter Sunde referred to it as "business" [4]. [4] PirateBay employs Hypercube, a closed-source BitTorrent tracking application that was eventually superseded by Opentracker, which is more scalable and open-source. [4] In addition to allowing users to submit and comment on their own torrents, The Pirate Bay indexes torrents from several sources and categories. [4] Other features on the website are a shop, donation page, blog, and forum. [4] it was renowned for his fortitude, inventiveness, political and ideological views, and thought-provoking and engaging demeanour. [4] It also ran into a lot of issues, including censorship attempts, domain name seizures, police raids, and litigation. [4] Its founder was found guilty of encouraging criminal activity in 2009 and received a prison term and fine. [4] Its servers were seized by Swedish police in 2014, but it quickly started using a different name and address. [4] The expansion of the torrent ecosystem has been spearheaded by Suprnova and Pirate Bay, who have drawn millions of users and produced a wide range of content. By supporting novel features like magnet links, DHT, and PEX, they also contributed to the development and enhancement of the BitTorrent protocol. As a result, they are now a crucial component.

Legal battles and shutdown 2006-2012:-

By the middle of the 2000s, torrent had become even more popular as more individuals had access to broadband Internet and file-sharing software was providing better results. However, the entertainment sector understands the danger that torrenting presents to its revenue streams and intellectual property. Various agencies and groups, such as the MPAA, RIAA, and IFPI, have sued certain pirate sites that link to user data sharing. Due to legal disputes, demonstrations, or operational difficulties, several of these websites, including Suprnova and Demonoid, have been temporarily or permanently shut down. One of the most contentious litigations pertaining to torrents involved other businesses like Pirate Bay; in 2008, numerous entertainment industries filed complaints. Through the hosting and indexing of its protected works—videos, music, and games—in torrent form, the complainant claims that the website encourages and allows infringement. The website's owners and developers (defendants) assert that their only responsibility is to act as a search engine for users to locate content; they decline any culpability regarding torrent content. They also assert that they are protected under the freedoms of speech and information. Increased public support and media attention for the website were the outcomes of the three-week trial. and mandated that the plaintiff pay US\$3.6 million in damages.

However, the website carried on in defiance of the court's ruling, even posing a challenge to the plaintiffs with a modified logo that featured a pirate ship smashing into the Hollywood sign.

Introduction to magnet link 2008:-

Magnet links are a type of URI scheme that allows users to download torrent metadata directly from other peers, without the need for a separate torrent file. Filenames, sizes, hashes, and trackers are just a few of the details that can be found in little files called torrents. However, the torrent's hash—a special identification that can only be used to locate and confirm data on the peer-to-peer network—is contained in magnet links. Additional parameters, such as the file name, file size, tracker URL, or file website, can be included in magnet links. Bitzi, a business that offers services for the generation and verification of data hashes, developed the Magnet URI initiative in 2002. Magnet linkages, however, were not commonly utilized until The Pirate Bay declared in 2008 that they would begin using magnet links as a method of torrent downloads. [2]. They assert that magnet connections will increase websites' legality and resistance to censorship while lowering the bandwidth and storage expenses associated with hosting torrent files [2].

Rise of private trackers and communities 2010s:-

Because private torrents offered a distinctive and regulated method of sharing digital information, their audiences and communities grew in number and diversity during the 2010s. Private audiences demand users to be invited by an existing member or requested through a screening process, in contrast to public audiences, which are accessible to everybody. Regarding content, upload/download rates, and user conduct, they also have stringent policies. Moreover, games, anime, novels, music, and film. They adhere to particular interests and specialties, like. In 2010, [What.] and [PassThePopcorn] were two of the most well-liked users of videos. [Bibliotik] for books, [Music CD] for music, and [AnimeBytes] for animations. Their goals are to boost community and loyalty while offering consumers a safer, more dependable, and convenient service. between users. However, they also have to deal with a lot of issues and dangers, like internal disputes, cyberattacks, legal threats, and data breaches.

One of the main reasons why private trackers and communities gained prominence in the 2010s was the increasing crackdown on public trackers by governments, ISPs, and anti-piracy organizations. Users are now forced to look for alternative torrent websites as a result of the closure, blocking, or arrest of numerous public trackers, including [The Pirate Bay], [KickassTorrents], and [ExtraTorrent]. Conversely, private trackers are challenging to target since they function covertly and safeguard users' identities and online activity using a range of techniques like encryption, proxies, VPNs, and seedboxes. They also benefit from having a devoted and devoted user base that contributes to the upkeep and expansion of the audience and their content. Personal tracker users must fulfill specific criteria, such as residing in maintaining equilibrium, growing, and being involved in the community. These requirements ensured that the tracker had a healthy and active swarm of peers, who could provide fast and consistent download speeds and a wide range of content.

Shift to legal content distribution 2010:

Streaming services and other tools became popular among consumers in the 2010s who were looking for software, games, movies, and music. Although torrent sites have always been the primary source of illegal content, they were unprepared for this recent surge. Unrestricted access to copyrighted content is made possible by certain torrent sites, such as KickassTorrents and Pirate Bay, which operate in a legal grey area[1][2]. However, authorities and ISPs constantly threaten to sue them, seize their property, and block them.

Public torrents allow for the free viewing, sharing, and distribution of both inexpensive and classic commercial films [4]. You can get historical and cultural data, as well as seeds of other open-source software and Linux distributions, via the Internet Archive and Linux Tracker [5–6]. These secure torrent websites demonstrate that sharing information via torrents may be beneficial and safe without posing a threat or breaking any laws. By offering legitimate torrents, these websites promote public works projects, democracy, alternative media, and free and open-source software.

Blockchain and decentralized torrents 2020:-

Decentralized torrenting is a peer-to-peer system for distributing files over the internet that stores and verifies metadata using blockchain technology so that anybody can view and download it without needing root access. While it has advantages like privacy, restricted access, and lower bandwidth costs, it also has drawbacks like robustness, security, and compliance. The term "scalability" describes how well a blockchain protocol can manage many users and transactions in relation to its constraints, including size, block time, and confirmation process. Protection against malicious assaults, such as denial-of-service attacks, man-in-the-middle attacks, Eclipse attacks, and Sybil attacks, that can compromise network security and data sharing is known as security. User confidentiality and anonymity. Compliance refers to the processes and users adhering to the guidelines and policies of the authority under which they function, since many torrent formats have the potential to host illicit, counterfeit, or pirated information, endangering the rights of private property owners as well as social standards.

2.2) How torrents work:-

File Creation: Users who want to share a file with others start the process by creating a small file called a torrent. This file contains metadata information about the files to be shared, including their names, sizes, and formats. The torrent file also contains information about the viewer.

Trackers are servers that help manage communication between peers on the network. Followers keep a list of friends who have information or some of the information and help them find each other.

The user then uploads the torrent files to a public or private website; here other users can download files and join the website network. Users who create torrent files are called seeders, and users who download files are called leechers. Seeders and leechers together form a swarm. According to a 2010 study by TorrentFreak, the average number of pirates on various torrent sites is 1.66, meaning that there are more pirates than seeders in the torrent network [1]. Users can also choose to encrypt torrent files to prevent unauthorized access or modification.

Users can also set up private torrents; This means the tracker will only accept links from authorized friends and the torrent will not be listed on public websites. This way, users can control who has access to information and limit the impact of content.

Torrent files are generally small; It varies from a few thousand bytes to several megabytes, depending on the number and size of the shared file.

Torrent Client: A torrent client is a software application that allows users to share files using the BitTorrent protocol. The torrent user must open the torrent file. The torrent client then displays some information about the torrent archive, such as the name, size and format of the files to be shared, the number of seeds and downloaders in the flock, download and download speed, and download progress. Information sharing process.

After opening the torrent file, the torrent client will connect to the tracker. The tracker will send a friends list to the torrent user, and the torrent user will call their friends and ask for the archived information they need. The torrent user also sends the files he has to other friends who request them. This allows peers to exchange information with each other without being tied to a central server or location. The torrent user will also contact the tracker from time to time to update their status and get a new peer list using something called a peer ID. The tracker acts as an assistant but does not store or transmit data itself.

The torrent user will verify the authenticity of the data by comparing the cryptographic hash value of each segment with the cryptographic hash value in the torrent file. Tracker communication takes place in two steps [1].

Announce: When a peer wants to join a swarm, it sends an announce request to the tracker, containing information such as the torrent's info hash, the peer's IP address and port, the amount of data uploaded and downloaded, the number of pieces left, and the event (started, stopped, completed, etc.). The tracker responds with an announced reply, containing a list of other peers in the swarm, their IP addresses and ports, and their peer IDs. The peer can then contact the other peers directly and exchange file pieces with them.[2][3]

Scrape: When a peer wants to obtain general information about a torrent, such as the number of seeders (peers who have the complete file), leechers (peers who are still downloading the file), and completed downloads, it sends a scrape request to the tracker, containing the torrent's info hash. The tracker responds with a scrape reply, containing the requested statistics[4][5]

The tracker knows which peers have which parts of the file by using a mechanism called "bitfield". A bit field is a string of bit that represent the availability of each block of data in the peer. For example, if there are 8 blocks in the file and friend has the first, third and seventh blocks, the bit position should be 10100010. The tracker transmits each friend's bit to the other friends in the swarm, so they can request the blocks they want from the friends who own them. This small field is updated every time a friend uploads or downloads a new block. [6]

Track verification: It is a way to ensure that files downloaded using a torrent client are complete and error-free. The hash of each segment is checked using the same hash function (SHA-1) used to generate the hash. The hashes come from the torrent file and there are hashes for each part of the file. If authentication fails, the data is discarded and requested again[1].

3. Social, Cultural and Ethical Issues of BitTorrent:-

Social and Ethical issues:

Cohen initially introduced BitTorrent as a free, open-source project at a hacker conference in 2002. Originally targeting geeks seeking a cost-effective way to exchange Linux (an operating system) software, Kali for hacking, to name one of the popular ones, it found a much larger audience among TV and movie enthusiasts. The purpose of sharing software that is open source means that software has always been made to be accessible and improved by everybody rather than being owned by a particular entity.

While the technology behind BitTorrent is legal, BitTorrent's innovative sharing features have resulted in massive infringement of intellectual property rights (*Social Impact/Legal Issues*, 2012). Copyright rules may impose legal liability on those distributing BitTorrent files or connections, further complicating the legal environment (*Social Impact/Legal Issues*, 2012). Then there are utilizers of torrenting. Users often upload and share movies, software, and other content in direct violation of intellectual property laws. BitTorrent's ease of use has made copyrighted material easily accessible to users without the need for financial transactions. Users can acquire movies and software without paying, affecting industries like movies and software and posing social questions about the ethics of obtaining content for free (*Social Impact/Legal Issues*, 2012). Traditional CD and movie sales have declined, which has been attributed to BitTorrent's ease of access to content. Industry associations, such as the Motion Picture Association of America (MPAA) and the Recording Industry Association of America (RIAA), attribute this decline to torrenting, leading to legal battles (*Social Impact/Legal Issues*, 2012).

When BitTorrent websites are unsupervised, the chances of the site being used as a propagation space for viruses and malware by hackers who are willing to go from shutting down computers to stealing important information. We can see adware featured on many torrent sites taking advantage of the users logging in.

Torrenting culture:- When talking about culture in general, we look at the values that certain individuals have that guide their behavior and perception in a community. The bit torrent users themselves share the sense of belonging to a community by downloading and uploading files between them. This tit-for-tat relationship is the basis that drives peer2peer communication and can be analyzed to pick into the mindset of torrent users towards their contribution in maintaining this communication:

1) Reciprocity and Common Good:

- Torrenting culture is built on the principles of reciprocity and the common good, emphasizing the idea that users should contribute by both downloading (leeching) and uploading (seeding) files.
- Without generosity and a sense of community, torrenting communities and trackers would become obsolete, leading to a decline in the available material.

2) Private Trackers and Exclusivity:

- Private trackers are exclusive BitTorrent communities where users need invitations from current members to join
- Membership is often restricted to maintain community integrity, and invitations are typically given to trusted users based on their contribution and status with the community (*BitTorrent - SI410*, n.d.)
- Enforced sharing ratio - private trackers use enforced sharing ratios, calculated as the amount uploaded divided by the amount downloaded (usually in megabytes or gigabytes), to ensure users contribute to the community. Users must maintain their ratio above a specified threshold to continue downloading torrents. Falling below the set threshold puts users on “ratio watch” and they are warned to increase the ratio within a certain timeframe to avoid account suspension or banning (*BitTorrent - SI410*, n.d.).
- Free Leech Torrents- Certain private trackers provide “free leech” torrents, meaning that while the download doesn’t affect the user’s ratio, subsequent uploads do. This feature allows users to build their ratio without affecting it negatively during certain downloads(*BitTorrent - SI410*, n.d.)

A live Culture of BitTorrent:- The author Jennifer Sano-Franchini in her paper on the Intellectual and cultures of BitTorrent conducted a mini-ethnography, a description of customs of individual people in cultures, of the BitTorrent community who.fm, aimed at understanding the cultural practices and the working of these communities. Founded in 2003, Who.fm is a tiny, exclusive community that is accessible exclusively via invitation. Regarding share ratios, behavior, and idleness of members, they have very severe standards(Sano-Franchini, 2010). This community is unique for several reasons, including its focus on independent music creating a very distinct sense of community among members, and a self-sufficient market economy that doesn’t require financial resources(Sano-Franchini, 2010).

Through examining the who.fm culture, the author found that culture plays an essential role in the context of BitTorrent communities. She argues that intellectual property is not solely a matter of law, but also culture. The author suggests that the evolution of technology has created a disconnect between cultural norms and traditions.

Legal and illegal issues of BitTorrent:

Illegal issues of BitTorrent:

Copyright Infringement:

- BitTorrent is often associated with the illegal distribution of copyrighted materials such as movies, music, software, and other proprietary content without proper authorization.

Piracy Concerns:

- The decentralized and peer-to-peer nature of BitTorrent makes it challenging to regulate or control the unauthorized sharing of copyrighted material, leading to concerns about piracy.

Legal use:

The legal distribution of digital content is when the intellectual property has no copyright, which means open-source. This can occur when content is not registered by the copyright office under the issuers of the intangible material and is thus not protected by the copyright law. The other way is for the copyright to become obsolete. We must also take into account what requirements have to be met for the copyright law to allow the reproduction of digital content to vary from government to government and from time to time (Marks, 2023).

Ways digital copyright is protected- By amending the copyright law to include strict punishments to users for illegal distribution of copyright content. ISPs together with copyright authorities monitor the users in the torrent network and warn them of illegal actions. This can go as far as shutting down the torrent website that hosts files facilitating copyright infringement, aiming to disrupt the illegal distribution (Marks, 2023).

4. Improving BitTorrent Topologies and Technologies:-

While researching for this project, our group has found that there are several ways of improving the technology of BitTorrent. The following include some of the ways BitTorrent can be improved.

4.1) Improving locality: -

One of the ways of improving BitTorrent is by increasing its locality. What do we mean by locality? Locality in the context of torrenting is the efficient distribution of data amongst the peers in the network. Locality is improved when a peer receives the data from one of its closest peers in the network. As a result, data transfer in the network becomes efficient. The formula of measuring locality is given below: -

$$L = (\sum_{a,b} \sigma(a, b) * d(a, b) * E[D]^{-1}) / \sum_{a,b} \sigma(a, b) \quad (\text{Decker et al., 2013})$$

In the above formula, a and b are peers. The value of $\sigma(a, b)$ can be either 0 or 1 which denotes if two peers are not connected or connected respectively. The value of $d(a, b)$ denotes whether. $E[D]$ indicates the expected distance between all possible connections (a, b) (Decker et al., 2013). The smaller the value of L , the locality is better. Furthermore if locality is close to or greater than 1, it is not locality-aware (Decker et al., 2013).

Decker, Eidenbenz, and Wattenhofer used a method known as Suggesting Neighbors to improve the locality of BitTorrent (Decker et al., 2013). The method uses a protocol called peer exchange (PEX) messages. This BitTorrent protocol allows peers to send lists of peer addresses to other peers (Decker et al., 2013). When a peer gets connected, more nearby peers get discovered by the PEX protocol (Decker et al., 2013). Since the PEX message contains IP address and port numbers of numerous peers, each peer in the message is called a suggestion (Decker et al., 2013). As a result, the peer can randomly select a suggestion from its set of peers and can try to establish a connection with it (Decker et al., 2013). Since the protocol allows more nearby peers to be discovered, it is more likely to get a peer that is close to the host peer instead of a peer that is too far away. A suggestion is successful if two peers get connected (Decker et al., 2013).

Decker, Eidenbenz, and Wattenhofer used the locality formula to measure the performance of their Suggesting Neighbors method (Decker et al., 2013). They had two groups; one was under the influence of the Suggesting Neighbours method, and the other was not. The group with the Suggesting Neighbors method received a locality of 0.994, while the non-influenced group had a locality of 1.062 (Decker et al., 2013). Since the method proposed by Decker, Eidenbenz, and Wattenhofer had a lower value for the locality, their locality is better. The PEX suggestion method had a 6.3% improvement in locality over the non-influenced group (Decker et al., 2013).

4.2) Distributed Swarm Management Algorithm (DISM): -

The set of peers exchanging pieces of a torrent is known as a swarm. The size of a swarm affects file-sharing performance. Analyzing data shows smaller swarms result in lower throughput (Dán & Carlsson, 2009). There are smaller swarms in the network, raising further concerns. Distributed Swarm Management algorithm can make a significant impact to improve the performance (Dán & Carlsson, 2009).

The DISM algorithm was designed to handle four cases. They are given below:-

- If swarms are considered too small, merge them to form a larger swarm. Larger swarms as mentioned earlier help enhance performance.
- If swarms become too large, split or re-balance them. Smaller swarms have benefits too. Allowing smaller swarms to exist can help with load sharing and reliability purposes (Dán & Carlsson, 2009).
- Maintain load conservation so that a tracker does not get overwhelmed with a huge number of peers.
- Reducing the number of peers that get shifted from one tracker to another (Dán & Carlsson, 2009).

The DISM algorithm consists of two algorithms. The two algorithms are given below:-

Distributed Negotiation Algorithm: -

Distributed Negotiation Algorithm assumes that each tracker knows about the set of torrents that it shares with other trackers (Dán & Carlsson, 2009). As a result, the sets of torrent that these trackers track are not disjoint.

The algorithm is initiated by the tracker sending out invitations to other trackers to carry out pairwise balancing (Dán & Carlsson, 2009). The receiving tracker will try to find the maximum overlap of the sets of torrents between it and the sending torrent. Due to this algorithm, it allows pairs of trackers to perform pairwise balancing only once (Dán & Carlsson, 2009). As a result this prevents repeated negotiations from taking place. When the receiving tracker finds the tracker with the highest overlapping sets of torrents, it accepts its invitation (Dán & Carlsson, 2009). Hence the host pair carries out pairwise balancing by querying the other host (Dán & Carlsson, 2009). This algorithm ensures fairness and efficiency in the distribution of torrents across the network of trackers.

Pairwise Approximation Algorithm:-

Pairwise Approximation Algorithm aims to improve the load conservation and it does this by performing three steps.

Step 1) Tentative peer shifting is carried out as the first step in the process. If a certain torrent requires merging, all the peers are shifted to the tracker who already has information regarding those peers (Dán & Carlsson, 2009). If a certain torrent requires re-balancing or splitting, the minimum number of peers required such that both trackers have the same amount of peers are tentatively shifted to the tracker with fewer peers (Dán & Carlsson, 2009).

Step 2) Peer responsibility adjustment of some torrents is carried out to achieve load conservation. By utilizing a greedy algorithm, allocations are removed from a tracker who is responsible for a lot of peers and given to a tracker who is responsible for less (Dán & Carlsson, 2009).

Step 3) Additional load adjustments are performed as the third step. This step is performed if load conservation has still not been achieved (Dán & Carlsson, 2009). It is done by flipping the responsibilities of the pair of torrents such that load conservation is perfect (Dán & Carlsson, 2009). Pruning and optimizations are introduced to reduce the complexity.

The researchers conducted experiments to identify whether the DISM algorithm actually improved the throughput of smaller swarms. They used Little's law ($S = I / \lambda$) and estimated that throughput to be equal to LD / IT (Dán & Carlsson, 2009). L is the file size, D is the number of downloads during that day, I is the number of leechers being currently served and T is the time between two measurements (Dán & Carlsson, 2009). Results showed that smaller swarms could improve their throughput up to 70% and larger swarms were affected less. Hence the dynamic swarm management algorithm (DISM) plays a significant role in improving the performance of file sharing between peers.

Conclusion:-

BitTorrent has made an essential impact on the digital world. Our project explores different aspects of BitTorrent. Researching these aspects helped us understand how it became so significant. This technology has forever changed how humans interact and share content. It has allowed both communities to form and raise legal issues. The technology of BitTorrent is still evolving, and one day it could become much more advanced with lower ethical concerns.

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