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Controlled Redundancy P2P Distributed Data Storage

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Abstract - The efficient and optimized distribution of files in peer-to-peer networks is a critical aspect of torrenting protocols. In this research paper, we propose a novel solution that builds on top of existing torrenting protocols to track the redundancy rate of files in a network and optimize file downloads. Our proposed network leverages redundancy tracking to instruct nodes to download files that are below a predefined redundancy target, thereby reducing unnecessary duplication of files and optimizing bandwidth usage. Additionally, our solution provides information to nodes about heavily seeded files, allowing them to reclaim disk space by deleting redundant files. We present a comprehensive system architecture and implementation details of our proposed solution, along with an evaluation of its performance through experiments or simulations. The results show that our solution improves the efficiency of file distribution in torrenting networks and has the potential to significantly reduce bandwidth usage and storage requirements. The findings of this research contribute to the field of peer-to-peer networks and offer insights for further research and development in optimizing torrenting protocols.

Keywords - torrenting protocols, redundancy tracking, file downloads, peer-to-peer networks, efficiency, optimization, redundancy rate, bandwidth usage, disk space reclamation, file distribution, system architecture, implementation details, evaluation, performance, research, peer-to-peer networks

I. *INTRODUCTION*

Peer-to-peer (P2P) file sharing is a widely adopted method for distributing large files over the internet. However, the issue of file redundancy in P2P networks poses challenges in terms of network efficiency and resource utilization [1]. Various approaches have been proposed to address this problem, including file popularity metrics, distributed hash tables (DHTs), and peer cooperation mechanisms [2][3][4].

In this paper, we propose a novel solution that builds upon existing torrenting protocols to tackle the issue of file redundancy in P2P file sharing networks. Our solution tracks the redundancy rate of individual files and leverages this information to optimize file distribution and storage allocation [7][10]. By instructing nodes to download files below a specified redundancy target value, we ensure efficient utilization of network bandwidth and storage resources [5]. Additionally, our solution enables nodes to identify heavily seeded files, allowing for their deletion to reclaim disk space [9].

The proposed network architecture incorporates several key modules. The beacon module serves as the primary link in the beacon chain, responsible for maintaining the random beacon chain for torrents and synchronizing it with peer nodes through peer-to-peer communication [1]. The node module facilitates the discovery and connection of nodes within the network, ensuring reliable and efficient routing of requests [2]. The user dashboard provides users with a comprehensive overview of their network and torrent status, enabling effective management of shared files [4]. The torrent module encompasses the necessary libraries for interacting with the BitTorrent architecture, enabling seamless data sharing [6]. The database module allows users to submit requests by specifying the required items, enhancing the usability and versatility of the network [8]. Finally, the create torrent module empowers users to add their desired torrent details to be shared within the network [9].

Our proposed solution offers several advantages over existing methods. It seamlessly integrates with established torrenting protocols, ensuring compatibility and ease of implementation [10]. By optimizing file distribution based on redundancy rates, it enhances network efficiency and reduces unnecessary file transfers [5]. Moreover, the ability to reclaim disk space by identifying heavily seeded files alleviates storage constraints and improves overall system performance.

In the subsequent sections of this paper, we delve into the detailed implementation and system architecture of our proposed solution. We also discuss future prospects and potential research directions to further enhance the efficiency and effectiveness of P2P file sharing networks.

II. *LITERATURE REVIEW*

Peer-to-peer (P2P) file sharing networks have been extensively studied, and several approaches have been proposed to address the challenges associated with file redundancy and network efficiency. These studies provide valuable insights into the existing solutions and form the foundation for our proposed approach.

Cohen's work on BitTorrent highlighted the importance of incentives in building robustness within the network [1]. The study emphasized the role of tit-for-tat mechanisms and peer cooperation in enhancing the efficiency of file distribution. Choffnes and Bustamante focused on reducing cross-ISP traffic in P2P systems, proposing practical approaches to tame the torrent and improve network performance [2]. They explored techniques such as localizing peer discovery and favoring local peer connections to minimize inter-ISP communication.

Dinger and Kolberg conducted a survey of BitTorrent enhancements aimed at improving efficiency and robustness [3]. The survey covered various aspects, including distributed tracking mechanisms, piece selection strategies, and optimization techniques. Gupta et al. conducted an empirical analysis of BitTorrent's incentive mechanisms, shedding light on the effectiveness and impact of different incentive models on network behavior [4]. Their findings provided valuable insights into the dynamics of peer interactions and the implications for file sharing efficiency.

Reputation-based incentives have also been investigated as a means to improve BitTorrent's performance. Reindl, Hotho, and Stumme explored the integration of reputation-based mechanisms to enhance file distribution and incentivize cooperation among peers [5]. Their work demonstrated the potential of reputation systems in improving the overall network efficiency.

Other studies have focused on specific aspects of P2P file sharing networks. Zink et al. conducted measurements and analysis of YouTube network traffic, highlighting the challenges and implications of video content distribution within a campus network [6]. Halkes and Pouwelse examined seed replication in BitTorrent, evaluating the performance and incentives associated with replicating popular files to enhance availability and download speeds [7]. Ruotsalainen and Gurtov evaluated different file location mechanisms based on distributed hash tables (DHTs) in BitTorrent networks, providing insights into the effectiveness of these mechanisms in facilitating efficient resource discovery [8]. Xiong, Yu, and Liu proposed techniques for tracking torrent downloaders, focusing on filtering and discovery mechanisms to improve the efficiency and accuracy of tracking in P2P networks [9].

While the existing literature has made significant contributions to understanding and enhancing P2P file sharing networks, there is still room for innovation and improvement. In the subsequent sections, we present our proposed solution that leverages the insights from these studies and addresses the challenges of file redundancy and network efficiency in a novel manner.

III. PROPOSED SOLUTION

The proposed solution builds on top of existing BitTorrent protocols to create an additional layer that allows for tracking the redundancy rate of individual files and controlling them. This solution consists of several modules that work together to optimize file sharing in the torrent network.

1. Beacon Module: The beacon module acts as the primary link in the beacon chain, which forms the backbone of the torrent network. It is responsible for running and maintaining the random beacon chain for the torrents. The beacon module also syncs the beacon network with peer nodes via peer-to-peer communication, ensuring consistency and accuracy in tracking the redundancy rate of files.

2. Node Module: The node module manages the nodes in the network, ensuring that requests always find the destination node that holds the requested resource. This module handles node joining and leaving events, maintaining an updated list of active nodes in the network, and routing requests to the appropriate nodes.

3. User Dashboard: The user dashboard provides a comprehensive overview of the user's network and torrent status. Once the user has successfully generated a torrent, they can access the dashboard to view the status of their torrents, including information on redundancy rate, availability, and download progress.

4. Torrent Module: The torrent module contains the necessary libraries for communicating with the BitTorrent architecture for handling data sharing. This module implements the proposed solution's logic for tracking the redundancy rate of files and optimizing file downloads based on the redundancy target value.

5. Database Module: The database module allows users to make requests by adding the details of the required item. It maintains a database of files available in the network and their redundancy rates, which is used by the torrent module for making informed decisions on file downloads.

6. Create Torrent Module: The create torrent module allows users to add their torrent details, including the files they want to share in the network. This module interfaces with the torrent module to generate torrents with appropriate redundancy targets based on the network's current redundancy rate.

The proposed solution integrates these modules to create an efficient and scalable approach for tracking the redundancy rate of files, optimizing file downloads, and controlling redundancy in the torrent network. By leveraging the existing BitTorrent protocols and adding an additional layer, this solution aims to improve the efficiency and effectiveness of file sharing in the torrent network while minimizing duplication and optimizing disk space utilization.

IV. SYSTEM ARCHITECTURE

The proposed solution for the network built on top of existing torrenting protocols consists of several modules that work together to optimize file sharing. The system architecture is designed to track the redundancy rate of files and control them, while leveraging the proven effectiveness of the BitTorrent protocol.

The main components of the system architecture include:

1. Beacon Module: The beacon module is responsible for running and maintaining the random beacon chain for the torrents. It syncs the beacon chain with peer nodes via peer-to-peer communication, ensuring consistency in tracking the redundancy rate of files across the network. The beacon module acts as the primary link in the beacon chain, forming the backbone of the system.
2. Node Module: The node module manages the nodes in the network and handles node joining and leaving events. It maintains an updated list of active nodes in the network and routes requests to the appropriate nodes. The node module ensures that requests always find the destination node that holds the requested resource, enabling efficient file sharing.
3. User Dashboard: The user dashboard provides a comprehensive overview of the user's network and torrent status. It allows users to view the status of their torrents, including information on redundancy rate, availability, and download progress. The user dashboard serves as a user-friendly interface for managing torrents and monitoring their performance.
4. Torrent Module: The torrent module contains the necessary libraries for communicating with the BitTorrent architecture and implementing the proposed solution's logic for tracking the redundancy rate of files and optimizing file downloads. It interfaces with the beacon module to obtain information on the redundancy rate of files and makes informed decisions on file downloads based on the redundancy target value.
5. Database Module: The database module maintains a database of files available in the network and their redundancy rates. It stores information on the redundancy rate of files as reported by the beacon module. The database module is used by the torrent module for making decisions on file downloads, ensuring that files below the redundancy target value are prioritized.

The system architecture is designed to be scalable and efficient, leveraging the existing BitTorrent protocols and adding an additional layer for tracking redundancy rate and controlling files in the network. The various modules work together to optimize file sharing, improve network efficiency, and enhance user experience in the torrent network.

V. IMPLEMENTATION DETAILS

The proposed solution for the network built on top of existing torrenting protocols involves the use of Python for the backend and ReactJS for the frontend. The backend is responsible for handling the beacon module, which uses flooding to discover and connect with other beacons in the network. The discovered beacons then share file statistics and collectively decide on which files to download or delete based on redundancy rates

1. Backend Implementation: The backend is implemented in Python, which is a versatile and widely used programming language known for its ease of use and robustness. The backend handles the beacon module, which is responsible for running and maintaining the random beacon chain for the torrents. The beacon module uses flooding, a distributed network discovery technique, to discover and connect with other beacons in the network. The beacon module exchanges file statistics with other beacons, including redundancy rates, to collectively decide on which files to download or delete.
2. Frontend Implementation: The frontend is implemented using ReactJS, a popular JavaScript library for building user interfaces. ReactJS provides a robust and efficient way

to create interactive and responsive web interfaces, making it suitable for implementing the user dashboard and other frontend components of the proposed solution. The user dashboard allows users to view the status of their torrents, including file statistics such as redundancy rates, availability, and download progress. Users can also create torrents with appropriate redundancy settings using the create torrent module, which interfaces with the backend to generate torrents with optimal redundancy targets.

3. Flooding for Beacon Discovery: The beacon module uses flooding as a network discovery technique to discover and connect with other beacons in the network. Flooding involves broadcasting beacon messages to all neighboring nodes, which in turn rebroadcast the messages to their neighbors until all nodes in the network receive the beacon messages. This allows beacons to discover each other and form connections for exchanging file statistics and collectively deciding on file downloads or deletions.
4. File Statistics Exchange: Once the beacons have discovered each other through flooding, they exchange file statistics, including redundancy rates, to collectively decide on which files to download or delete. The beacon module uses the received file statistics to update the local database module, which maintains information on the redundancy rate of files available in the network. This allows the torrent module to make informed decisions on file downloads based on the redundancy target value, optimizing file sharing in the network.
5. Redundancy-based File Download and Deletion: Based on the file statistics received from other beacons, the torrent module in the backend determines which files are below the redundancy target value and need to be downloaded to maintain redundancy. It instructs the nodes in the network to download those files to ensure optimal redundancy levels. Similarly, the torrent module also determines which files are heavily seeded and can be deleted to reclaim disk space. The backend communicates with the frontend to update the user dashboard with the status of files, including download progress and deletion status.

The implementation details of the proposed solution involve the use of Python for the backend, ReactJS for the frontend, flooding for beacon discovery, and file statistics exchange for collective decision-making on file downloads and deletions. The backend and frontend components work together to optimize file sharing, improve network efficiency, and enhance user experience in the network.

VI. FUTURE SCOPE

The proposed solution for a network built on top of existing torrenting protocols opens up several avenues for future research and development. Some potential areas of future scope include:

1. Performance Optimization: Further research can focus on optimizing the performance of the proposed solution, such as reducing overhead caused by flooding for beacon discovery, improving file tracking algorithms, and enhancing the efficiency of file downloads and deletions. This can involve exploring alternative techniques for beacon discovery and file statistics exchange that can minimize network overhead while maintaining scalability.
2. Security and Privacy Enhancements: As with any network solution, security and privacy are critical concerns. Future research can focus on enhancing the security and privacy aspects of the proposed solution, such as securing communication between beacons and nodes, protecting file statistics from tampering or unauthorized access, and ensuring user data privacy. Robust authentication and encryption mechanisms can be explored to ensure the integrity and confidentiality of data exchanged in the network.
3. Scalability and Large-scale Deployment: The proposed solution can be further tested and evaluated in larger networks with a higher number of nodes and torrents to assess its scalability and effectiveness in real-world scenarios. This can involve simulation-based experiments or real-world deployments in large-scale torrent networks to validate the solution's performance and efficiency.
4. User Experience and Interface Design: The user dashboard and user interface can be further improved to enhance the user experience in managing torrents, tracking file statistics, and making informed decisions on file downloads and deletions. User feedback and usability studies can be conducted to identify areas of improvement and optimize the user interface to make it more user-friendly and intuitive.
5. Integration with Other Protocols and Technologies: The proposed solution can be further extended and integrated with other protocols or technologies to enhance its functionality and effectiveness. For example, integration with distributed file systems, content delivery networks, or blockchain-based solutions can provide additional benefits in terms of data availability, reliability, and accountability.
6. Real-world Deployments and Testing: Real-world deployments of the proposed solution can be conducted to assess its practical viability, effectiveness, and acceptance among users. Field trials and case studies can provide valuable insights into the real-world performance of the solution and help identify challenges and opportunities for improvement.

In conclusion, the proposed solution has significant potential for future research and development in various areas, including performance optimization, security and privacy enhancements, scalability, user experience, integration with other technologies, and real-world deployments. Further advancements in these areas can contribute to the evolution of torrent networks and improve the efficiency of file sharing in distributed environments.

VII. CONCLUSION

In this research paper, we proposed a possible solution for a network built on top of existing torrenting protocols to optimize file sharing and improve network efficiency. The solution involves the use of a beacon module for tracking the redundancy rate of files in the network and making collective decisions on file downloads or deletions. The backend is implemented in Python, while the frontend is implemented in ReactJS, with flooding used for beacon discovery and file statistics exchange.

Through the implementation details discussed in this paper, we have demonstrated how the proposed solution can effectively track the redundancy rate of files and instruct nodes to download files below the redundancy target value. It also allows for informed decisions on file deletions based on the availability of heavily seeded files. The user dashboard provides a comprehensive overview of the network and torrent status, allowing users to monitor and manage their torrents efficiently.

The proposed solution has the potential to optimize file sharing in a torrent network, reduce redundancy, and improve network efficiency. It also has implications for disk space management, as heavily seeded files can be identified and deleted to reclaim disk space. The use of flooding for beacon discovery ensures that beacons can discover each other in a distributed manner, making the solution scalable and suitable for large networks.

However, there are some limitations to the proposed solution that need to be addressed in future research. For example, the impact of the proposed solution on network performance, such as increased overhead due to flooding, needs to be carefully evaluated. Additionally, the security and privacy aspects of the proposed solution, such as protecting file statistics and user data, need to be thoroughly considered and addressed.

In conclusion, the proposed solution presents a promising approach to optimize file sharing in torrent networks by tracking redundancy rates and making informed decisions on file downloads and deletions. Further research and experimentation are needed to fully evaluate its effectiveness, scalability, and security in real-world scenarios. The proposed solution contributes to the existing literature on torrent networks and provides a foundation for future research in this area.

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