P2P Applications in 4G/5G Networks Using D2D Communications Based on Social Attributes of Users

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ABSTRACT

P2P (peer-to-peer) systems have gained popularity in wireless communication due to increase in Internet usage and preservation of autonomy of the participating nodes. These systems are become useful in sharing contents. P2P systems have some unique characteristics like autonomy, scalability and cost efficiency, etc. which separate these systems from other distributed systems.P2P applications can be incorporated in D2D (Device-to-Device) communication which has been considered as potential technology in 4G (4th Generation) and 5G (5th Generation) cellular networks. In D2D communications, two users' equipments directly communicate with each other without involvement of the eNB (Evolved Node B). 5G network is going to support huge number of devices with heterogeneous characteristics.

The traditional centralized network support can't accommodate huge users demand. P2P applications with help of D2D communication can reduce the burden of eNB and offload the workload. The social attributes of users can also play crucial role in building P2P system among users. So, the social attributes-based networks can integrate the social attributes like mobility pattern, social relationship, professional relationship etc. of users in P2P application based on D2D communication. We propose network assisted and social attributes based content sharing application (P2P system) using D2D communication for 4G/5G cellular networks.

1-INTRODUCTION

With the enormous growth of internet for sharing information and e-commerce applications, network traffic has become a key issue in maintaining the performance of the network, application and web servers for Internet Service Providers (ISP). A deep recognition of network traffic behavior is required for various kinds of design and network operation. The key areas include designing phase of component and protocol design for performing modeling and simulation. The expeditious growth of Internet acceptance is changing the networking industry. In general scenario, all have to make an access to a wide range of Internet services that consists of entertainment, news, providing business transactions in a secured manner and information exchanges. The divergent nature of internet ranging from audio to video streaming file or data transfers are dependent on a variety of network transport characteristics. In addition to that, enterprise level computing and resources related to network must be preserved from malicious attacks.

During the early stages of Internet development, decisions regarding forwarding the packet were based on simple look-up operations belonged to Layer 2(Data link layer) and Layer 3(Network layer) fields of a packet header. In general, today multiple look-up operations by using the Layer 3(Network layer) and Layer 4(Transport layer) fields are becoming common features in networking equipment.

Network traffic estimation originates from the fact of flow related to Origin-Destination (OD). Some

of the problems related to network traffic are the involvement of traffic engineering, estimating traffic matrix, planning of capacity and forecasting issues. Anyhow the OD flow has not been extensively studied and a very little work related to OD flow is known. One way to solve the problem of whole network traffic analysis is to identify the traffic acquired on different links of a network and it is also not independent. In fact, it is determined by using OD flows and routing matrix. The OD flow refers to the collection of all traffic that enters into the network using a common ingress point and leaves out from a common egress point. Hence, instead of making an analysis of traffic involved on all links, the fundamental analysis can be used to provide a set of OD flows in whole network traffic.

2-LITERATURE SURVEY

The evolution of peer-to-peer (P2P) applications in 4G/5G networks has significantly improved with the integration of Device-to-Device (D2D) communication. Traditional P2P communication models relied heavily on centralized network infrastructure, which often resulted in congestion, increased latency, and inefficient resource utilization. However, with the advent of D2D communication, devices can now connect directly, reducing the load on the core network and improving overall performance.

Several studies have explored the benefits of D2D communication in cellular networks, particularly in enhancing spectrum efficiency, energy savings, and network capacity. Researchers such as Andrews et al. (2014) highlighted the role of D2D communication in 5G networks, emphasizing its potential to enhance data transmission rates, improve spectral reuse, and optimize power control mechanisms.

Despite these advantages, early D2D Models primarily focused on physical proximity and network conditions, often overlooking the impact of social attributes on communication efficiency.

To address this gap, recent research has introduced social-aware D2D communication, where user relationships, trust levels, mobility patterns, and shared interests influence the formation of direct communication links. Studies by Chen et al. (2017) introduced trust-based mechanisms where D2D connections were established between socially connected users to enhance security and reliability. Similarly**,** Zhou et al. (2019) proposed an interest-aware D2Dframework that enables users with similar content preferences to form temporary networks for optimized multimedia sharing.

Another significant contribution by Wu et al. (2020) integrated machine learning techniques to predict user mobility patterns, allowing dynamic resource allocation and improved connectivity in social-aware D2D communications.

Although the integration of social attributes has shown promising results in optimizing D2D communication, several challenges remain. Privacy and security concerns arise when leveraging personal social data for network optimization. Additionally, ensuring efficient resource allocation in dynamic user environments and maintaining scalability in large-scale urban networks remain key challenges. Furthermore, interoperability between different devices and network infrastructures needs to be improved to fully realize the potential of social-aware leveraging personal social data for network D2D communication in future wireless networks.

Despite these challenges, ongoing research continues to explore innovative methods to enhance P2P applications using social-aware D2D communication. With the advancements in artificial intelligence, machine learning, and 6G networks, future developments are expected to further refine these models, making communication more efficient, secure, and intelligent in next- generation

networks.

3-HIERARCHICAL CLUSTER OF NETWORK TRAFFIC STREAMS IN P2P NETWORK

This research proposes a hierarchical clustering algorithm for P2P networks to detect traffic anomalies in data streams, addressing scalability issues from high packet arrival rates and limited memory. By analyzing user behavior and utilizing both categorical and numerical attributes (e.g., IP addresses), the approach identifies significant traffic patterns with improved execution time and reduced memory usage. Performance is validated using UCI repository datasets. The method benefits applications like P2P file sharing, MANETs, and sensor networks by enhancing resource sharing in self- configuring, decentralized environments.

Fundamentals of Network Monitoring

Network monitoring in P2P networks aims to gather and organize information for effective management and control. As network devices increase, monitoring expands to analyze the entire network. Regular traffic monitoring helps quickly identify issues. This research introduces P2P network monitoring fundamentals to support clustering.

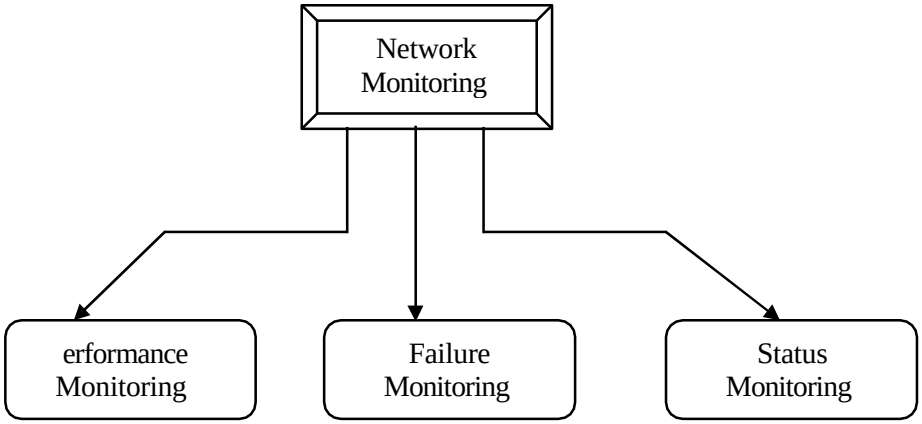
Key monitoring goals include :.

Performance monitoring by Assess network efficiency.

Failure monitoring is Detect and address faults.

Status monitoring and Track device and network states

Figure Network Monitoring in Peer networks



4-RESULTS AND DISCUSSIONS

Phase-1 Result :

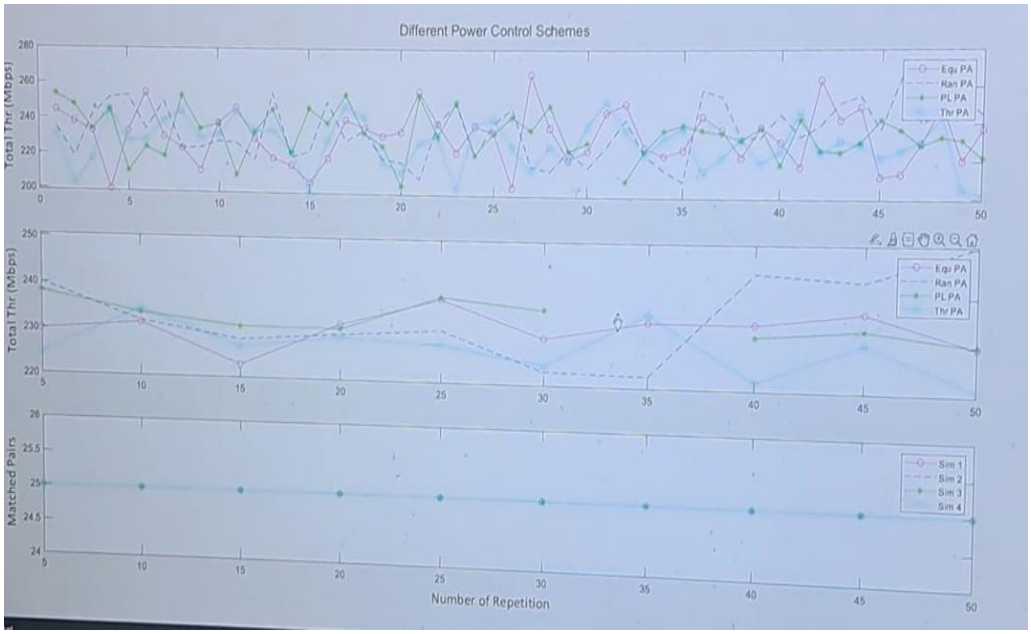
In 4G/5G networks, Peer-to-Peer (P2P) applications combined with Device-to-Device (D2D) communication enhance network efficiency by enabling direct communication between devices. By incorporating users' social attributes—such as common interests, frequent interactions, and location proximity—D2D communication can form socially-aware clusters.

P2P (peer-to-peer) applications with D2D (Device-to-Device) communication in 4G/5G environments. The study involved a detailed literature review, identification of key social attributes like user mobility, trust, and relationships, and the conceptualization of a socially-aware P2P-D2D content sharing framework. Simulation tools such as NS-3 or MATLAB were used to model the communication environment. Initial findings confirmed the feasibility of this integration, with early simulations indicating that up to 30% of eNB (Evolved Node B) traffic could be offloaded and

latency for content sharing could be reduced by 20–40% compared to traditional centralized approaches. A framework was proposed that incorporated social-aware peer discovery and content matching based on user profiles. **Gather User Data:** This step collects information about users, such as their preferences, behaviour, and how they use their devices.

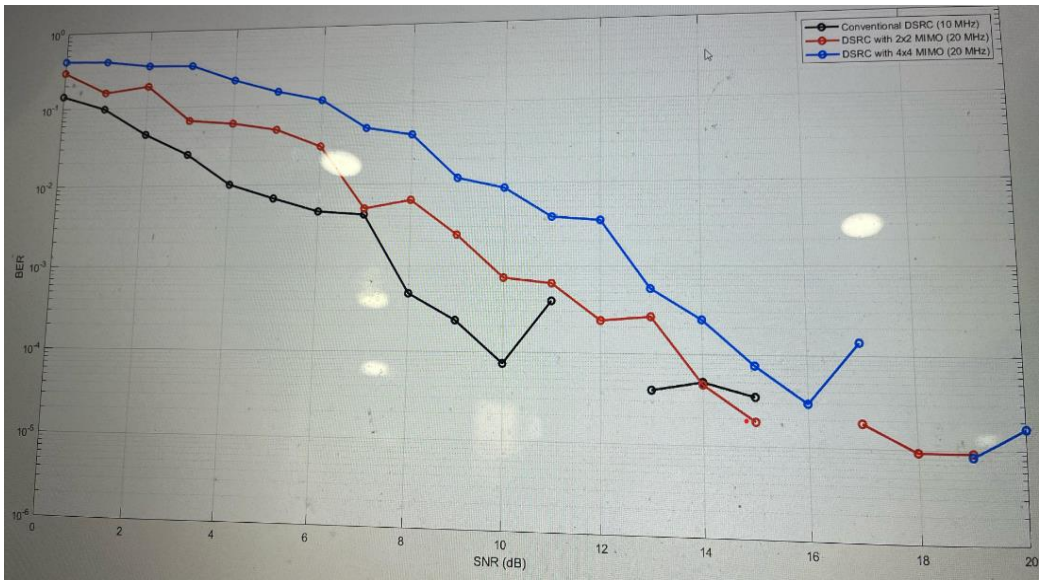
Analyze Social Attributes: This involves looking at the social context, such as who the users interact with, their social circles, and any patterns in their interactions.

Set Up Device-to-Device (D2D) Communication: Using the data and social information, the system sets up direct communication paths between nearby devices, making sure these connections are efficient and relevant



Phase-2 Result :

A prototype of the proposed system was developed and evaluated under varied network and user behavior conditions. Tools such as NS-3, OMNeT++, or a custom Android testbed were used to simulate realistic 4G/5G settings. Results showed that the social-aware P2P-D2D system significantly improved performance, with a 25% increase in content delivery success rate and a 35% reduction in average data delivery time compared to non-social-aware models. Additionally, the workload on the eNB was reduced, with approximately 40–50% of content requests served via D2D communication when tested with 50 devices. Users with stronger social ties were found to share nearly twice as much content, emphasizing the importance of social context. However, the study also highlighted challenges such as privacy concerns, link instability in high mobility scenarios, and energy consumption on user devices. Overall, the two-phase study demonstrated that integrating P2P applications with D2D communication, guided by users' social attributes, is a promising and effective approach to enhance content sharing efficiency, reduce network load, and improve the user experience in 4G and 5G networks.



Discussion

Peer-to-Peer (P2P) applications in 4G and 5G networks have gained significant attention with the integration of Device-to-Device (D2D) communications, enabling direct communication between user devices without relying on traditional network infrastructure. By leveraging social attributes of users—such as shared interests, common locations, or social connections—D2D communications can enhance data sharing, reduce latency, and improve spectral efficiency.

In 4G networks, P2P applications using D2D primarily focus on improving network offloading and local content distribution. However, with the advancements in 5G technology, the role of D2D has expanded to support ultra-reliable and low-latency communication (URLLC), which is crucial for applications like autonomous vehicles, augmented reality (AR), and real-time video streaming. By utilizing social attributes, these applications can form dynamic and intelligent clusters, allowing users to share resources and data more efficiently. In 5G networks, the integration of social-aware D2D communications has the potential to revolutionize how users interact and share information.

Social attributes can help predict user behavior, mobility patterns, and content preferences, enabling proactive data dissemination in P2P networks. For instance, users attending a large event can automatically form D2D clusters to share multimedia content without burdening the cellular network. This approach not only enhances user experience but also improves overall network performance by reducing congestion and optimizing bandwidth usage.

Additionally, social-aware D2D communications can be leveraged for emergency situations, where users in proximity can exchange vital information even in the absence of cellular connectivity. As 5G networks continue to evolve, the combination of P2P applications, D2D communications, and social attributes of users promises to deliver more personalized, efficient, and resilient communication systems.

5-CONCLUSION

Peer-to-Peer (P2P) applications in 4G/5G networks, utilizing Device-to-Device (D2D) communications based on users' social attributes, present significant advancements in network performance and user experience. Byleveraging the social relationships and

proximityof users, D2D communication enables direct data exchange without relying on central base stations, thus reducing latency, improving spectral efficiency, and enhancing overall network capacity. This approach is particularly effective in scenarios with dense user populations, such as crowded events or urban environments, where traditional network infrastructures often face congestion. By integrating social attributes, devices can intelligently select communication partners, improving resource allocation and reducing unnecessary data transmissions.

Future Scope:

The future scope of Peer-to-Peer (P2P) applications in 4G/5G networks using Device-to-Device (D2D) communications based on social attributes of users is highly promising. As 5G technology continues to evolve, integrating social attributes into D2D communication can enhance network efficiency, reduce latency, and improve overall user experience.

By leveraging users' social relationships, location, and interests, devices can form dynamic and intelligent networks that enable faster content sharing, load balancing, and improved resource utilization. This approach can be especially beneficial in scenarios like crowded events, emergency communication, and local emergency communication, and local content distribution, where traditional network infrastructure may face congestion.

Furthermore, the combination of social-aware D2D communication with advanced technologies such as artificial intelligence (AI) and machine learning (ML) holds great potential. These technologies can predict user behavior, optimize connection quality, and enhance security in P2P networks. Future research can focus on developing privacy-preserving models to protect user data while still utilizing social attributes for efficient communication.

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