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Review on 5G Network using Peer-to-Peer Communication

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Abstract*: For efficient use of data in 5G RAN, the link that still exists today, it is recommended to use the concept of communication with an integrated service environment to support radio access network (RAN). Monitoring traffic is an essential part of RAN management. The Incorporated System Resource Administration (ISRA), which divides resource requests into various types of network slices, has been proposed to accommodate different Quality of Services requirements. For direct peer-to-peer communication, ISRA utilizes a mini-cloud based on route resource needs. Peers in the network which are having high quality processing capacity undergo docking. Storing data in the mobile abode mini-cloud is a widespread practice, and it moves freely between peers. The data is backed up using the peer docking process and ambient services. Network slicing is a prominent method for enhancing network flexibility and offers the advantage of cost-effectiveness. By employing this strategy, the required bandwidth for backhaul networks is significantly reduced.*

Keywords: 5G RAN

I. INTRODUCTION

Earlier generations of flexible systems aimed to offer clients simple, reliable, and portable information services. The introduction of 5G has expanded this goal, providing a wide range of remote services across different access levels, multi-layer systems, and peer-to-peer (P2P) communication. This paper discusses the feasibility of designing a flexible and adaptable mobile core system using system decomposition and functional decay. The mobile industry needs to deliver a cost- effective performance and support process that surpasses traditional remote frameworks like LTE, providing superior coverage and an enhanced user experience. 5G is undoubtedly a flexible structure with various cutting-edge improvements, catering to diverse applications. Unlike previous architectures, 5G has a design, as Radio Access Networks (RANs) are no longer restricted by base station proximity. The direction 5G is taking involves a disaggregated, flexible, and virtual RAN, with new boundaries serving as additional information gateways. The concept of Cloud/Centralized RAN has gained prominence in the 5G era, where unified Base Band Units and Remote the Radio Heads which are connected via optical Mobile Front Haul links. This approach allows for shared resources among the combined BBUs, leading to reduced operational requirements, capital expenditures, and energy consumption. While considering the characteristics of emerging 5G scenarios, such as ultra- reliable low-latency communications for flexible broadband consumers (uRLLC), it is suggested to employ an ambient service- based peer-to-peer communication framework to overcome bandwidth limitations and address peer-to-peer data routing challenges. The structure of the paper involves an introduction to peer-to- peer 5G networks in Section 1, the proposed method elaborated in Section 2, results illustrated in Section 3, and concluding in Section 4.

II. PEER-TO-PEER CLOUD FEDERATION

This document presents a new peer-peer communication protocol for 5G networks using media services. It also commissioned the Incorporated System Resource Administration, which can allocate necessary resources to different channels. Network slicing is considered an effective way to achieve network flexibility without sacrificing cost effectiveness. This new solution reduces the bandwidth requirements of optical precarrier and blackhaul networks.

Adding to that, the integration of connections in Mobile Intelligent Black Haul networks improves resource management.

2.1 Model for Network Sharing in Telecommunication Systems

The implementation of a geographical network sharing model is accompanied by RAN. In some countries, operators collaborate by sharing their complementary 5G infrastructure through national roaming arrangements, aiming to enhance coverage. The sharing process focuses on effective radio resource management, and data routing between peers. Cooperative game theory is employed to address resource sharing and network techniques. Axiomatic sniping, a concept within cooperative game theory, provides a robust framework for determining fair and Pareto optimal operational points. Pareto optimality refers to the situation where the resources in a su pply are optimal such that a dimension can be improved without a second disadvantage a second worsening. Cooperative game theory has been widely utilized to address various challenges related to resource allocation. A game-theoretic model based on Nash bargaining solution is investigated for the distribution of bandwidth in dynamic data traffic within 5G networks. Effective data routing and adaptability should be achieved in an energy-efficient manner by dynamically repositioning, replacing, and resizing virtual machines in the cloud. As a result, mobile nodes or sensor networks participating in a mini cloud should be capable of altering the flow direction of information through an Elective RAN. This is motivated by various reasons, including: Drastic and unexpected variations in data flow patterns and characteristics in a packet-switched system. Mobility of versatile nodes that migrate between zones due to insufficient or non- existent signal coverage to base stations Handover situations caused by factors such as insufficient energy or load balancing requirements.

2.2 Direct Peer-to-Peer Communication via the Radio Access Network

Two peers, namely a transmitting peer and an accepting peer, form the foundation of the peer-to-peer framework. The transmitting peer establishes a Peer Dock, which serves as an ordered memory buffer for one-way P2P transmission. Direct P2P channels are fixed and redundant with the RAN, enabling independent processes such as PUSH and PULL messages. In normal operations, PUSH messages are sent to the peer dock, while PULL messages are utilized to retrieve missed messages from the buffer in case of failure or interruption. Figure 1 illustrates the regular mode operation of the Peer Dock.

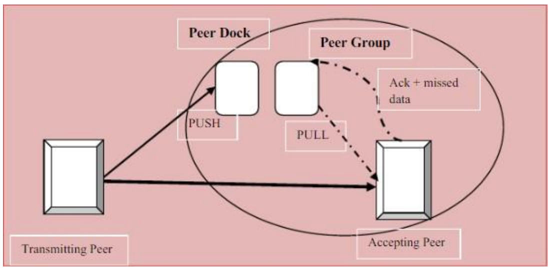

Figure 1 Working of peer dock.

The sliding window technique is employed between the transmitting peer and the peer dock to eliminate packets that are already processed at or beyond the peer dock. Consequently, if any data packets are missed, damaged, or delayed in the channel, the accepting peer utilizes the PD to recover the data stream. In the event of sustained channel disruption, the packets stream is redirected through the Peer Dock.

The concept of a mini-cloud is integrated with ambient services, establishing a peer- to-peer communication system. This necessitates a distributed network of peer docks that covers the RAN. To ensure distribution feasibility, Peer Dock functionality is extended to all peers. The Peer Docks can be either movable or fixed depending on device design, and they can be dynamically deployed on devices. Handover support must align with the data direction method and avoid interference with routing among other peers. To facilitate the P2PCF Ambient Service across three mini-clouds (CCN, WiFi1, and mini-cloud3), PDs are deployed in each random-access network-mini-cloud (4G). Figure two illustrates the transition of functionality From mini clouds to peer-to- peer slots. Accepting the mini cloud

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using floating window with just a PD remo ves the accepted packet from the peering q ueue to free the cache. If a problem occurs due to packet loss or delay, Select one or more peer slots to restore.

The RAN's peer docks receive and analyse data traffic occurring between mini-clouds through the RANs. In the event of traffic overload, the Distributed Agreement protocol compares traffic analysis results before advising the transmitting peer to select an alternative network for further communications. The expansion potential of steady cut method allows for more Peer Dock applications in transmission channels by enabling peers to freely advance their statistics based on communication needs and system topology. The impact of transmitting or accepting peers and peer docks on the latest performance is still unclear.

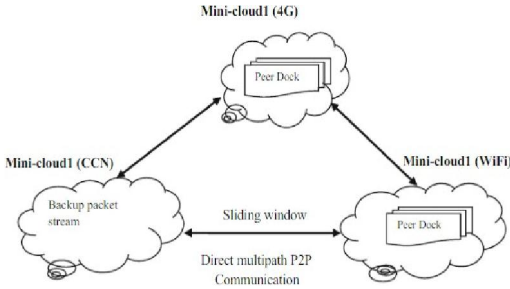

Figure 2 Transition of functionality from Mini-cloud to Peer Docks.

Flexibility of the approach presents challenges in terms of ensuring reliability and dominance. Peer docks provide essential support for peers within the communication scope and uphold this process in mini-clouds. Traffic control strategies for peer docking need to be tailored to the specific characteristics of mini-cloud function and communication. The traffic analysis amount calculation algorithm, which accurately measures performance, operates in RAN PDs as a dynamically bound traffic application without interfering with the core Peer Dock code execution. Figure 3 depicts the architecture of the RAN Peer Dock. When a traffic application is generated, transmitting or accepting peers submit it to the peer dock. The RAN peer dock session handles the data traffic during the joining process. As the traffic volume expands, the RAN is utilized to perform the handover process, known as a status vector. If only one peer dock initiates handover, the Distributed Agreement algorithm synchronizes all peer docks processing within the same session. The protocol is built on the three phases of the 3-Phase- Commit algorithm: request to commit, ready to commit, and finish commit. Buffers transition from a persistent state to an end-line state once the Peer Port handover segment is completed, and vice versa.

2.3 Integration of System Resource Administration in the Network

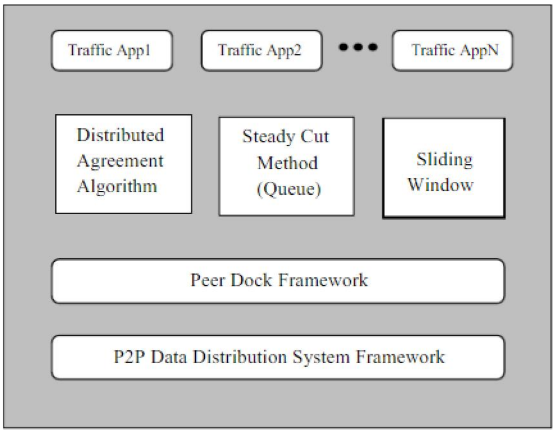

Figure 3 Structure of RAN.

The ISRA scheme employs a selection process to determine the optimal mini- cloud based on the QoS requirements of the data channel and the utilization status of the optical supply, as indicated by traffic analysis. The evaluation factor 'Q' is defined to capture the multiple stratum constraints, with Umc representing the current cloud resource utilization and the optical network constraint captured by the traffic analysis weight Wt. Figure 3 illustrates the flowchart of the integrated system resource administration.

The overall mini-cloud function (Eq. 1) and the PD function (Eq. 2) are combined using adjustable parameters Ψ and Φ to ensure a fair comparison between PD and storage space usage. The peer network function (Eq. 3) is expressed as a result. The integrated resource utilization assessment factor 'Q' is represented by Eq. 4, where α, β, and γ are weighting factors that satisfy the condition $\alpha + \beta + \gamma = 1$. The categorization process and slicing detection are based on service requests for cloud offloading or resource allocation.

For direct peer-to-peer communication, the ISRA scheme selects the mini-cloud based on the Route Resource Requirement (RRR). Among the K candidate mini- clouds, the best candidate is chosen based on resource consumption. Network slicing is performed according to bandwidth demands, and the OpenFlow control protocol is utilized between source and destination peers. Pre-emptive bandwidth allocation is crucial for routes between mini-clouds to ensure minimal transmission latency and packet loss.

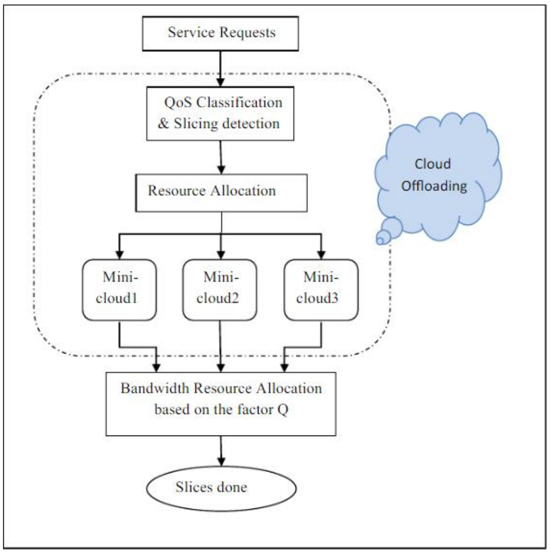

Figure 4 Flow diagram of ISRA.

III. FINDINGS AND ANALYSIS

Previous analysis of the new P2PCF method is analyzed and compared to traditional methods such as Adaptive Resource Balancing and HECA. The analysis is done usin g OMNET++ and includes metrics such as packet gain comparison, resource usage, bandwidth usage, ETE latency and throughput. Sensors can be sent in real time in man y places such as cars, homes, offices, hospitals and other places. Friends dock is used in random access gateway to provide a deep network infrastructure. Key metrics inclu ding packet reception rate, resource utilizat ion, ETE latency, bandwidth usage, and throughput are used to compare the proposed protocol with the standard protocol.

3.1 The Simulation Model

is used to evaluate the performance of the proposed P2PCF approach with the available adaptive resource balancing and HECA schemes and makes a good evaluation of the results. Previous analysis of the new P2 PCF method is analyzed and compared to traditional methods such as Adaptive Resource Balancing and HECA. The analysis is done using OMNET++ and includes metrics such as packet gain comparison, resource usage, bandwidth usage, ETE latency an d throughput. Sensors can be sent in real ti me in many places such as cars, homes, off ices, hospitals and other places. Friends do ck is used in random access gateway to provide a deep network infrastructure. Key m etrics including packet reception rate, resource utilization, ETE latency, bandwidth us age, and throughput are used to compare th e proposed protocol with the standard protocol.

3.2 Packet Reception Proportion

The Packet Received Proportion (PRP) is a metric that represents the ratio of the number of information packets received by the receiving peer to the rate of packets sent by the transmitting peer. In comparison to the traditional

Adaptive Resource Balancing and HECA protocols, the suggested P2PCF approach demonstrates higher information packet delivery rates at the receiving peer. P2PCF achieves this by leveraging the ambient service of a random access network and intelligently selecting a high-bandwidth data channel for transmitting the data packets. As a result, P2PCF significantly improves packet delivery rates and reduces packet loss at the recipient node. The formula for calculating PRP is:

PRP = (Sum of Packet Received) / Time (5)

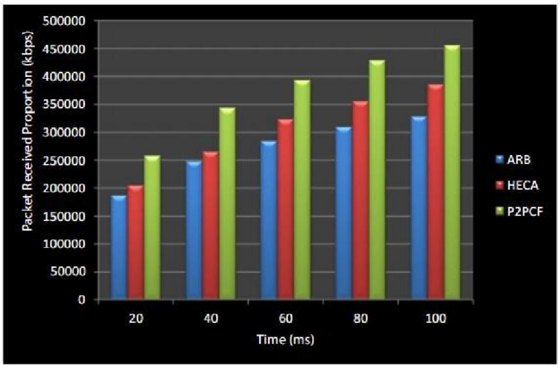

Figure 5 Packet reception proportion.

3.3 Analysis of Resource Utilization

Packet Received Rate (PRP) is a measure t hat represents the ratio of the amount of da ta received by a receiver to the amount of packets sent by the sender. Compared to traditional resource transfer and HECA methods, the P2PCF plan offers a broader package of beneficiaries. P2PCF achieves this by using media services in random access networks and intelligently choosing high- bandwidth data channels to transmit packets. Therefore, P2PCF increases the packet transmission rate and reduces packet loss on the receiving side. PRP calculation formula: Packet Received Rate (PRP) is a measure that represents the ratio of the amount of d ata received by a receiver to the amount of packets sent by the sender. Compared to traditional resource transfer and HECA methods, the P2PCF plan offers a broader package of beneficiaries. P2PCF achieves this by using media services in random access networks and intelligently choosing high-bandwidth data channels to transmit packets. Therefore, P2PCF increases the packet transmission rate and reduces packet loss on the receiving side. PRP calculation formula:

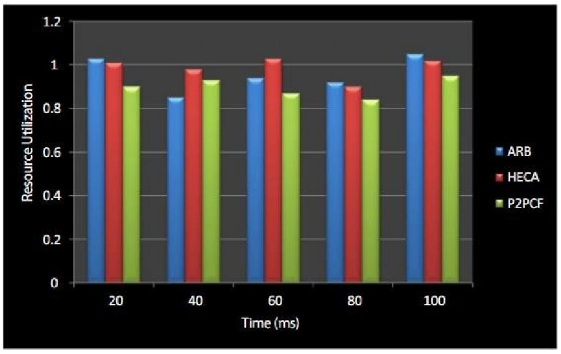

Figure 6 Resource Utilization analysis.

3.4 End-to-End Delay Analysis

The delay is calculated using processing time, queuing time, allocating time, and transmission time. The total data transmission time from the source to the destination peer is determined by adding these components. The end-to-end delay, as shown in Figure 6, is measured using Equation 6. Comparing the P2PCF, Adaptive Resource Balancing, and HECA protocols, the P2PCF scheme demonstrates favourable ETE delay results, indicating minimal delay in processing data transmission when compared to traditional schemes. The formula for calculating the delay is:

Delay = (Sum of Pt + Qt + At + Tt) / DT (6)

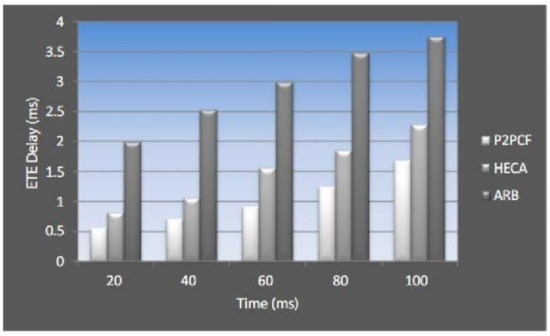

Figure 7 ETE delay.

3.5 Quantifying Throughput Performance

Throughput refers to the successful transmission of information at the receiving peer through the optimal network channel.

The overall performance of the network system is evaluated using Equation 7. Figure 8 depicts the system's performance as throughput, comparing the P2PCF scheme with the conventional protocols ADAPTIVE RESOURCE BALANCING and HECA. The formula for calculating throughput is:

Throughput = (Packets received X 10^3) / (Delay in ms) kbps (7)

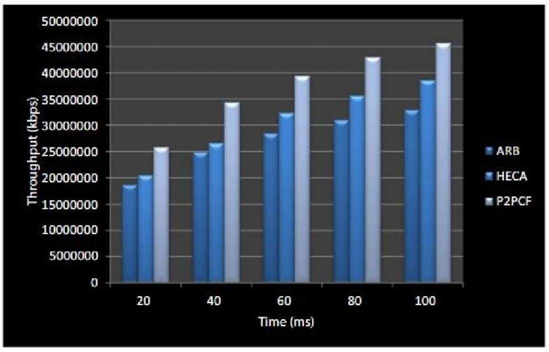

Figure 8 Throughput delay.

3.6 Evaluating Bandwidth Utilization

Higher system performance is achieved by reducing data congestion and maximizing bandwidth utilization. Bandwidth utilization directly impacts data speed, which increases as capacity is efficiently utilized. Figure 8 displays the bandwidth usage for the three compared protocols: P2PCF, ADAPTIVE RESOURCE BALANCING, and HECA. The proposed P2PCF scheme demonstrates high bandwidth utilization, enabling faster data transfer between partner docks. Through integrated system resource management, the bandwidth is effectively distributed among users.

Figure 9 Bandwidth utilization.

IV. SUMMARY AND KEY FINDINGS

This proposal introduces Peer-to-Peer Cloud Federation for 5G networks, emphasizing increased utilization of the Radio Access Network. The RAN management dynamically monitors network traffic across multiple backhaul networks. To enhance system resource administration the division of resource demands into different types of network slices is recommended. It provides both flexibility and cost-effectiveness. The proposed Intelligent System Resource Administration approach selects a mini- cloud based on the resource requirements for direct P2P communication. Data is stored in the mini-cloud located within the user's premises, allowing seamless peer-to- peer flow and backup through the Peer Dock procedure in conjunction with ambient service. Peer Dock is applied to all peers that have processing capabilities, leading to a significant reduction in backhaul network bandwidth requirements.

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