Deliver 10 Gbps Immersive Content in mmWave Wireless Mesh Backhaul

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Abstract

The demands of immersive applications, such as augment or virtual reality grow significantly with the development of modern mobile technologies. In near future, such applications would require more than 10 Gbps TCP throughput per flow to ensure their QoS requirement. mmWave wireless backhaul in a ultra dense network (UDN) is expected apply to flexibly set small cell basestations (SBSs) in the network to accommodate the explosion of realtime traffic. With mmWave wireless backhaul, packets are forwarded wirelessly among SBSs due to the limited service coverage of a SBS. However, in the presence of the dynamic change of network environments, packets forwarding may experience performance degradation when packet loss or delay occurs. In this work, we consider an adaptive packet forwarding scheme in network layer to route TCP packets with 10 Gbps throughput per flow in a mmWave mesh backhaul network.

Introduction

Wireless backhaul provides the flexibility deploying wireless access for supporting various applications in 5G. Immersive applications such as AR/VR requires more than 1 Gbps data rate to ensure their QoS. To maintain QoS, TCP would be a good candidate since it ensures the packet ordering and delivery. Further, mmWave wireless backhaul is considered as a key technology provide more than 10 Gbps bandwidth for data transmission. Hence, it can be expected that dense deployed SBSs with mmWave wireless mesh backhaul would become common place supporting not only 10G bps immersive content delivery but also various applications in 5G.

Since the network bandwidth, traffic loads, user density and so on would change from time to time, the network requires schemes to dynamic manage the transmission aiming to sustain the TCP throughput which is sensitive to the delay and loss during transmission. Several aspects, including routing, scheduling, power control, etc. can be considered and integrated for design and development in order to utilize the available network resources efficiently.

Proposed Approaches:

Take and Give (TAG) Algorithm

TAG Mechanism

At eNB:

1. Linearly combine unprocessed packets across different traffic flows at time iT.
2. Mark combined packets as set i and forward them.
3. Forward additional combined packets of set i till $(i+1)T$ when possible ('Take').

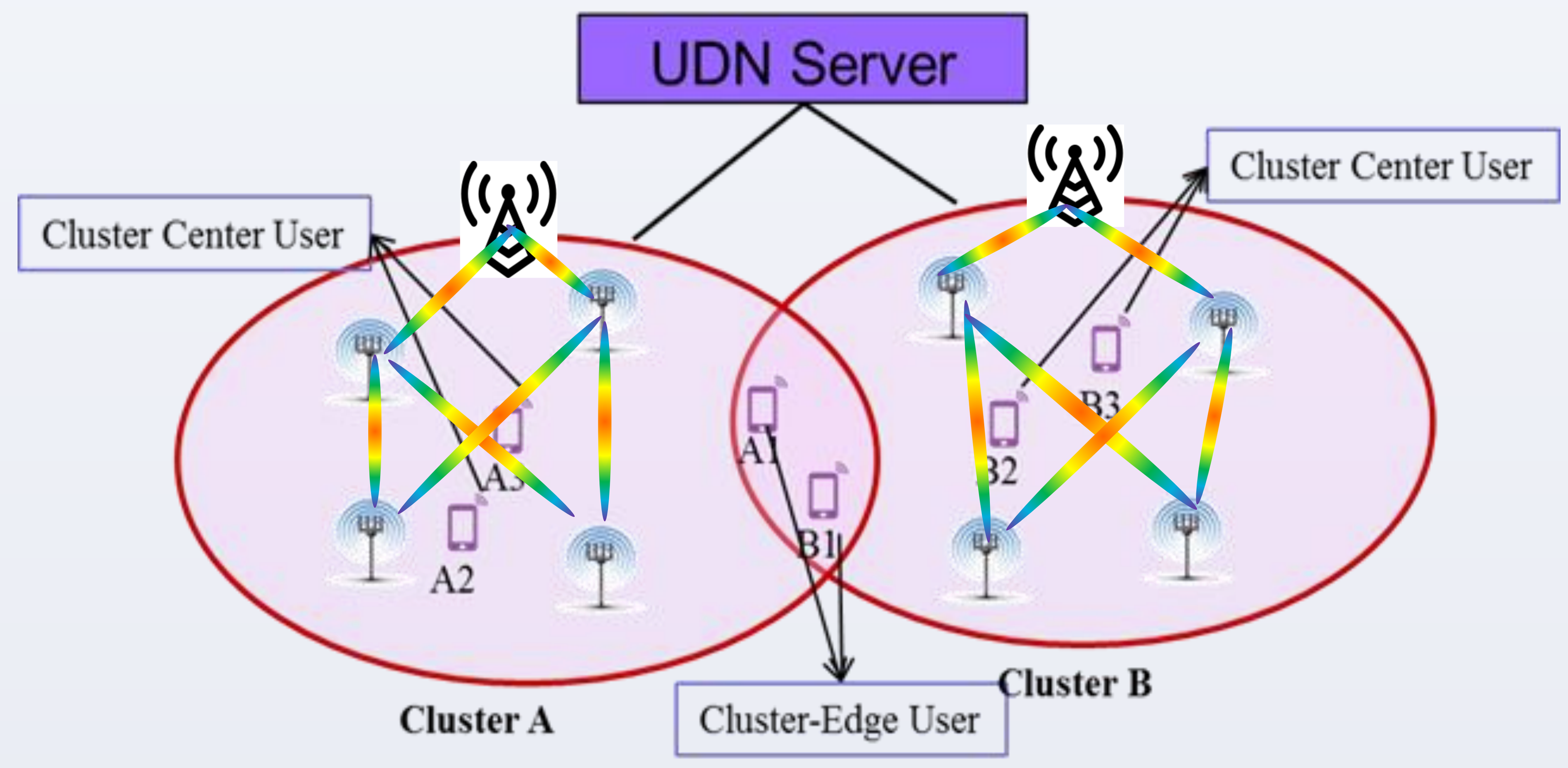
At R-SBS:

4. Process set i packets when possible.
5. Recombine and forward received set i packets to next hop.
6. If link bandwidth is insufficient,
7. Conditionally discard set i packets when lacking of link bandwidth
7. ('Give').
8. Else,
9. Forward additional recombined set i packets ('Take').

At D-SBS:

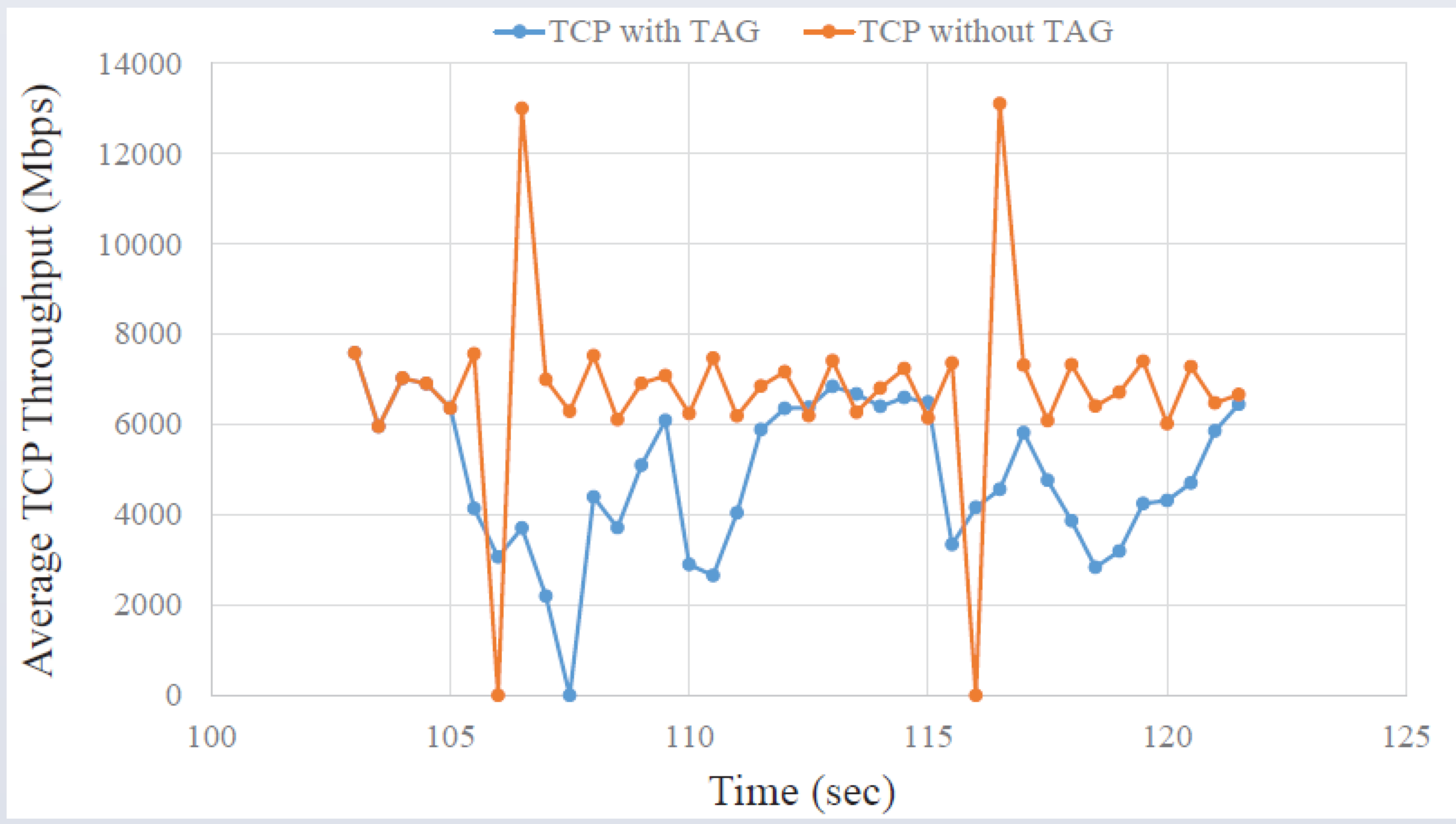
10. Process set i packets when possible.
11. Forward recoverable packets to the corresponding UEs.
12. Discard unrecoverable packets.

System Architecture



- To butter utilize the link bandwidth provided by mmWave wireless backhaul, a UDN server is managed the coordination of SBSs. Specifically, several SBSs are grouped together as a cluster to organizing the network resource for content delivery.
- SDN will be introduced to assist the functioning of the UDN server and the content delivery in the network.

Preliminary Results



Conclusions and Future Work

- Dense deployed mmWave wireless backhaul can provide high link bandwidth and is a possible approach to support immersive content delivery.
- To react to the dynamic change of network, TAG is proposed to adaptively utilize the link bandwidth of the wireless backhaul.
- Current results illustrate the potential of the proposed TAG algorithm to enhance the TCP throughput in mmWave wireless mesh backhaul environment.
- In the future, we will implement TAG algorithm in NS-3 which integrates with mmWave and mobility module for further performance investigation.
- SDN will be considered as next step to find proper clusters among SBSs as well as appropriate routing paths which could utilize TAG for packet forwarding
  in the network for better immersive content delivery.

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