International Conference on Engineering & Technology (ICET-2020)

Available at: International Journal of Scientific Research and Engineering Development

RESEARCH ARTICLE OPEN ACCESS

Shortest Path Selection Based on Floyd-Warshall for 5g Self Backhauled Millimetre Wave Networks

Dharani L.*

(CSE,J.K.K.Munirajah College of Technology,Anna University,and T.N.Palayam,

Email:dharanigowthami14@gmail.com)

Abstract

Owing to severe path loss and unreliable transmission over a long distance at higher frequency bands, this paper investigates the problem of path selection and rate allocation for multi-hop self-backhaul millimetre-wave networks. Enabling multi-hop millimetre-wave transmissions raises a potential issue of increased latency, and thus, this paper aims at addressing the fundamental questions: how to select the best multi-hop paths and how to allocate rates over these paths subject to latency constraints? In this regard, a new system design, which exploits multiple antenna diversity, millimetre-wave bandwidth, and traffic splitting techniques, is proposed to improve the downlink transmission. The studied problem is cast to as a network utility maximization, subject to the upper delay bound constraint, network stability, and network dynamics. By leveraging stochastic optimization, the problem is decoupled into: 1) path selection and 2) rate allocation sub-problems, whereby a framework which selects the best paths is proposed using reinforcement learning techniques.

Keywords: path selection,bandwidth,network stability,network dynamics,path selection

I.INTRODUCTION

Millimeter Wave is also known as MMW, E-band, V-band or Millimetre Wave technology is being rapidly adopted for users ranging from enterprise level data centres to single consumers with smart phones requiring higher bandwidth, the demand for newer technologies to deliver these higher data transmission rates is bigger than ever before.

Millimeter waves represent the RF Signal spectrum between the frequencies of 30GHz and 300GHz with a wavelength between 1 – 10 millimetres but in terms of wireless networking and communications equipment, the name Millimeter Wave generally corresponds to a few select bands of radio frequencies found around 38, 60 and, more recently, the high potential 70 and 80 GHz bands that have been assigned for the public domain for the purpose of wireless networking and communications.

Commercial Millimeter Wave (MMW) links from CableFree feature high performance, reliable, high capacity wireless networking with latest generation features.

In the UK, there have been 3 frequency bands that have been allocated for commercial Millimeter Wave usage, these are as follows:

57 – 66GHz: The 60GHz Millimeter Wave Band or V-Band is governed by OFCOM for licensed operation. The large amount of signal absorption via atmospheric

 ©IJSRED:All Rights are Reserved

oxygen and tight regulations make this frequency band more suited to short range, Point-to-Point and Point-to-Multipoint Millimetre Wave solutions. Between 57 – 64GHz the band is licensed and regulated but from 64 – 66GHz the band is unlicensed and self coordinated.

71 – 76GHz and 81 – 86GHz: The 70GHz and 80GHz Millimeter Wave Bands or E-Bands are governed by OFCOM for licensed operation only and are regarded to be the most suited band for Point-to-Point and Point-to-Multipoint, Millimeter Wave Wireless Networking and communication transmission. Each band has a 5GHz spectral range available which totals to be more than all other assigned frequency bands added together. Each 5GHz range can act as a single contiguous wireless transmission channel allowing very efficient use of the whole band and in turn these result in high throughput speeds from 1 to 3 Gbps whilst only using simple modulation techniques such as OOK (On-Off-Keying) or BPSK (Binary Phase Shift Keying).

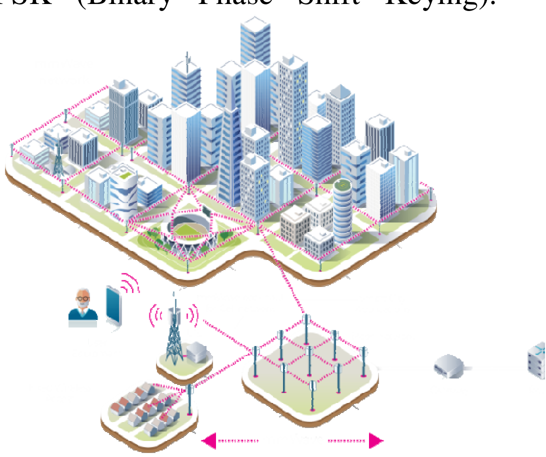


Fig .1 Network Connection

The band is essentially undeveloped and available for use in a broad range of new products and services, including high-speed, point-to-point wireless local area networks and broadband Internet access. WirelessHD is another recent technology that operates near the 60 GHz range. Highly directional, "pencil-beam" signal characteristics permit different systems to operate close to one another without causing interference. Potential applications include radar systems with very high resolution.

The upcoming Wi-Fi standard IEEE 802.11ad will run on the 60 GHz (V band) spectrum with data transfer rates of up to 7 Gbit/s.

Uses of the millimeter wave bands include point-to-point communications, intersatellite links, and point-to-multipoint communications.

SELF-BACKHAULING:

Self-backhauling defined as when the access (BS-MS) and the backhaul (BS-BS or BS-Network) share the same wireless channel. Sharing options of the wireless channel resources (Time, Frequency, and Space)

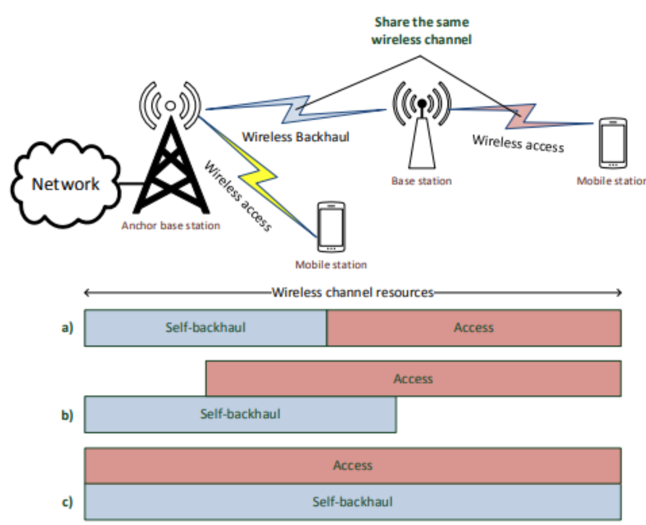


Fig . 2 Self-backhauling

II.EXISTING SYSTEM

 ©IJSRED:All Rights are Reserved

In network is used widely today. The work of 4G is totally depends on the cooperation of various nodes in the network. As we compared with the wired network, wireless network has various advantages, such as 4G doesn't require any infrastructure; it is decentralized system and dynamic in nature. Hence 4G is popular in various areas such as Military application, wireless sensor network, Public network and more. But these advantages of 4G may become disadvantages: As its openness, decentralized and dynamic nature, it is highly prone to various attacks. That's why security is the challenging job in 4G. Various systems for detection of attacks is in-efficient and may require more computation and space as in cryptography technique.

In 4G, devices rely on each other to stay connected and keep network alive. The unguided wireless medium combined with node mobility make the network vulnerable to kinds of attacks not possible with its wired and/or infrastructure counterpart. To achieve availability, network should be robust against both topology changes and malicious attacks. Active attacks in 4G can be launched by either an external attacker or a compromised node as described below.

Disadvantages

- An external attacker by injecting malicious, erroneous routing information, replaying old routing information or distorting routing information could successfully partition the network or introduce a traffic overload by causing retransmission and inefficient routing.
- And most severe kind of threats comes from compromised nodes. It may misuse routing information to other nodes in order to induce service failures. Recently proposed incentive mechanisms for enforcing cooperation among nodes can be classified and trust-based model.

III. PROPOSED SYSTEM

Leveraging stochastic optimization framework , thestudied problem is decoupled into two sub-problems,namely PS and RA. By utilizing the benefits of historicalinformation, a reinforcement learning (RL) is used tobuild an empirical distribution of the system dynamicsto aid in learning the best paths to solve PS , .Therein, the concept of regret strategy is employed,defined as the difference between the average utility whenchoosing the same paths in previous times, and its averageutility obtained by constantly selecting different paths, . The premise is that regret is minimized overtime so as to choose the best paths. Second, to solve anon-convex RA sub-problem, the concept of successiveconvex approximation (SCA) method is applied due toits low complexity and fast convergence .

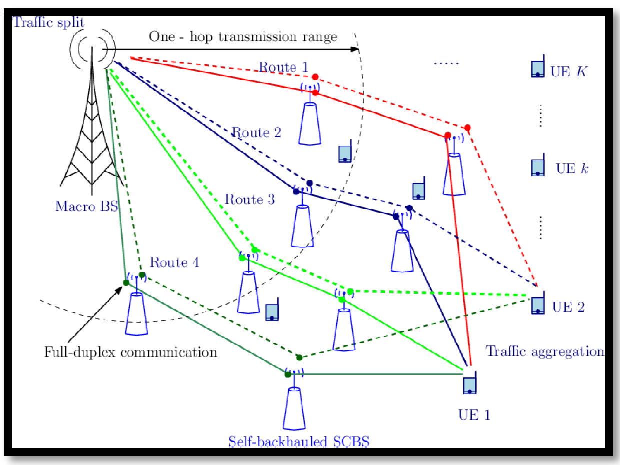
The proposed approach answers the following fundamentalquestions: (i) over which paths should the traffic flowbe forwarded? and (ii) what is the data rate per flow/subflow?,
while ensuring a probabilistic delay constraint,and network stability. By using a mathematical analysis,a comprehensive performance of our proposed stochasticoptimization framework is scrutinized. It is shownthat there exists an utility-queue backlog
trade-off, which leads to an utility-delay balancing ,where is a control parameter. In addition, a convergenceanalysis of both two sub-problems is studied.

 ©IJSRED:All Rights are Reserved

Advantages:

- Our approach takes advantage of this capability by assuming that we have a large number of nodes.
- On the other hand, data will transfer the end with shortest path way.
- The path transfer the data with fast and easy way, so the data node and power of the network is not lost.

SYSTEM ARCHITECTURE



MODULES AND DESCRIPTION

LIST OF MODULES

- Node Initialization
- Path Selection
- Energy Watcher
- Trust Manager

MODULES DESCRIPTION

Node Initialization

In this module, to design a mobile adhoc network, with base station and other sensor nodes. For a node N, a neighbor (neighboring node) of N is a node that is reachable from N with one-hop wireless transmission.

Path Selection

For a TARF-enabled node N to route a data packet to the base station, N only needs to decide to which neighboring node it should forward the data packet considering both the trustworthiness and the energy efficiency. Once the data packet is forwarded to that next-hop node, the remaining task to deliver the data to the base station is fully delegated to it, and N is totally unaware of what routing decision its next-hop node makes. N maintains a neighborhood table with trust level values and energy cost values for certain known neighbors.

Energy watcher

For a node N, the energy cost of a neighbor is the average energy cost to successfully deliver a unitsized data packet with this neighbor as its next-hop node, from N to the base station. That energy cost is denoted as E.

In a 4G network, a dynamic topology change and decentralized makes routing a challenging task in mobile ad hoc network. Energy efficient routing is the most challenging task in network due to limited energy of mobile nodes. Limited power of batteries typically use in network, and this is not easy to change or replace while running communication. Network disorder can occur for many factors but in middle of these factors deficiency of energy is the most significant one for causing broken links and early partition of the network.

Trust Manager

For a node N, the trust level of a neighbour is a decimal number, representing N's opinion of that neighbour's level of trustworthiness. Specifically, the trust level

 ©IJSRED:All Rights are Reserved

of the neighbour is N's estimation of the probability that this neighbour correctly delivers data received to the base station. That trust level is denoted as T.

ALGORITHM

The Floyd-Warshall algorithm is a shortest path algorithm for graphs. Like the Bellman-Ford algorithm or the Dijkstra's algorithm, it computes the shortest path in a graph. However, Bellman-Ford and Dijkstra are both single-source, shortest-path algorithms. This means they only compute the shortest path from a single source. Floyd-Warshall, on the other hand, computes the shortest distances between every pair of vertices in the input graph.

Imagine that you have 5 friends: Billy, Jenna, Cassie, Alyssa, and Harry. You know a few roads that connect some of their houses, and you know the lengths of those roads. But, Floyd-Warshall can take what you know and give you the optimal route given that information. For example, look at the graph below, it shows paths from one friend to another with corresponding distances.

Floyd-Warshall will tell the optimal distance between *each* pair of friends. It will clearly tell you that the quickest path from Alyssa's house to Harry's house is the connecting edge that has a weight of 1. But, it will also tell you that the quickest way to get from Billy's house to Jenna's house is to first go through Cassie's, then Alyssa's, then Harry's house before ending at Jenna's. This is the power of Floyd-Warshall; no matter what house you're currently in, it will tell the fastest way to get to every other house.

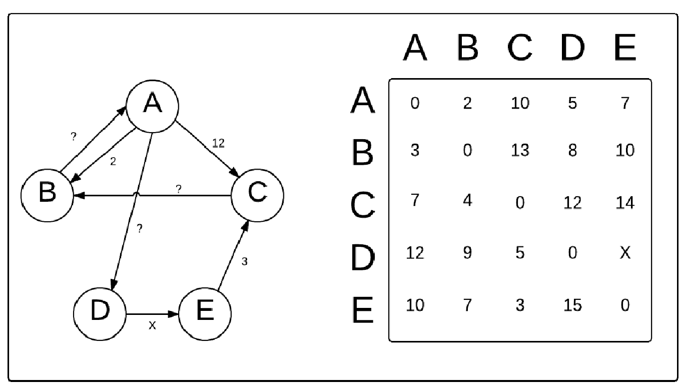
The Floyd-Warshall algorithm is an example of dynamic programming. It breaks the problem down into smaller subproblems, then combines the answers to those subproblems to solve the big, initial problem. The idea is this: either the quickest path from A to C is the quickest path found so far from A to C, or it's the quickest path from A to B plus the quickest path from B to C.

Floyd-Warshall is extremely useful in networking, similar to solutions to the shortest path problem. However, it is more effective at managing multiple stops on the route because it can calculate the shortest paths between all relevant nodes. In fact, one run of Floyd-Warshall can give you all the information you need to know about a static network to optimize most types of paths. It is also useful in computing matrix inversions.

FLOYD-WARSHALL ALGORITHM

```
Create a |V| x |V| matrix, M, that will describe the di
For each cell (i, j) in M:
   if i == j:
      M = 0
   if (i, j) is an edge in E:
      M = weight(i, j)
   else:
      M = infinity
for k from 1 to |V|:
   for i from 1 to |V|:
      for j from 1 to |V|:
         if M > M + M:
            M = M + M
```

.



 ©IJSRED:All Rights are Reserved

IV. RESULTS

InthissectionMonteCarlosimulations arecarriedoutin orderto evaluatethe systemperformanceof ourproposed algorithm.Tosolve**Algorithm**,weuseYALMIPtoolbox tomodeltheoptimization problem withMOSEKasinternal solver.Forsimulations, weassumethattherearetwo flowsfromtheMBStotwoUEs,whilethenumberofavailable pathsforeachflow isfour.TheMBSselectstwopaths fromfour mostpopularpaths.Eachpathcontainstworelays, thetotalnumber ofSCBSsis8,andtheone-hop distanceis varyingfrom50to100meters.Singlehopscheme considers thattheMBSdelivers datatoUEsoveronesinglehopatlongdistanceinwhich theprobabilityofLOScommunication islow,andthenthe blockageneedstobetakenintoaccount.

V.FUTURE WORK

Future works will focus on improving the capacity of the backhaul, which is currently the main limitation in the s-BH architecture at the sub-6 GHz frequencies. At first, we aim to investigate how to improve the LoS probability in the backhaul links.

This improvement can be achieved by increasing the altitude of the s-BH SCs, for example by means of drone-BSs hovering above the UE locations. Secondly, we aim to increase the bandwidth and limit the interference of the backhaul links.

This can be realized by using the mmWave frequencies which can simultaneously guarantee the availability of abundant spectrum in the mmWave bands, and partially avoid the inter-cell interference issue, due to the high directionality of the transmission at those carrier frequencies.

VI.CONCLUSION

In this paper, the authors proposed a multi-hop multi-path scheduling to support reliable communication by incorporating the probabilistic latency constraint and traffic splitting techniques in 5G mm-wave networks. In particular, the problem was modeled as a network utility maximization subject to a bounded latency with a guaranteed reliability probability, and network stability. The authors employed massive MIMO and mm-wave communication techniques to further improve the DL transmission of a multi-hop self-backhauled small cells.

By leveraging stochastic optimization, the problem was decoupled into PS and RA, which are solved by applying the reinforcement learning and successive convex approximation methods, respectively. A comprehensive performance analysis of our proposed algorithm was mathematically provided. Numerical results shown that our proposed framework reduces latency by 50.64% and 92.9% as compared to the baselines with and without learning, respectively.

REFERENCES

1) T. K. Vu, C.-F. Liu, M. Bennis, M. Debbah, and M. Latva-Aho, “Path selection and rate allocation in self-backhauled mmWave networks,” in Proc. IEEE Wireless Commun. Netw. Conf. (WCNC), Barcelona, Spain, Apr. 2018, pp. 1–6.

2) J. G. Andrews et al., "What will 5G be?" IEEE J. Sel. Areas Commun., vol. 32, no. 6, pp. 1065–1082, Jun. 2014.
3) T. S. Rappaport et al., "Millimeter wave mobile communications for 5G cellular: It will work!" IEEE Access, vol. 1, pp. 335–349, 2013.
4) F. Gómez-Cuba, E. Erkip, S. Rangan, and F. J. González-Castaño, "Capacity scaling of cellular networks: impact of bandwidth, infrastructure density and number of antennas," IEEE Trans. Wireless Commun., vol. 17, no. 1, pp. 652–666, Jan. 2018.
5) E. Björnson, E. G. Larsson, and T. L. Marzetta, "Massive MIMO: Ten myths and one critical question," IEEE Commun. Mag., vol. 54, no. 2, pp. 114–123, Feb. 2016.
6) Anpalagan, M. Bennis, and R. Vannithamby, Design and Deployment of Small Cell Networks. Cambridge, U.K.: Cambridge Univ. Press, 2015.
7) T. K. Vu et al., "Joint load balancing and interference mitigation in 5G heterogeneous networks," IEEE Trans. Wireless Commun., vol. 16, no. 9, pp. 6032–6046, Sep. 2017.
8) N. Bhushan et al., "Network densification: The dominant theme for wireless evolution into 5G," IEEE Commun. Mag., vol. 52, no. 2, pp. 82–89, Feb. 2014.
9) T. K. Vu et al., "Ultra-reliable and low latency communication in mmWave-enabled massive MIMO networks," IEEE Commun. Lett., vol. 21, no. 9, pp. 2041–2044, Sep. 2017.
10) M. Bennis, M. Debbah, and H. V. Poor, "Ultrareliable and low-latency wireless communication: Tail, risk, and scale," Proc. IEEE, vol. 106, no. 10, pp. 1834–1853, Oct. 2018.