A NOVEL SYSTEM TO COMMUNICATE BETWEEN DEVICES IN A WIRELESS NETWORK WITHIN MACRO-CELL USING MMWAVE AND EXPLOITING SPATIAL REUSE

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Abstract— **In this era of technical evolution, large scale demand and use of wireless mobile communication is drawing attention of academics researchers as well as the industries. The exponential growth of mobile data network traffic, here 4g plays an important role. 60GHz radio frequencies, up to 7GHz bandwidth are allocated worldwide for license free. With the help of unlicensed frequency bandwidth of mmWave of 60Mhz band, many giga- bites per second can be transmitted. Communication can be done between the nodes with the spectrums of mirco frequencies available in plenty which provided cost effective communication with high capacity backhaul. Wireless backhaul is one of the emerging options for small cells as it provides a less expensive and easy-to-deploy over fiber cables. There are multitude of bands (e.g. spatial multiplexing, LOS/NLOS etc.) that need to be smartly used to connect to the small cell for communication. Candidate bands include: sub-6 GHz band that is useful in non-line-of-sight (NLOS) scenarios, microwave band (642 GHz) that are used in point-to-point line-of-sight (LOS) scenarios, and mmWave bands (e.g. 60, 70 and 80 GHz) that are mostly being commercially used in LOS scenarios. In many deployment topologies, it is more profitable to use aggregator nodes, located at the roof tops of tall buildings near small cells. This paper proposes, development of new protocol for communication between devices. The protocol provisions concurrent transmission in minimum frequency to the greater extent. Further to enhance the efficiency of network, performance analysis and different parameters will be calculated.**

Keywords- ***Small cells, MAC scheduling, millimeter-wave communications, 60 GHz, device to-device communications.***

I. INTRODUCTION

Device-to-device (D2D) communication that enables direct communication between neighboring mobiles is an exciting and innovative feature of next-generation cellular networks. It will facilitate the interoperability between critical public safety networks and global commercial networks based on. Device-to-Device (D2D) communication is a technology component for LTE-A. The existing researches allow Device-to-Device as an underlay to the cellular network to increase the spectral efficiency. In D2D communication, user equipments (UEs) transmit data signals among connected devices over a direct link using the cellular resources instead of through the BS, which differs from Small Cell where users communicate with the help of small low- power cellular base stations. Device-to-Device users communicate directly while remaining controlled under the BS. Therefore, the possible of improving spectral utilization has promoted much work in recent years, which shows that the system can improve system performances by reusing cellular resources. Thus, D2D is expected to be a key feature supported by next generation cellular networks. Users can communicate via the current microcell as well as the small cells. In the small cells, mobile users are associated with access points (APs), and APs are connected through wireless backhaul links. Some APs are connected to the Internet through a direct and high speed wired connection which are called gateways. In this targeted small cells system, both the radio access and backhaul links are in the 60 GHz band, which provides high data rate for both radio access and backhaul, and reduce implementation complexity and deployment cost. Considering the fundamental differences between mm Wave communications and existing other communication systems that uses lower carrier frequencies, scheduling over both the radio access and backhaul networks is a difficult problem and should be carefully designed. There are two aspects of challenges. In the first aspect, it is necessary to consider both radio access and backhaul networks jointly.

I. RELATED WORK

A joint transmission scheduling scheme for the radio access and back haul of small cells in the mmWave band, termed D2DMAC, where a path selection criterion is designed to enable device-to-device transmissions for performance improvement. In D2DMAC, a concurrent transmission scheduling algorithm is proposed to fully exploit spatial reuse in mmWave networks [1]. An efficient scheduling scheme for downloading popular content in mmWave small cells called popular content downloading scheduling (PCDS), where both Devices are near and concurrent transmissions are exploited to enhance transmission efficiency. In PCDS, a transmission path selection algorithm is designed to establish multi hop transmission paths for users, aiming at better utilization of D2D communications and concurrent transmissions. After transmission path selection, a concurrent transmission scheduling algorithm is designed to maximize the spatial reuse gain [2]. Small cells have been proposed as a vehicle for wireless networks to keep up with surging demand. Small cells come with a significant challenge of providing backhaul to transport data to (/from) a gateway node in the network. Fiber based backhaul offers the high rates needed to meet this requirement, but is costly and time-consuming to deploy, when not readily available. Wireless backhaul network connection is an attractive option for small cells as it provides a less expensive and easy- to-deploy alternative to fiber [3]. Spatial interference statistics for multi giga bit, where outdoor mesh networks operating in the unlicensed 60-GHz millimeter (mm) wave band. The conectivity links in such networks are highly directional: Because of the small carrier wavelength (an order of magnitude are smaller than those for existing cellular and wireless local area networks), narrow beams are essential for overcoming higher path loss and can be implemented using compact electronically steerable antenna arrays [4]. Millimeter-wave (mmW) frequencies between 30 and 300 GHz are a new frontier for cellular communication that offers the guarantee of orders of magnitude greater bandwidths combined with further gains via beamforming and spatial multiplexing from multi element antenna arrays. This approach makes measurements and capacity studies to access this technology with a focus on small cell deployments in urban environments. The conclusions are extremely encouraging; measurements in New York City at 28 and 73 GHz demonstrate that, even in an urban canyon environment, significant non-line-of-sight (NLOS) outdoor, street-level coverage is possible up to approximately 200 m from a potential low- power microcell or picocell base station [5]. The mmWave communication system is operating at a regime with high number of antennas and very limited number of RF analog chains. Large number of antennas are used to increase the communication range for recovering the high path loss while fewer RF analog chains are designed to reduce transmit and processing power as well as hardware complexity. In this regime, typical MIMO algorithms are not applicable. Before any communication process starts, devices are needed to align their beam pointing angles towards each other. An efficient searching protocol to get the best beam angle pair is therefore needed [6].

II. EXISTING SYSTEM

Introduce UltraAlert, a system aimed at improving the safety of pedestrian mobile us To meet this explosive growth demand and enhance the mobile network capacity, there has been an increasing interest in deploying small cells underlying the conventional homogeneous macrocell network. This new network deployment is usually referred to as heterogeneous cellular networks (HCNs). However, reducing the radii of small cells in the carrier frequencies employed in today's cellular systems to reap the spatial reuse benefits is fundamentally limited by interference constraints. Use of higher frequency bands, such as the millimeter wave (mmWave) bands between 30 and 300 GHz, and bringing the network closer to users by a dense deployment of small cells, HCNs can significantly boost the overall network capacity due to less interference and higher data rates. System has two phases, the scheduling phase and the transmission phase. Scheduling phase includes scheduling of frames to be transmitted and in the transmission phase, frames ready for transmission are being transmitted via direct path or ordinary path as scheduled in the scheduling phase and finally on the basic of working of system, performance analysis is done by using various performance measuring parameters. Use of higher frequency bands, such as the millimeter wave (mmWave) bands between 30 and 300 GHz, and making the network closer to users by a dense deployment of small cells, HCNs can significantly boost the overall network capacity due to less interference and higher data rates.

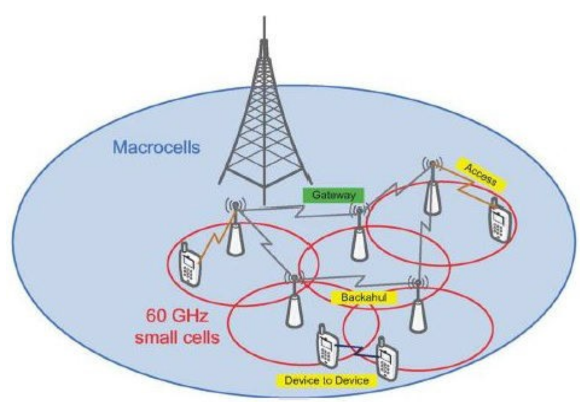

Fig. 1. Dense deployment of small cells in the 60 GHz band underlying the macrocell network [1]

III. PROBLEM STATEMENT

Communication link of the network, connecting nodes (de- vices) have fixed channel size to transmit packets from one node to another. When a node A needs to transfer a packet of size 5 to node B and the transmission link has capacity to transfer only 3 packets in one time slot, then in that case two time slots has to be scheduled to transfer packet of size 5. Therefore, designed communication protocol and scalable transmission link to transmit a packet of possible max size in a single time slot.

IV. PROPOSED SYSTEM

In this paper propose a Communication system to have communication Between Devices using mmWave within Small Cells in Wireless Network and Exploiting Spatial Reuse.

Proposed system presents an approaches a new frequency based protocol for Device to Device communication using a frequency band for transmitting the data from source node to destination node at higher frequency rate, to increase the performance and efficiency of network. Further as per the performance analysis better understanding study is made for concurrent transmission within the nodes via communication link.

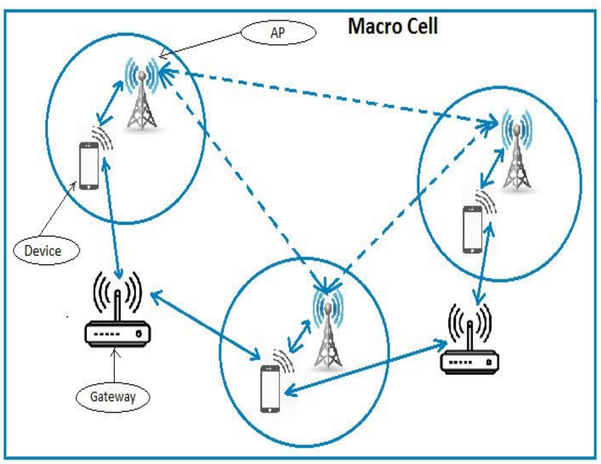

Fig. 2. Proposed System Architecture

A. System Overview:

Considering the scenario that multiple small cells are deployed. In each small cell, there are several wireless nodes (WNs) and an access point (AP), which synchronizes the clocks of WNs and provides access services within the cell. Also including Repeaters in the system for direct transmission in devices. Repeaters are used to connect network, which transmit information between two nodes, then accomplish the replication, adjustment and enlargement of the signal. Thus, the length of the network can be extended. Figure 2: shows Communication among 3 cells There is a repeater at Device 1 and Device 2. The radiation scope of the repeater can cover both, so communication can get through Device1 to Device2 directly. To build up a network covering all these 3 cells, setting a repeater around Device 2 and Device 3, to keep the network smooth. Thus, the topological structure of a repeater radiation network can accomplish the communication in the whole area.

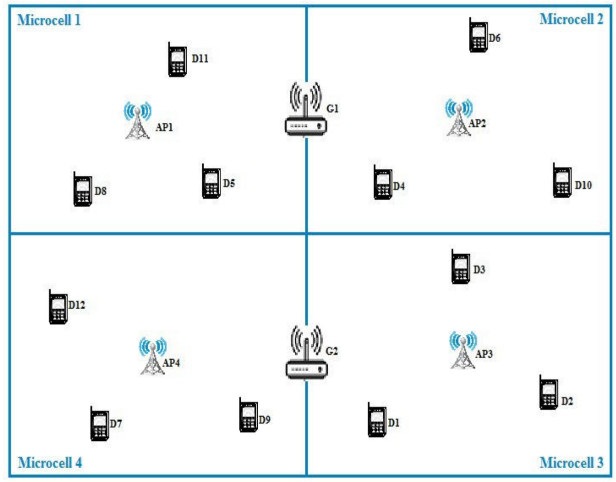

Fig. 3. Architecture of the System

B. Mathematical model:

Assuming a schedule S, with m number of stages. For each flow f , we define a binary variable dm f to indicate whether the direct link is scheduled to transmit in m^{th} stage or not. And a binary variable bm f to indicate whether the j^{th} hop of the ordinary path of flow f is scheduled to transmit in m^{th} stage.

t- Indicates the distance between S & D;

wt - Indicates a constant temporary variable;

H- Indicates the Multi hops between S D;

c- Capacity of the link r-demand of user Total number of time slots f a schedule is

Total number of time slots f a schedule is

$$\sum_{m=1}^{M} \alpha^{m}$$

$$h_{ij} = \begin{cases} 1, & \text{if } d > 0 \ \& \ j <= H_f \\ 0, & \text{otherwise} \end{cases}$$

$$\sum_{m=1}^{M} \alpha \left(\alpha_m b^{m}_{fj} c^{b}_{fj} + h_{fj} \alpha^{m}_{f} c^{r}_{f}\right)$$

C. Model Description:

Device Registration: As a new device comes into the communication area and need to have communication with other devices, it registration process is done by entering information about device which includes type of device, network status, co-ordinates of device, downloading and uploading capability. Once the device is registered, it’s added to the network scenario and it appears to the maps of mircocell communication network Once a device is registered and added to the network, it appears as the following in the map.

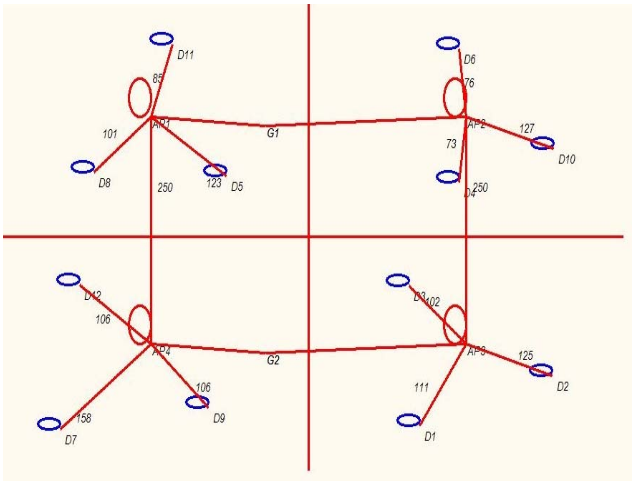

Fig. 4. Map of Network Scenario

The Map shows the actual position of device in the network including its distance between the other devices and the Access Point of that quadrant.

- Connect Device using D2D protocol: After getting registered device(user) get connected to other devices by D2D protocol, but first check device authentication. If the device is authorized for the sending or receiving data.
- Data Transfer to another device: When device is connected to another device by D2D protocols then data transmission is done successfully otherwise device cant send data one device to another device. Data reaches the destination device from source device via one of the two paths.

The First one is Ordinary path, where a data, converted in the form of packets are sent through hopping, ie; packets are traversed from nodes to nodes having minimum distance from source node to destination node.

The second one is Direct path, where the data is sent directly from source node to destination node without hopping. To find the distance between two distance (x1,y1) and (x2,y2), all that need to do is use the coordinates of these ordered pairs and apply the formula pictured below. The distance formula is :

$$\sqrt{\{(X_1\text{-}X_2) + (Y_1\text{-}Y_2)}$$

- Database: Data transferred from one device to another device are saved to the database in both sender's storage as well as the receiver's storage and all log history of data transfer from various device is logged into database for performance evaluation.

D. Requirement Specification

Software Requirement

- Operating System: Windows 8,10
- Front End: C#.Net
- Database: SQL Server
- Scripts: JavaScript
- Database Connectivity: Entity Framework
- Tool: Visual Studio-2013

Hardware Requirements:

- Processor: Intel(R) Core(TM)2 Duo CPU
- Speed: 1.1 Ghz
- RAM: 4GB
- Hard Disk: 20 GB
- Key Board: Standard Windows Keyboard
- Mouse: Two or Three Button Mouse
- Monitor: 14 inch

E. Steps to be Carried

Step 1: Initially setup small cells network.

Step 2: Deploy access points and Gateways within network.

Step 3: Deploy Nodes for communication.

Step 4: Select Source node and Destination node for communication.

Step 5: Find Hops of path between selected nodes for transmission.

Step 6: Transfer data between selected Nodes.

F. Algorithm:

Scheduling Algorithm Steps:

1. Input set of all devices.
2. Select Source node.
3. Select destination node.
4. Find D1 ‾ X Coordinate of nodes. & D2 = Y Coordinate of nodes.
5. Find Center point of source node and destination node.

D1(X1, Y1)

D2(X2, Y2)

Calculate approximate Center

(X, Y) X = (X1 + X2) / 2 Y = (Y1+ Y2) / 2

6. D= Distances of node. Calculate distance from (X, Y) to every node D ((x2- x1)2 + (Y2-Y1)2)2

7. Find Nodes between source and destination based on short distance and set Hops of path.

Transmission Algorithm Steps:

1. The path selected in the scheduling algorithm is considered.
2. Data is selected by the sender to be sent.
3. Transmitted data passes through each device present in Hops of path.
4. Then data transmitted to corresponding Access point of Destination device.
5. Data transmit from Access point to Destination Device.

V. RESULT AND PERFORMANCE

Novel and optimal scheduling algorithm to connect backhaul of networks for small cells in the mmWave band for the purpose of communication. Designed a centralized scheduling scheme, where direct data transmissions between devices, i.e., device-to-device data transmissions, are enabled for performance improvement as well as D2D data transmissions by traversing (hopping) other nodes present in the network having shortest distance. The system includes, a path selection criterion to decide the path for device-to-device transmission and a transmission scheduling algorithm to explore the potential of concurrent transmissions for maximizing spatial reuse gain.

In this way, this paper deals with a development of a D2D protocol for transferring data between the nodes. The connection is done with un-licensed frequency band which require no special permission for using this frequency band for communication. This can help the communication technology to boost to a greater extent through efficient and cost effective transmission.

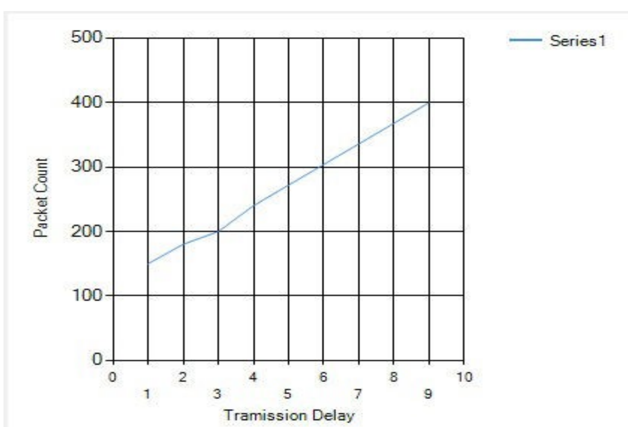

Fig. 5. Traffic Load Vs Transmission Delay for Successful Transmission

The protocol is implemented in such a way that it should be capable of producing maximum speed i.e. above 60 GHz. A communication system which is reliable and accurate having no packet losses and data is transferred with enhanced speed.

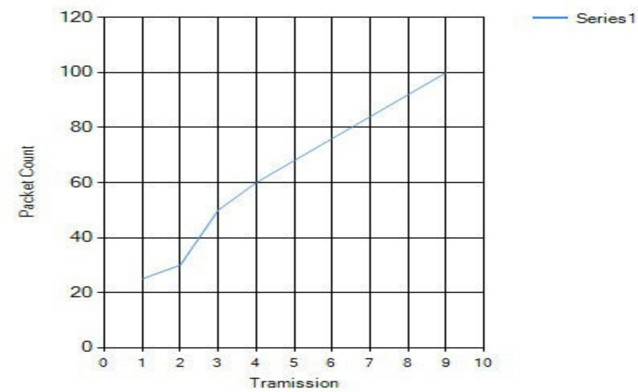

Fig. 6. Traffic Load Vs Transmission Delay for Unsuccessful Transmission

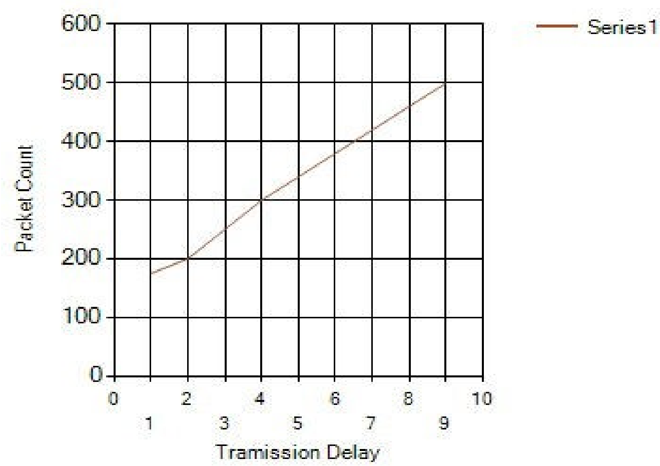

Fig. 7. Traffic Load Vs Transmission Delay

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