Light Fidelity (Li - Fi) Access Point Selection for Heterogeneous Network with Non Overlapping Li - Fi Access Points

T. Veeramakali, S. Prabu, S. Jayashri

Abstract: ***Data transmission is a part of our life in today's scenario. Data communication can be carried out by wired technology and wireless technology. Radio frequency is a part of the electromagnetic spectrum, which is used for wireless communication. Many technologies are used for wireless communication such as Wi-Fi, Blue Tooth, Ad-hoc, and etc. These are all transmitting data through radio spectrum for short distance. New technology called as Li-Fi (Light-Fidelity) is going to be a major wireless communication technology in future. In the proposed system a heterogeneous network has been consider as a system model. Li-Fi technology is having the capacity of low coverage area. So, non movable wireless devices are getting better usage of Li-Fi technology in an indoor environment. For mobile devices need more number of Li-Fi access points. When the user moves from one access point to another access point covering range, the service should be continued without break. System handover is a major issue in the Li-Fi technology. If the user goes out of the range of light emission area, then the user can get the service through Wi-Fi access point. Proposed system focusing on the handover process based on the measured handover efficiency value. Data transmission can be disturbed due to some power failure or LED fault. In this situation immediately the entire load should be handled by the Wi-Fi access point. In such a situation data rate is coming down than the threshold value. So handover process will be handled by the common controller. Data rate is observed when the number of user increased and for variation in channel gain and the simulation results are analysed.***

Keywords: Li-Fi, WI-Fi, Access point, Mobile Users

I. INTRODUCTION

In overcrowded wireless data communication, Li-Fi (Light Fidelity) is a phenomenon technology that uses the light source as a communication media for short range wireless communication [1] . In this world every second enormous of data are transmitted through electromagnetic spectrum. According to the Cisco Visual Networking Index (VNI) report data traffic was raised 69% in the end of the year 2014 than the end of the year of 2013 [2]. In today's scenario 80% of mobile data traffic occurs in indoor locations [3]. In the conventional wireless communication Radio frequency has been used as a data carrying media. Wi-Fi is the most adaptable, capable and perfect technology for fast wireless data transmission. In Wi-Fi major challenges and issues are spectrum capacity, spectrum efficiency, spectrum availability and security [4]. Limitations of the Wi-Fi technology are the main overhead in the improvement of capacity. The development of 3G and 4G technology has occupied most of the electromagnetic spectrum. The huge usage of user leads to lack in efficiency [5]. Electromagnetic spectrum consists of Gamma rays, X-rays, Ultraviolet, Visible light, Infrared, Microwaves and Radio waves. Fig.1 [6] shows the electromagnetic spectrum. Many Industries, research organizations and institutions are focusing in Li-Fi Technology. Many researchers carried out the experiments towards the Li-Fi technology would be overcome the limitations and drawbacks of the Radio Frequency based wireless communication [7].

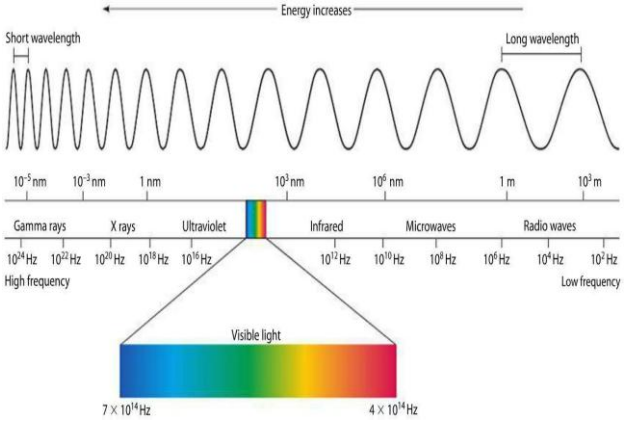

Fig.1. Electromagnetic Spectrum [15]

Radio frequency free environment is more important and many researches are focusing on that [8].

Table I: Difference between Wi-Fi and Li-Fi [12]

Parameters	Wi-Fi	Li-Fi
Distance	30Meters	10 Meters
Speed	~150Mbps	~1Gbps
Spectrum Used	Visible Light	Radio Frequency
Standard	IEEE802.11	IEEE802.15.7
Power Conception	High	Low
Cost	High	Low
Bandwidth	Limited	Unlimited

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Data transmission by light fidelity technology has been introduced by a German Physicist Herald Hass [1].
These two technologies (Wi - Fi and Li - Fi) had lot of pro and cons according to the spectrum usage and performances. The table I describes the difference between Wi-Fi technology and Li-Fi technology based on different parameters [13], [14].
Two types of handovers are known as horizontal and vertical handover. Handover among Li-Fi APs are referred as horizontal handover. Handover between Li-Fi and Wi-Fi are known as vertical handover [9],[10]. Average time taken by central unit varies between 30 to 3000 m seconds [11].

II. SYSTEM MODEL

In this proposed system, heterogeneous network environment has been considered in an indoor area. It contains number of Li-Fi access points (AP) denoted as N_l and one Wi-Fi access point to cover the indoor area. In first case when number of users increased in indoor environment with only Wi-Fi AP, due to limited unlicensed spectrum availability speed of the transmission, throughput will get reduced. In case two to cover the entire indoor location, we need more number of Li-Fi APs and it may not cover the corner or some part of the indoor area. So we considered both Li-Fi and Wi-Fi technology environment for data communication. Handover process can be occurred between Li-Fi APs or Li-Fi and Wi-Fi AP. Handover between two Li-Fi APs are known as Horizontal handover. By the same time handover between Li-Fi AP and Wi-Fi AP is known as vertical handover. In the proposed system we considered vertical handover scenario.

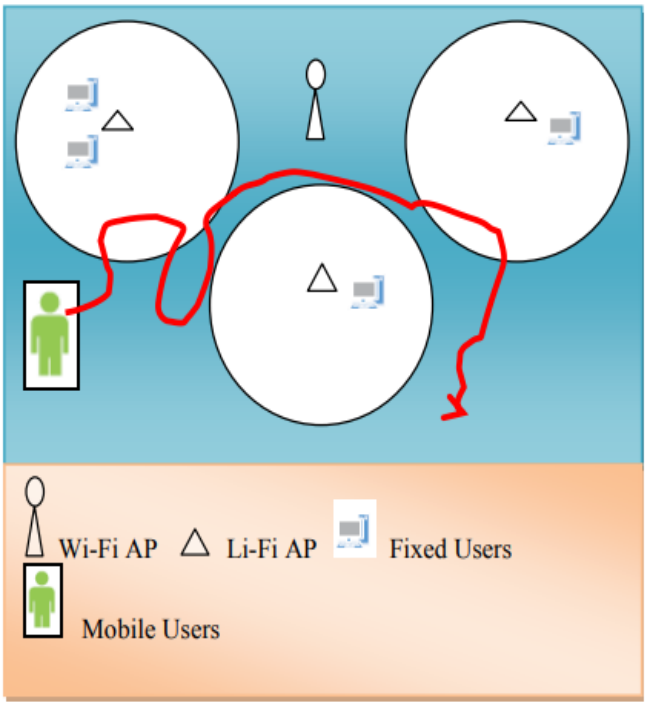

Fig.2. System Model

A central unit is connected with all the APs. When the mobile move from one AP covering range to another one, immediately central unit make the handover process. Li-Fi is using light as a transmitting media. The optical channel gain is based on the Line Of Sight ((LOS) and reflection property.

Handover Process:

Most of the previous works are concentrated on non movable device for getting Li-Fi connection. This paper is mainly focusing on the mobile device, which is getting service from the Li-Fi and the Wi-Fi source. In this proposed system non overlapping Li-Fi APs are used and covering range is taking as a circle. The circle radius is denoted as L_r and handover radius is denoted as L_{hr}. Whenever the mobile device crosses the handover radius, then handover process will be performed.
The data rate of the transmission is calculated by the following equation for the Li-Fi AP N_l and the user u.

$$R_n^u = B\log(1 + SINR_n^u)$$

SINR is signal to interference and noise ratio between Li-Fi AP N_l and the user u.

$$SINR_n^u = \frac{P_{gain}}{cN_0B + \sum kP_{op}}$$

Power gain of the receiver photo detector is denoted as P_{gain} and calculated as follows

$$P_{gain} = kP_{op}C_{n,u}$$

Where, k is efficiency of the optical to electrical conversion, P_{op} is an optical power and $C_{n,u}$ is a Li-Fi AP and user channel gain

$$c = P_{op}/\sqrt{P_{el}}$$

Here P_{el} is a electric power.
Here, P_a is the physical area of the photo detector, $H_{u,n}$ is the distance between Li-Fi AP N_l and the user u, h is a hall height, $\emptyset$ is an incident angle and θ is an irradiation angle.

$$C_{n,u} = \frac{(m+1)P_a}{2\pi\left(H_{n,u}^2 + h^2\right)} g(\theta)T(\theta)\cos(\emptyset)\cos(\theta)$$

Handover efficiency is denoted as

$$E = \begin{cases} 1, & R_n^u < Thresold \\ 0, & else \end{cases}$$

Based on the irradiation angle, incident angle and all other parameters data rate is calculated and decision taken based on the result.

Algorithm for handover between Li-Fi to Wi-Fi

1: **Assign** $n = l$
2: **for** all Li-Fi access point N_l **do**
3: **for** all users u *belongs to* N_l **do**
4: Calculate the R_n^u
5: **if** $R_n^u < Thresold\ value\ then$
6: Change the access point from Li-Fi to Wi-Fi
7: **else**
8: Continue with same AP
9: **end for**
10: **end for**

III. PERFORMANCE ANALYSIS

The tableII shows that the parameter used in the simulation for the proposed system.

Table II: Simulation Parameters

PARAMETERS	VALUES
Li-Fi cell Radius	4 meter
Electric power to optical power	3
Optical power	10W
Bandwidth	20MHz
Physical Area	1 Cm^2
Height of the hall	2.5 meter
Noise Power	10^{-19}

The simulation result worked out for the data rate for the Li-Fi transmission in two scenarios. In first one, data rate is calculated when the channel gain increased against various c values. Whenever the c value increased, then the SINR value will get reduced. So that automatically the rate will be increased. The simulation result is shown in the figure3. Table III shows the numerical values of the simulation result. It clearly explored that the effect of the c value changes in the data rate.

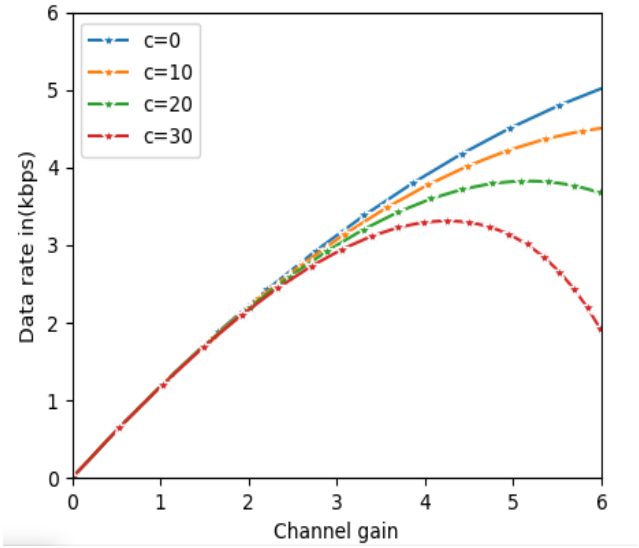

Fig.3. Channel gain Vs data rate

Table III: Data Rate for various C and Channel values

C	Channel Gain						
	0	1	2	3	4	5	6
0	0	1.21	2.32	3.82	4.11	4.64	5.16
10	0	1.20	2.31	3.69	3.79	3.92	4.21
20	0	1.12	2.26	3.49	3.14	3.4	3.11
30	0	1.11	2.22	3.27	2.92	2.41	1.53

The variation in the H value affects the channel gain and power gain. The figure 4 shows Ithat the data rate against number of Li-Fi users, when the H value varies. The result proves that the lesser H value is lead to the higher data rate. Based on these calculations

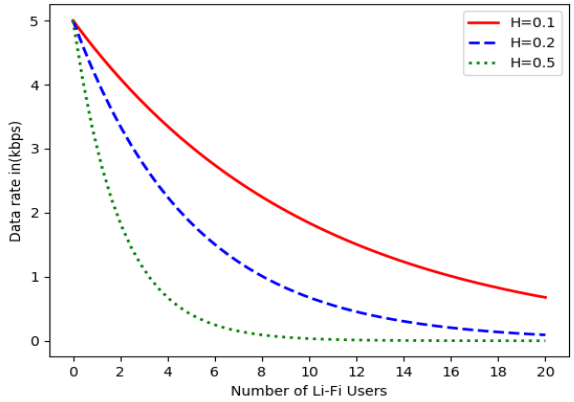

Fig.4. Data rate Vs Number of Li-Fi users

Table IV: Data Rate for various H and Number of Li-Fi Users

H	Channel Gain						
	2	4	6	8	10	12	14
0.1	4.8	0.7	0.4	0.2	0.2	0.2	0.2
0.2	4.5	2.8	1.9	1.2	0.8	0.8	0.3
0.3	4.2	4.3	3.9	3.4	2.9	2.9	1.6

Efficiency of the handover is calculated and if it is one the handover process will be carried out, else the user continues the transmission over Li-Fi channel. Table IV shows all the values of data rate against H and Channel gain. It proven that the when the H value and number of Li-Fi users are increased the data rate is decreased

IV. CONCLUSION AND FUTURE WORK

This proposed work was focused on heterogeneous (Li-Fi and Wi-Fi) network. The system efficiency value for handover is measured and based on this value handover process will be carried out. A small region for Li-Fi has been considered and decision on handover process is taken based on the data rate and E value. Based on the E value access point is selected for the data communication.Non overlapping Li-Fi access point is considered in this proposed system. The future work which focuses the multiple access points with overlapping scenario.

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