

Study on indoor Optical-RF hybrid Wireless Access Scheme

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I. Introduction

- Optical wireless communication (OWC) is working in high frequency spectrum provides high speed communication service for UE, OWC's characteristics including big capacity, high coding rate and OWC can supports security network for people
- Visible Light communication (VLC) work in visible band (400THz-800THz) is a OWC transmitter method use visible light to supports communication service in small area, due to background interference as sun light or artificial light, VLC almost use Light-emitting diode (LED) provides indoor communication service.
- By the development of communication technology, heterogeneous VLC-WiFi network is a way to meet next generation communication technology requirement for indoor environment, combine VLC support high data rate transmission and WiFi will provides a reliable connect. Vertical Handover (VHO) will be a way to increase system performance.
- We consider a VHO scheme for VLC-WiFi heterogeneous network in order to increase UE's communication quality of service (QoS), and reduce handover delay, Markov Decision Processing (MDP) will be used to make the handover decision. The result will show the advantages of MDP handover scheme.

II. System Model

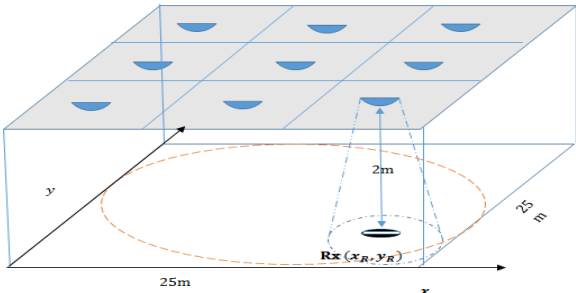


Fig. 1. Room setup

- As figure 1 showed, we setup indoor environment in a room has the dimension of 25 × 25 × 3 m3(length, width and height), we assumed UE is 1m height above the floor level. the VLC receiver is keep horizontal level, and assumed UE will go in straight line when they move in room. LED lights are all used, and field of view angle (FOV) is 70 degree.
- We set blue circle as VLC can provides connect and the orange circle as WiFi coverage in the room

III. Handover scheme and Markov processing

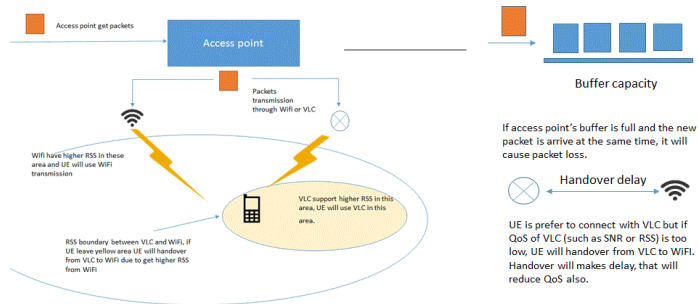


Fig. 2. handover model.

We consider about handover scheme depends on consider about QoS as RSS and found out the relationship between time UE use VLC connect service, If UE is only moving in straight line average delay of handover by the time UE using VLC increase.

The SNR in VLC coverage is

$$SNR = \frac{(RP_r)^2}{\sigma^2}$$

In function (1) R is means Photodiode Responsivity and P_r is meaning UE's receiver power, σ^2 is total noise

P_r is given by

$$P_r = P_t \frac{(m+1)}{2\pi d^2} \cos \theta^m \times T_s \times g \times \cos \phi$$

In function, m is the order of lambertian, θ is the angle of irradiance, T_s is filter transmission and g is concentrator.

SNR of WiFi is given by

$$SNR = \frac{P_t \times h \times P_l}{N}$$

Which P_t is transmission power, h is channel gain, and P_l is path loss of WiFi

The time UE using VLC is a interval between UE's SNR begin to bigger than threshold and UE's SNR begin to smaller than threshold, we will find out a stable time as figure 4 showed

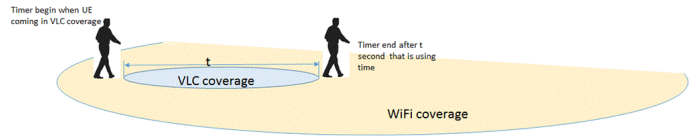


Figure 3 time UE using VLC

the time t UE using VLC will be collected and use to calculate the probability UE use any VLC connect link according to function: $P_{VLC} = \frac{t}{T_{totally}}$, after that, in order to find the best t out we will use value function: $g(t) = P_{VLC} \times RSS_{VLC} + (1 - P_{VLC}) \times RSS_{WiFi}$. Where g(t) is means the RSS value for different t, value iteration will be used also to find out the best t that can make the best RSS value during the whole processing.

V. Numerical Results

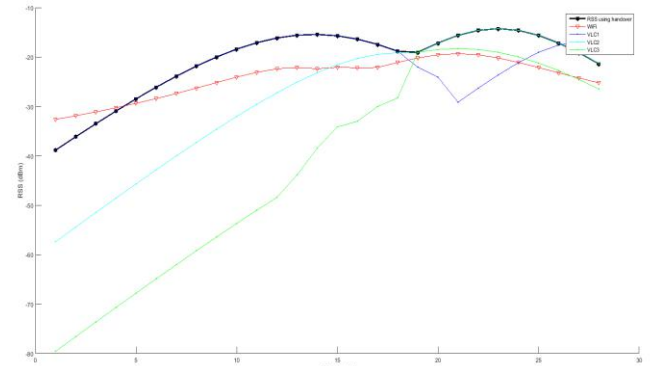
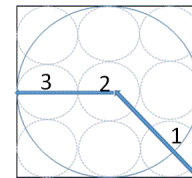


Figure 4 UE's final RSS using handover system



Small circle means VLC coverage and bigger circle means WiFi coverage, when the UE moving in the room (shown as square) he will follow the blue route. Because UE will through VLC and WiFi's coverage, the handover system will make the decision for UE, according to MDP, UE will not handover to other connect link if the time UE use it will not exceed 5 second, and the result is showed as figure 1, UE didn't use WiFi although WiFi's RSS is better than VLC in the current time.

VI. Conclusions

- We assume UE in the room is moving in straight line, with UE's moving, SNR and receiver signal strength (RSS) will changed, as we talked in section I, VLC could support high data rate communication but RSS of VLC will reduce if UE just leave from one VLC coverage but not close to another LED.
- WiFi will support a more stable communication for UE but consider about data rate, use VLC can reduce packet loss rate so UE should use VLC as long as possible during moving.

VII. References

Wang F, Wang Z, Qian C, et al. Efficient vertical handover scheme for heterogeneous VLC-RF systems[J]. Journal of Optical Communications and Networking, 2015, 7(12): 1172-1180.