Data Distribution to Vehicular Passengers Through PLC Systems

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Abstract

In this paper, we propose an innovative idea where data can be distributed to vehicle passengers through power line communication (PLC) systems. Power line is connected with roadside access points (APs) of wireless local area networks (WLANs). Data packets are pre-downloaded through power line and buffered in the storage of AP. Vehicle passengers' devices download the data when the vehicle crosses the transmission range of AP. We also propose off-time cooperation process to increase the downloading data blocks.

1. Introduction

Nowadays, the vehicle passengers use internet through the following technologies such as 3G, WiMAX, High-Speed Downlink Packet Access [1] [2]. The new IEEE 802.16 standard offers 3 to 5 Mbps [3] but the recent investigations shows that the download speed from the vehicle is around 300 Kbps [2]. This speed is not enough for large number of vehicle passengers. Moreover, these technologies are expensive for the users as well as for the operators. We can use PLC systems to enhance the growing demand of data for the vehicle passengers.

Power line communications has long been used for different applications such as voice and data communications. Data rates of PLC system are increasing due to the development of modulation and transmission techniques [4]. Residential houses, factories, shopping malls, and post lamps remain randomly beside the road. Power line reaches each of these places in order to distribute electricity. If we deploy WiFi access points (APs) in these places then we can interconnect those APs with internet through PLC systems. Thus, vehicle passengers can download data when it arrives in the transmission range of APs. Already some projects, such as Singapore [2], Kent Ridge [5] deployed roadside APs to distribute data to vehicular passengers for smaller scale investigations.

In this paper, we propose data distribution mechanism to vehicle passengers using PLC systems. We consider that PLC systems connect all the roadside APs. Data are pre-downloaded and stored in the buffer of AP where PLC is used as transmission media. Passengers' devices download the data packets when the vehicle arrives in the transmission range of AP.

Our proposed system is not the replacement of existing WiMAX or 3G rather it will co-exist with existing systems to increase the data downloading at lower cost.

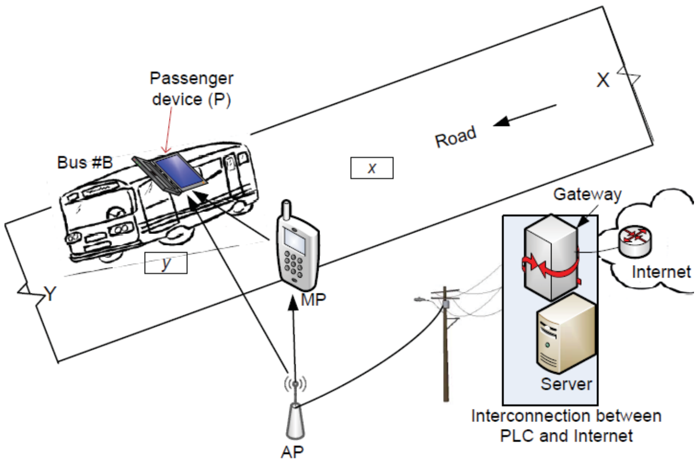

Fig. 1 Data distribution model to vehicular passengers

2. Protocol Operation and assumptions

In our proposed mechanism, passenger sends request to the database of PLC systems through 3G or WiMAX for specific data. Subsequently, the database resends a request to internet for that data. The database contains the locations of APs and travel history of the vehicles. Thus, based on the trajectory [1] of the vehicle, the PLC system predicts that the vehicle will arrive at nearby AP after certain time. Therefore, the required data are pre-downloaded to that AP before that time. Roadside APs buffer the pre-downloaded data and provide services to the visiting passengers' devices when arrive in the transmission range of AP.

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Suppose, the bus #*B* is traveling through a road XY and the current location of the bus #B is *x* at time *t* and speed is *v*, shown in Fig. 1. When the bus arrives at location *x*, a passenger of the bus sends a request (message) to the server of PLC systems to download a data blocks. This request is sent using vehicle's existing communication technologies such as 3G or WiMAX. The message includes bus's present location and speed. Based on the present location and speed, mobility information can be predicted with high accuracy using Automatic Vehicle Location and past history [2]. According to the predicted mobility information, the bus #*B* will arrive at location *y* at time *t+dt*, where AP is available. The service centre of the PLC system contains the database of all the roadside WLANs' or hotspots' APs. The requested data blocks are downloaded from the internet and are sent to the respective AP before visiting that WLAN.

3. Cooperation Method

In this study, we use two levels of cooperation: real-time cooperation and off-time cooperation. Real-time cooperation is traditional cooperation [6] is used to download data while the vehicle remains in the transmission range of AP. In this case, AP transmits data to pedestrian's smart device and subsequently the smart device transmits the data to vehicle passengers' device. If the pedestrian's smart device is not available then AP transmits directly to the vehicle passenger. The real-time cooperation increases the transmission rate and range.

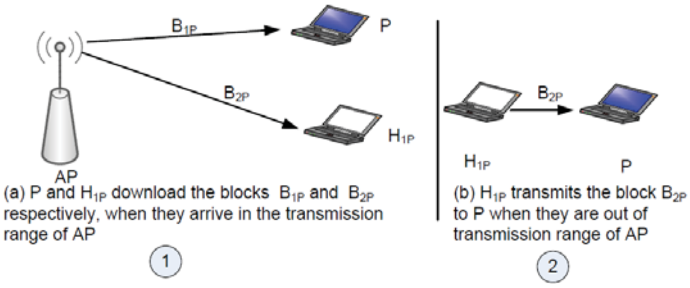

Fig. 2. Off-time cooperation mechanisms for passenger P

Off-time cooperation is used to download data after crossing the transmission range of AP and thus increases the number of downloading data packets. For example, the passenger's device P sends a request for data blocks B_{1P} and B_{2P} before arriving in the transmission range of AP. Note that the request is sent using 3G or WiMAX. We assume that the blocks are downloaded from internet via PLC systems and buffered in the AP accordingly before arriving in the transmission range. If the vehicle arrives in the transmission range of AP then the blocks B_{1P} and B_{2P} are downloaded by P and H_1 respectively, shown in Fig. 2. The blocks B_{1P} and B_{2P} are downloaded either directly or using real-time cooperative mode. The helper H_1 transmits the block B_{2P} to P after crossing the transmission range of AP. These mechanisms are defined as off-time cooperation in this paper. Important assumption is that each AP has multiple interfaces.

Basically the device H_1 is another passenger's device and functionally similar to P. Since, H_1 is idle for the time being thus it acts as a helper. The major benefit of this mechanism is that downloaded packets increase significantly. The more the interface is the more the benefits is. However, if the interface number is higher than the available channel number then the performance will degrade due to the channel switching overhead.

4. Conclusion

In this paper, we propose an innovative model to distribute data to the vehicle passengers through the APs of roadside WLANs. In our proposal, data blocks are pre-downloaded to AP using PLC systems and passenger download those blocks while crosses the transmission range of AP. The innovative idea of off-time cooperation will increase the number of downloading packets. Our preliminary simulation results show that if the vehicle speed is 100 km/sec and the packet size is 1024 byte then a passenger can download more that 6000 data packets within crossing time of single AP's transmission zone. Rigorous simulation is required for the proposed systems to evaluate the performance.

References

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