Computers and Electrical Engineering 000 (2016) 1–21

Contents lists available at ScienceDirect

Computers and Electrical Engineering

journal homepage: www.elsevier.com/locate/compeleceng

Physical constraint and load aware seamless handover for IPTV in wireless LANs

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ARTICLE INFO

Article history:
Received 9 August 2015
Revised 5 January 2016
Accepted 6 January 2016
Available online xxx

Keywords:
Wireless LAN
IPTV
Seamless handover
BER
Congestion

ABSTRACT

In wireless LANs (WLANs), handover is usually performed based on either signal power or congestion level. However, considering only the congestion level could be insufficient for handover since it may cause traffic loss. Therefore, besides the load of access points (APs), it is necessary to consider the physical conditions of different WLANs for performing a seamless handover. This article introduces a novel scheme for seamless handover of IPTV streams in WLAN carrying IPTV traffic, called Physical Constraint and Load Aware (PCLA) handover. The PCLA can compute the load of APs for congestion detection purposes. In PCLA, a mobile node chooses the best network considering signal strength, bit error rate in the relevant environment, and the congestion of APs for making a seamless handover. The simulation results show the appropriateness of PCLA in improving handover performance.

1. Introduction

Nowadays, Internet Protocol Television (IPTV) is a competitive service in business and commercial areas, and most service providers attempt to deploy this platform because of its attraction and economical potential [1]. IPTV is a method for delivering digital television signals (involving audio, video and data) over Internet Protocol (IP) as the transport platform via broadband infrastructure, usually in a managed network to guarantee quality of service (QoS) [2]. "IPTV is defined as multimedia services such as television/video/audio/text/graphics/data delivered over IP based networks managed to provide the required level of quality of service and experience, security, interactivity and reliability" [3].

IPTV services can use wired or wireless technologies as their communication infrastructures. The IEEE 802.11n wireless local area network (WLAN) and Ultra Wideband (UWB) standards are two examples of wireless technologies that can be used. In 802.11n, data rate can increase up to 540 Mbps within 50 meters range of AP (Access Point). In UWB, data rate is between 55 Mbps and 480 Mbps within small ranges [4].

With the growth of portable devices such as laptops, notebooks, and cell phones, the demand for accessing IPTV services through wireless networks has increased. IPTV users like to access multimedia services everywhere and at any time. However, there are some challenges in wireless networks for establishing IPTV services such as bandwidth, coverage area, Quality of Service (QoS), and Quality of Experience (QoE). IPTV subscribers may be unwilling to tolerate any degradation in quality of received video, and therefore, service providers should try to satisfy users in order to increase the number of customers [5]. An architecture is proposed in [6] for guarantying the QoS of mobile IPTV users which can be implemented

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http://dx.doi.org/10.1016/j.compeleceng.2016.01.005
0045-7906/

in different OSI layers. For improving IPTV QoE in [7], a method has been proposed based on a circular buffer which uses two application layer strategies: forward error correction (FEC) and automatic repeat request (ARQ).

For transmission of IPTV packets, Real-time Transport Protocol (RTP) [8] and **RTP Control Protocol (**RTCP) [9] can be used. The RTP is an application layer protocol that defines a standard format for packets of multimedia systems such as IPTV. The RTCP is used for gathering transmission statistics and QoS issues. Both RTP and RTCP operate over UDP, where they can be multiplexed on a single UDP port used for each video stream [10].

WLAN is currently the most popular technology for transmitting traffic in local area networks. For supporting movement in WLAN, various mobility management schemes have been introduced. Balancing traffic load among APs is a requirement, especially when multiple APs are attached to one operator's network. It has been proposed in [11] that dynamic management of mobile nodes according to the bandwidth usage of each host can distribute traffic load among APs, thus increasing overall throughput. Due to the fact that IPTV has traffic streaming nature, a seamless service method is required for uninterrupted video playing. For seamless service of IPTV, an architecture that adjusts video streams according to link capabilities has been proposed in [12]. With multiple APs available for IPTV users, handover may reconnect a mobile node (MN) from one AP to another one. Typically, a MN chooses the AP with the highest received signal strength indicator (RSSI) for handover. In this paper, we call this method RSSI-based handover (RSSIH) from now on. However, this parameter is not sufficient by itself [13]. RSSI depends on the AP transmitter power and the distance of the MN from the antenna of AP, while there are many other factors which result in bit error in the MN. This motivates us to propose a new mechanism in which the MN should take into account physical constraints and the load of APs for making better decision in its handover procedure.

Our objective in this paper is to propose a new mechanism, called Physical Constraint and Load Aware (PCLA) handover, which considers various parameters involved in the handover management such as:

- RSSI which is the key parameter in handover procedure and represent the magnitude of signal power that can be received from AP.
- BER which can represent environmental conditions that affect the quality of received data.
- And finally, congestion level of available APs. If traffic in an AP grows so that it becomes congested, packets destined to mobile nodes will suffer from much delay and even loss. Thus, handover of mobile users to other available non-congested APs can overcome this problem.

By this mechanism, an optimum network is selected for handover with the objective of minimizing packet loss and delay of IPTV streams.

Our contribution is to propose a seamless handover procedure that selects the best network for handover in WLAN by considering signal strength, bit error rate (BER), and network congestion all at the same time.

This paper is organized as follows. Section 2 describes related research on mobility management and handover techniques. Section 3 details the proposed PCLA method for seamless handover of IPTV streams. Section 4 presents performance evaluation followed by a conclusion in Section 5.

2. Related work

There are some challenges in IPTV such as multicasting, admission control, and traffic management as discussed in [14]. Handover is desirable for supporting movement and connectivity in a WLAN with multiple APs. Handover is performed either by the network or by an end user or by cooperation of both. Handover can be divided into two categories: horizontal handover in homogeneous networks and vertical handover in heterogeneous networks with different infrastructures [15]. IEEE 802.21 has been produced for vertical handover between different wireless networks which are available now [16]. In [17], a protocol has been proposed to handover vertically between different types of WLANs with considering QoS.

According to another classification, handover could be either soft or hard. In the hard handover, before establishing a new connection, the current connection is terminated. On the other hand, there are two simultaneous connections at a period of time under the soft handover. The soft handover is crucial for providing seamless service for real time applications such as IPTV.

Handover procedure includes three steps. First, overlapping WLAN networks are found in the network discovery phase. Second, the best network is determined for handing over. In handover procedure for network selection, multiple parameters can be taken into account such as received signal strength indicator (RSSI), Signal to Noise Ratio (SNR), bandwidth, power consumption, price, and QoS parameters. Selection of appropriate criteria is important since an incorrect handover leads to the degradation of service level, thus reducing QoE. Finally, handover is performed.

For improving throughput of devices, an adaptive congestion control mechanism for vertical handover between 3G and WLAN has been provided in [18]. In [19], a Session Initiation Protocol (SIP) based procedure for handover in heterogeneous networks has been proposed which considers network congestion status.

It has been shown that received signal strength cannot detect reduction in quality of communication for WLAN handovers [20]. For handover initiation in the next generation networks, a fuzzy-logic adaptive threshold has been proposed in [21], where it is shown that in addition to RSSI other parameters such as receiver and transmitter heights are important for determining this threshold.

Please cite this article as: H.S. Fard, A.G. Rahbar, Physical constraint and load aware seamless handover for IPTV in wireless LANs, Computers and Electrical Engineering (2016), http://dx.doi.org/10.1016/j.compeleceng.2016.01.005