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Vertical Handover Time Estimation Method

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Abstract. The paper presents a method for vertical handover (VHO) switching time estimation. This method shows a high accuracy of estimation for the session setup procedure and can be applied for vertical handover procedure. Unlike the estimation methods for open queueing network we consider not only the main foreground traffic but the background traffic too. Moreover, the estimation can be obtained for any service time distribution function. The paper shows the switching vertical handover procedure fro LTE to Wireless Regional Area Network (WRAN) including authorization and authentication. The sojourn time for customer premise equipment (CPE) at the IEEE 802.22 WRAN is a key performance index for a making decision about from a current wireless access network as 3GPP LTE to the 802.22 WRAN.

Keywords: sojourn time, cognitive radio, customer premise equipment, method, IEEE 802.22, white space, TVWS.

1. Introduction

We introduce an analytical method for vertical handover switching time esimation. In this paper we present a vertical handover procedure from 3GPP Long Term Evolution (LTE) to WRAN. The IEEE 802.22 WRAN is the first wireless officially approved standard [1,2] based on the technology and principles of noninterfering cognitive radio (CR) networks. This standard is the most appropriable radio access technology for a rural or another territory with a low population density, for a vehicular cognitive access at the intelligent transport system. A VHO analytical model can be used as a metric of CPE effectiveness for the VHO in the context of seamless or non-seamless physical connection and IP–session establishment.

2. Vertical handover procedure from 3GPP LTE to IEEE 802.22 WRAN

For this day, there is no analytical method of IEEE 802.22 signaling procedure with focus on the CPE sojourn time on VHO 3GPP LTE – IEEE 802.22. With a proposed analytical method there is a way to make an objective estimation of CPE's time period for identification and sojourn time at the IEEE 802.22 WRAN during VHO from the 3GPP LTE.

During VHO CPE (User Equipment) requests Access Network Discovery Service Function (ANDSF) about capabilities of IEEE 802.22 base stations (BS). There is a principal signaling message exchange between CPE (UE) and dedicated servers with support of AAA for IEEE 802.22. We will discuss unicast service time CPE model with a step-by-step initialization procedure. Unlike [3] this procedure will include phase of CPE IP–registration. Discussed procedure can be introduced as show in Fig. 1.

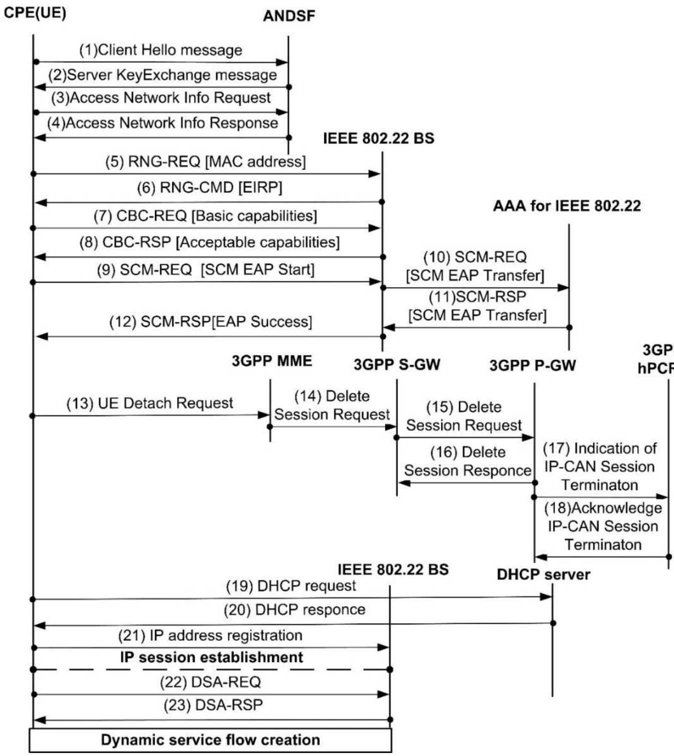

Figure 1. Service flow creation for VHO LTE - IEEE 802.22 WRAN

Let us describe the switching procedure. The CPE (UE) sends a message (1) and has response (2) with a security key. The message (3) is a request to retrieve network discovery. The message (4) is a respond with an information about IEEE 802.22 BS. The messages (5) Ranging Request is a request Equivalent Isotropically Radiated Power (EIRP) value. Message (6) Ranging Command shall be transmitted by the BS in response to (5). The CPE transmits Basic Capability Requests message (7) with an information elements concerning communication parameters. Message (8) CPE Basic Capability Request is a response to (7). The Security Control Management (SCM) message (9) is an Extensible Authentication Protocol (EAP) request. The message (10) is a message that shall be retransmitted to the AAA server. Message SCM–RSP (11) is an AAA server response. Message (12) is a finish message for the CPE (UE) authentication.

With message (13) a process of detachment is beginning. With message (14) a 3GPP Mobility Management Entity (MME) will deactivate bearers. The Service Gateway (S-GW) is sending request (15) for a bearer release. Message (16) is response to the message (15). The message (17) is an indication at the hPCRF about IP session termination. The hPCRF removes the data concerning terminated IP-Connectivity Access Network (IP–CAN) session and sends acknowledgement (18). From this moment there is no IP–session throw 3GPP EPS for the CPE (UE). With message (19) the CPE (UE) shall invoke DHCP mechanism. The CPE (UE) received the IP address with a message (20). With a message (21) the CPE starts the process of IP address registration. A Dynamic Service Addition Message Request message (22) contains a service flow parameters. The BS responds with a Dynamic Service Addition Response (23) indicating acceptance of parameters which associated with upstream/downstream and QoS rules. There is dynamic service flow creation completed.

3. The method of vertical handover time estimation

We propose the approximate method for sojourn vertical handover switching time estimation in multistage queueing system with background traffic.The accuracy of this method was shown in [6]. Unlike the estimation method for open queueing network [7] we divide incoming flow at each node into foreground and background traffic (see Fig. 2). Signaling messages (1)-(23) construct foreground traffic. Another tasks form at each node background traffic. For our preliminary analysis we use the incoming Poisson flow [8].

The routing chain consists of $K{=}24$ steps, from the processing of ClientHelloMessage in the 1-node CPE (UE) till the processing of DSA-RSP message in the same node. We denote the arrival rate and the average service time of the foreground customers at k-step as λ_0 and b_k, and the arrival rate and the average service time of the background customers as λ_k and d_k.

The sojourn time Δ of a vertical handover switching time can be find by formula (1).

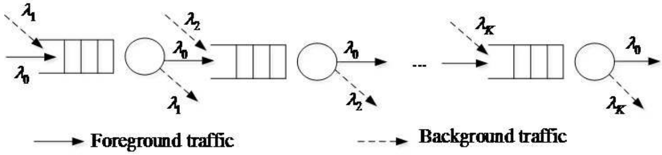

Figure 2. Multistage queueing system with background traffic

$$\Delta = \sum_{k=1}^{K} (w_k + b_k), \tag{1}$$

where w_k is the average waiting time in the node at k-step, obtained from the Pollaczek-Khinchin's formula (2):

$$w_k \approx \frac{\rho_k^2 (1 + C_k^2)}{2(1 - \rho_k)(\lambda_0 + \lambda_k)}, \tag{2}$$

and $\rho_k = \lambda_0 b_k + \lambda_k d_k$ is the offered load on the node at k-step. The squared CV of service time at k-step is shown by the formula (3):

$$C_k^2 = \frac{(\lambda_0 + \lambda_k)(\lambda_0 b_k^2 + \lambda_k d_k^2)}{(\lambda_0 b_k + \lambda_k d_k)^2} - 1. \tag{3}$$

An analytical method allows to estimate the sojourn swithing time of proposed vertical handover procedure. For a numerical experiment, we used input data from the IEEE 802.22 standard. The amount of transactions per second depends on the network situation and configuration and many random parameters. We assume that a maximum of 10% of 512 subscribers at a regular IEEE 802.22 cell are in service after VHO from the 3GPP LTE. The procedure generates at least 23 signaling messages that have been described above.

4. Conclusions

We propose a method for vertical handover sojourn time estimation in multistage queueing system with background traffic. Vertical handover procedure procedure switches user equipment from 3GPP LTE network to cognitive wireless regional area network. This procedure includes at least 23 signaling messages including authorization and resource allocation. This method has following advantages: possibility of sojourn time cumulative distribution function estimation, accuracy of estimation as compared with the simulation model.

Acknowledgments

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