Optimized MIH designfor Handover over Next Generation Wireless Networks

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Abstract:*Next Generation Wireless Networks (NGWNs) are expected to be heterogeneous networks which integrate different Radio Access Technologies (RATs) such as 3GPP's Long Term Evolution (LTE) and IEEE 802.11 wireless local area network (WLAN). The integration of heterogeneous wireless networks poses several challenges. One of the major challenges is vertical handover management. Vertical handover occurs when a Mobile Node (MN) decides to switch between networks of diverse technologies. In this paper, we present a new scheme for vertical handover management in NGWNs. We consider the Media Independent Handover architecture (MIH), proposed by the IEEE 802.21 working group in order to provide the required information for handover and mobility management entities. The performance analysis shows that the proposed approach efficiently uses the network resources by switching between LTE and WLAN to offer best connectivity to the users.It is observed that resource utilization ratio increases to (99%) and the integration of LTE with WLAN using the proposed algorithm reduces the call dropping probability (less than 0.15 for Voice over IP service when switching to LTE network) and call blocking probability for data service (less than 0.24).*

Keywords:*Next Generation Wireless Networks, Vertical handover, Handover decision, MediaIndependent Handover (MIH).*

1. Introduction

The Next Generation Wireless Networks (NGWNs) combine multi Radio Access Technologies (RATs) such as IEEE 802.11 wireless local area network (WLAN), IEEE 802.16 worldwide interoperability for microwave access (WiMAX), third generation partnership project long term evolution (LTE) and LTE-Advanced (LTE-A). The integration of different RATs offers the flexibility for mobile devices to move across multiple RAT with varying strengths to cater numerous applications.

For users, mobility management especially vertical handover with QoS support is an imperative issue in NGWNs. One of protocols offering seamless handover is the published IEEE standard 802.21 media independent handover (MIH) [7]. The aim of this standard is to make link layer intelligence and other associated information available to upper layers in order to perform the handover mechanism between different access technologies while optimizing session continuity.

For heterogeneous networks, this aim only is not enough. There still exist a number of limitations in MIH architecture [11]:

- In MIH, the handover procedure typically based on measurements and triggers collected from link layers, which ignores the influence of the application and user context information on mobility management.
- Collection mechanism for information in network side and mobile node is based only static and less dynamic information resulting.

In addition, no handover decision is made within MIH, "the implementation of the decision algorithm is out of the scope of MIH" [9].

This paper proposes new mobility management framework which involves handover among heterogeneous networks based on IEEE 802.21 MIH standard.

The rest of the paper is organized as follows: Section 2, summarizes the various handover frameworksdesigned on the basis of IEEE 802.21 for NGWNs.In section 3, we present the proposed vertical handover framework. In section 4, we present the MIH signaling of the proposed vertical handover. Section 5 shows the performance analysis of the new approach, and we finally conclude by Section 6.

2.Related Works

In this section, we review previous research that has been done by other researchers on vertical handover based MIH in heterogeneous networks.The authors of paper [8] summarized the current works in the vertical

handover on all three fronts: initiation, decision and execution. The survey revealed the need for new solutions to enable seamless handover with least handover latency and reduced call drop ratio. In [3], the authors described a new framework of improved media independent handover to perform vertical handover in the context of heterogeneous networks. New functional entities are introduced in the terminal side to optimize the handover decision-making in the proposed framework.

Authors in reference [12] raised a mobility management framework for network mobility handover. It used IEEE 802.21 to collect context information and make handover decisions. An improved network mobility protocol was further suggested for the handover execution, with the purpose of overcoming the applications' traditional dependence on network mobility application deployment and the infrastructure network. Authors in [1] made a survey of different approaches of decision-making algorithm based on Received Signal Strength (RSS), bandwidth and combined (RSS and bandwidth), concluding that current decision algorithms lack deliberation of various network parameters pertaining to the 4G/5G specifications. The open challenge is to formulate various parameters based on network context and user preference for intelligent decision-making. In [4], the authors proposed a zone-based media independent information service (MIIS) using the IEEE 802.21 standard to accelerate the neighbor discovery procedure.

Other recent schemes on vertical handover and radio resources management were considered in [6, 5, 2, 10], including decision-making, QoS, network selection, mobility and architectural design.

4. ENHANCED VERTICAL HANDOVER FRAMEWORK

In this section we propose an enhanced vertical handover framework based on IEEE 802.21 standard. The proposed framework is depicted as Figure 1, with focus on the handover preparation and decision procedures.

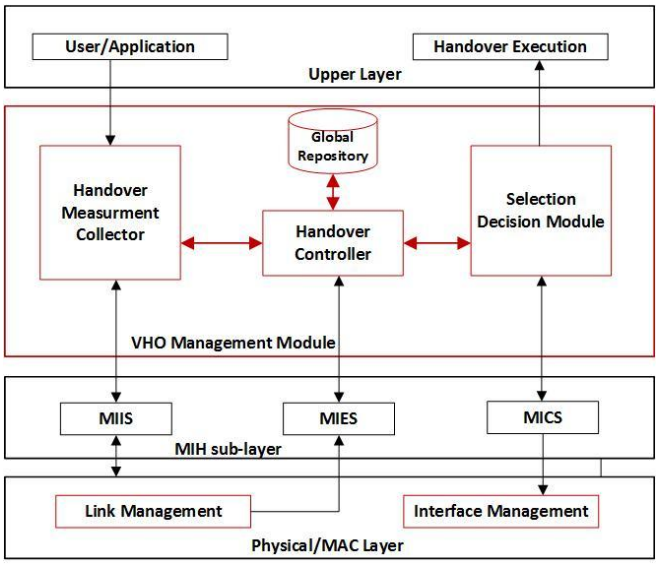

Figure 1.Proposed Vertical Handover Framework

i. Physical/MAC Layer

The Physical/MAC layer is responsible for effective interface switching and handover trigger generation through Media IndependentEvent Service (MIES), it gathers link quality information and provides current data rate measurements.

ii. MIH sub-layer

This sub-layer is responsible for different tasks related to the handover initiation and links control. It offers services such as MIIS, MIES, and MICS.

iii. Vertical Handover Management Module

This module is added to improve the efficiency of the vertical handover decision making and to reduce the network handover latency. The module consists of four entities, as detailed below.

1) Handover Measurement Collector (HMC)

This entity is responsible for collecting different measurements and information at the preparation phase in order to make the most appropriate decision in a short time. The acquired measurements and information will then be stored at the Global Repository.

2) Handover Controller (HC)

This sub-module acts as an MIH user and achieves handover preparation through MIH signaling messages. It links directly to handover measurement collector, repository and selection decision module.

3) Selection Decision Module (SDM)

This sub-module is responsible for final handover decision-making. Multiple parameters are considered to decide the optimal candidate network.

4) Global Repository (GR)

This entity maintains all the required information that will be used by the selection decision algorithm when the optimal network selection decision is made.

iv. Upper layers

This module is a collective name for the network, transmission and application layers. Two sub-modules are included: the application module and the handover execution module. When an application session is initiated, the user/application block informs the handover measurement collector about this application QoS requirements. When a handover is required the Handover execution block manages the IP handover execution.

5. THE PROPOSED VERTICAL HANDOVER

Triggers generated by the link layer are exploited by the MIH function incorporated in the mobile terminal. Link corruption will be reported to Handover Controller directly as link layer events and requestfor a new link is triggered, followed by the handover preparation and decision procedures.

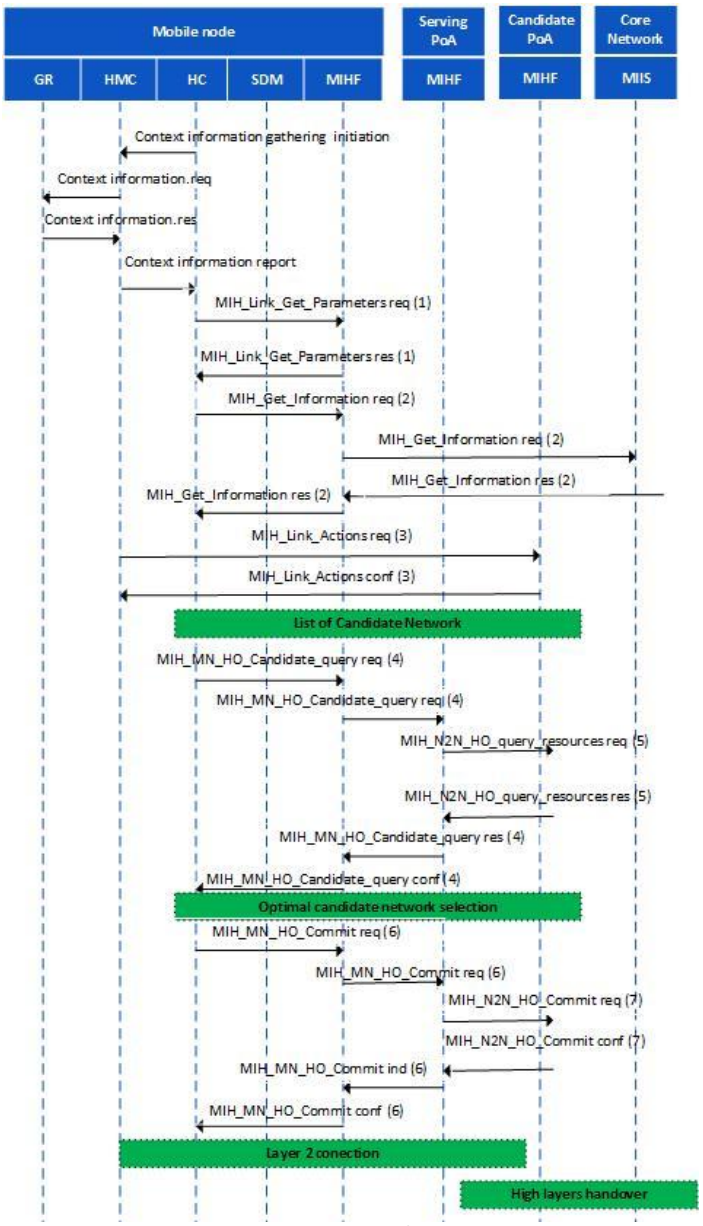

Figure 2.Proposed MIH signaling for vertical handover

The handover procedure is shown in Figure 2. The detailed procedures are as follows:

Step 1: In the handover initiation phase, the Handover Measurement Collector (HMC), extracts context information of neighboring radio access networks and collects some information about mobile user from the upper layers such as user preference, terminal conditions, application requirements, etc. All collected information will be stored in the Global Repository (GR).

Step 2: The Handover Controller (HC), sends a MIH_Link_Get_Parametersrequest message to its local MIHF asking for information concerning the status of an active radio access technology.

Step 3: The latter responds with a MIH_Link_Get_Parameters response message to this request.

Step 4: Handover Controller queries static network information from MIIS server by applying the MIH_Get_Information message primitives.

Step 5: MN checks the link conditions of candidate networks by applying the MIH_Link_Actions primitives.

Step 6: Handover Controller starts resource availability controls over each selected candidate network. It acts as a MIH user and exchanges the following primitives: MIH_MN_HO_Candidate_query and MIH_N2N_HO_query_ resources, with both the serving and candidate PoAs. A list of resources available including QoS requirements is available at the HC and one or more candidate RAN can be selected.

Step 7: Until now the MIHFs of all entities implicated in the handover are informed, the resource availability control of the candidate RANs is performed and the HC have enough information about the neighboring networks to take decision based on policies and multi-criteria decision network approach. The access selection mechanism and its implementation are out of scope of this paper.

Parameters	Values
3GPP LTE System bandwidth	50 Mbps
WLAN IEEE 802.11n data rate	100 Mbps
LTE Coverage Radius	1500 meters
WLAN Coverage Radius	150 meters
Mobility Model	Random Walk point model
Movement speed	20 Km/h
Traffic type	VoIP service Data service

Step 8: After executing the selection mechanism and determining the preferred candidate target radio access network, the HC initiates the MIH_MN_HO_Commit and MIH_N2N_HO_Commit primitives to check the directed network as the target. The commitment stage involves resource reservation and QoS resource requirements at the target network.

6. PERFORMANCES EVALUATION

6.1. Simulation model

In this section, we study the performance of our proposed vertical handover scheme for heterogeneous networks via simulation analysis. We use Matlab to implement our own network simulator that permits the modeling of heterogeneous wireless networks.

A simple network configuration, shown in figure 3 is considered in the simulation. The network incorporates two WLAN Access Points AP1 and AP2 (802.11n) located inside an LTE eNodeB coverage area and one Mobile Node (MN) equipped with multiple interfaces. In this simulation, it is assumed that the IEEE 802.21 mechanism is properly considered.

Call requests are generated randomly based on Poisson process with a mean arrival rate of λ (calls/s). The channel holding times are exponentially distributed. Two types of traffic were considered: VoIP and Data on Demand. The mobility model used is Random Walk model.

The system parameters used are shown in Table 2.

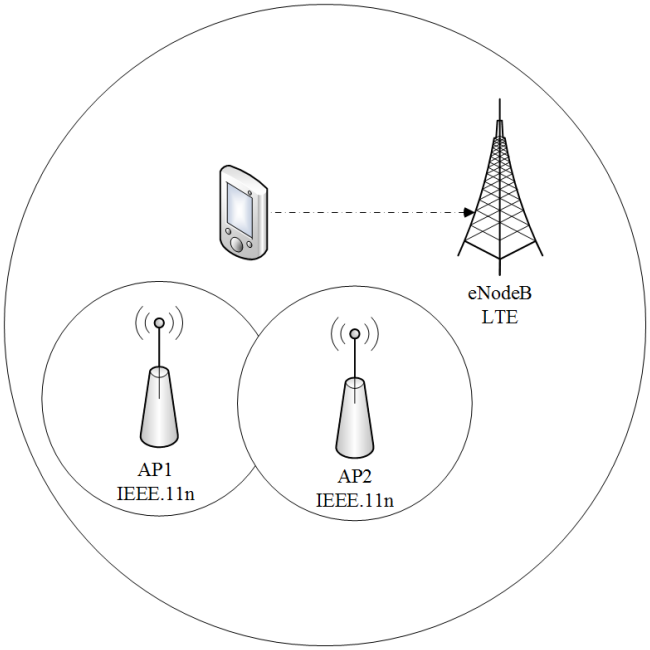

Figure 3.Scenario topology

Table 1.Simulation parameters

6.2. Results and discussion

To evaluate the performance of the proposed approach, we have measured, the handoff call dropping probability (HCDP) for VoIP and Data services and the average system utilization.

Dropping probability are defined as the ratio of the number of rejected handover calls and total number of arrived handover calls. Figure 4 and 5 illustrates the HDCP for the two LTE and WLAN technologies of our proposed scheme by varying the arrival rate of vertical handover connections. When arrival rate of vertical handover connections is low, the vertical handover dropping rate in our scheme is almost equal to zero. However, when the number of simultaneous vertical handover connection requests increases, the vertical handover dropping rate increases to reach about 11% and 14% for VOIP service for a rate equal

to 10 handover calls/s in LTE and WLAN respectively. We also perceive that call blocking probability for Data service does not exceed 24% for a rate equal to 10 handover calls/s in LTE network. This value is smaller in the WLAN (20% for a rate equal to 10 handover calls/s). In the case of VoIP service, these values are even smaller. This can be explained by the notion of high priority for VoIP service compared with data service.

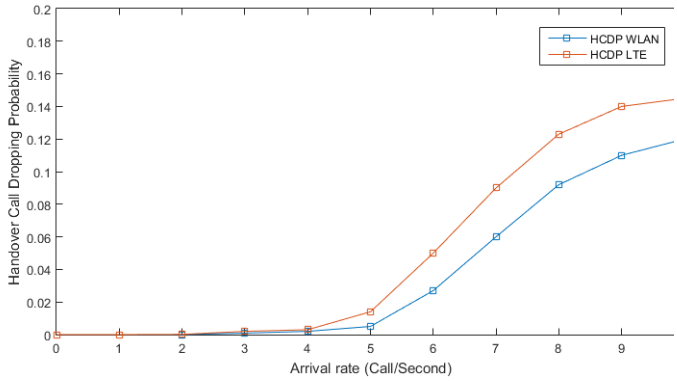

Figure 4.Handover call dropping probability for VoIP service

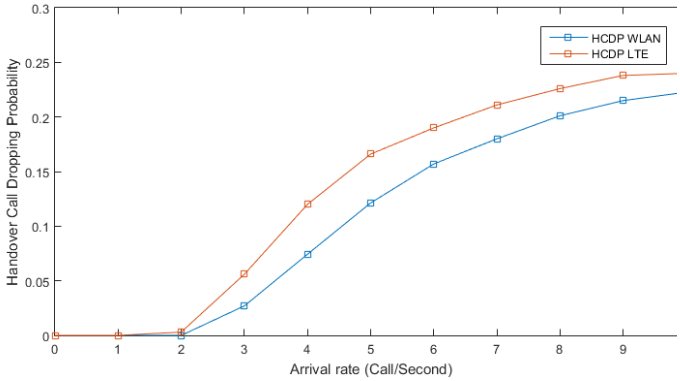

Figure 5.Handover call dropping probability for Data service

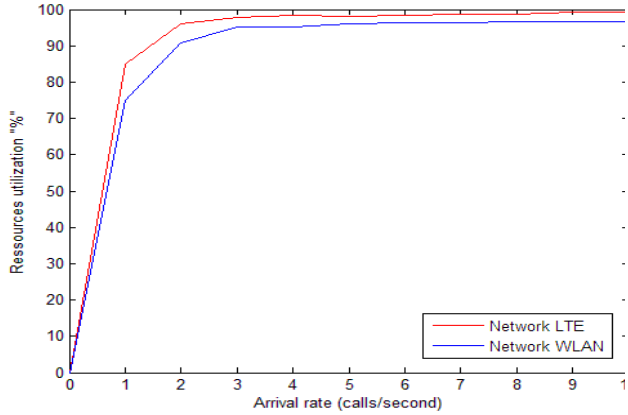

Figure6.Radio resource utilization

Average system utilization is defined as the ratio of the radio resources allocated to UEs during the whole simulation time.

Figure 6 depicts the results of the radio resources utilization according to the call arrival rate. We observe that the proposed approach allows an efficient use of resources. Indeed, the rate of resource utilization can reach 99%. This best use of resources is due to the use of our decision strategy that shares resources properly.

7. Conclusions and Future Work

This research work presents a new mobility management framework based on IEEE 802.21 MIH standard for Next Generation Wireless Networks. New functional entities are introduced in the terminal side to optimize the vertical handover.

Simulation results show that the proposed mechanism can improve the vertical handover process by reducing handoff call dropping probability (HCDP) for VoIP and Data services Moreover, our approach improves the system radio resources utilization.

Our future works include development of network selection algorithm in the context of heterogeneous networks.

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