Asian Journal of Information Technology 15 (9): 1447-1456, 2016
ISSN: 1682-3915

Son Based Simple Light-Weight Seamless Handover Rapid Re-Authentication Protocol for Tactical Battlefield Wireless Communication System

[1]K.S. Balamurugan, [2]B. Chidhambararajan and [3]Padmanaban Ramasamy
[1]Department of Electronic and Communications Engineering,
Madurai Institute of Engineering and Technology, Madurai, India
[2]Department of Electronic and Communications Engineering,
SRM Valliammai Engineering College, Chennai, India
[3]Government and Defence BU, HCL Infotech Ltd, Noida, India

Abstract: Heterogeneous handover always had been a challenge for seamless roaming. Security aspects like authentication and re-authentication is a key factor in providing seamless connectivity. Self Organizing Network (SON), an innovative intelligent network management system proposed by 3G Partnership Project (3GPP) enhances the best possibility of Inter-Rat handover and security re-authentication by using advanced mobility management procedures. A novel SON based simple light-weight seamless handover Rapid Re-authentication Protocol (3SH_RRP) is proposed in this study. This protocol provides fast seamless handover using Cloud RAN architecture based deployment. It provides a rapid re-authentication within Cloud RAN with the help of Virtual Homing (VH) concept in SON. 3SH_RRP is implemented in SON which gives better results as it eliminates involvement of too many network elements causing severe processing overhead and multilevel communications. This protocol uses log likelihood weighted factor (Bandwidth, Security level, Power Level and Received Signal Strength Indicator) function to maximize the probability of successfully selecting the most appropriate BBU well in advance to perform super-fast or rapid re_authentication during inter_RAT HO. This Work helps service provider to offer spectrum efficient distribution of services. It aims at supporting future bandwidth and delay sensitive applications like high definition digital TV broadcast, telepresence and other multimedia applications by with-holding fairer usage to other services like voice and low bandwidth internet data. Simulation was implemented using OMNET++ with Simu-LTE network simulation package. Experimental results have shown that multi-media serviced user was able to seamlessly connect to networks with low latency and improved quality of service. The proposed algorithm has shown better results with higher transition rate, lower delay upto 300km/$^{-1}$ h fast mobility of user equipment.

Key words: Cloud_RAN, self organizing network, seamless handover, log likelihood rapid re-authentication, weight factored distribution, heterogeneous network

INTRODUCTION

Wireless has evolved since, its inception and seen several generational changes to the service offerings. Future wireless access should be seen as the overall solution to providing wireless access to people and devices. Taking into consideration the requirements such as support of large number of connected devices, "always online," energy efficiency and support of flexible air interfaces can be achieved by evolution of new protocols and access technologies. It is predicted that mobile data traffic will grow >1000 times compared with the end of 2010 beyond 2020 and billions of devices will be connected with mobile broadband connections by then (Sthapit and Pyun, 2014). The industry foresees a future of wireless in an increasingly interconnected world where voice, video, medical, entertainment and other applications and services will be served by a highly integrated and automatically configurable network. Users will simply request the information they need and the information will be delivered to their desired location and device. Additionally, a number of other changes in the end-to-end system will be a part of future wireless evolution both in the Cloud Radio Access Network (CRAN) (Wang *et al*., 2014) and core network. Future wireless networks must provide a robust, highly reliable,

Corresponding Author: K.S. Balamurugan, Department of Electronic and Communications Engineering, Madurai Institute of Engineering and Technology, Madurai, India

resilient and low-latency communication infrastructure. Issues that need to be addressed are the ways in which the user community will need to interact with information in an environment where on-demand and high-speed mobile data have become a reality. That means there will be some significant changes in the way that user interfaces are designed and higher-layer features are developed. In summary, Future wireless is all about enabling new services and devices, and empowering new user experiences (Sarddar *et al*., 2010; Yen *et al*., 2013). This will entail connecting people and things across a diverse set of scenarios. Interruption times of the order of a few milliseconds for both inter-RAT and intra-RAT handovers (Shooshtari, 2011; Chow *et al*., 2014; Yan *et al*., 2010; Hussein *et al*., 2011) can be expected in this sense. Services such as ultra-high definition video or tactile Internet will require end-to-end latencies in the order of 1 millisecond Interruption times well beyond that could destroy the attractiveness of these services.

The aim of this study is to address these challenges and requirements using the combination of key new technology components and solutions for future seamless wireless communication (Andrews *et al*., 2012). Novel approach proposed in this study aims to support:

- Higher transition rate (10-40 times more) than today
- Lower delay (millisecond level)
- More device connectivity(10 to 40 times more) than today
- 1000 times traffic density;
- Upto 500km h^{-1} fast mobility of User Equipment (UE)

At the same, it is desirable to have 99.999% coverage, while energy consumption and cost for the infrastructure should not increase. Secondly, operators expect to reduce networks operational costs and improve spectral efficiency within an area, to maintain optimal performance in future cellular systems (Ghosh *et al*., 2012) by more flexible resource usage and more advanced self-organization functions. As we are handling multiple radio technique, each radio techniques has its own authentication and security features. All of these in the proposed approach are integrated into one single CRAN; the core network integrated with SON. Although SON makes it possible to reduce overall delay and improve throughput, when the criticality of the network is very high i.e., down time or increased latency of the network may not be acceptable in such areas (tactical a battlefield area). To handle such scenarios we need a superficial or an intelligent method within SON to perform rapid re-authentication, so that we have a seamless Handover within this inter_RAT. So, we propose a algorithm called 3SH_RRP that performs the task of evaluating by using the weighted factors to maximize the log likely hood probability of successfully selecting the most appropriate BBU or the best suitable BBU well in advance to perform super-fast or rapid re_authentication during inter_RAT HO. The proposed algorithm is a combination of probabilistic (log likely hood ratio) and weighted parameters (WFDA) used by SON for decision making process. 3SH_RRP protocol is implemented in SON which gives better results as it eliminates involvement of too many network elements causing severe processing overhead and multilevel communications compared to other known works. This research helps service provider to offer spectrum efficient distribution of services. Simulation was implemented using the test bed setup evaluated using OMNET++ simulation engine. Moreover, the simulation-based investigation has shown that the use of 3SH_RRP has the potential to perform inter_RAT seamless handover to networks with low latency and improved quality of service for user accessing multi-media services.

MATERIALS AND METHODS

Network architecture-simple light-weight seamless handover rapid re-authentication protocol: Handover is needed when a User Equipment moves out of range of the current network. Handover is one of the key procedures for ensuring that the users move freely (Balasubramanian *et al*., 2010) through the network while still being connected and being offered quality services. Depending on the required QoS, a seamless handover or a lossless handover is performed as appropriate for each radio bearer. The objective of seamless handover is to provide a given QoS when the UE moves from the coverage of one network to the coverage of another network. One of the main goal of the SON based 3SH_RRP network is to provide fast and seamless handover from one network to another while simultaneously keeping network management simple. Our proposed 3SH_RRP architecture exploits significant features using the combination of key new technology components and solutions enabling UE to securely and seamlessly perform fast handover through rapid re-authentication during inter_RAT. It makes use of a superficial (3SH_RRP) procedure executed within SON to maximize the probability for successful selection of the most suitable Base Band Unit (BBU) well in advance to perform super-fast or rapid re_authentication during inter_RAT HO.

The most promising enabling technologies are adopted in 3SH_RRP network. The 3SH_RRP network architecture comprise a collection of layers, technologies, namely Cloud RAN (C-RAN), Network Function Virtualization (NFV) and Self Organizing Network (SON) to cater the requirements, especially to:

- Seamlessly interwork when moving across networks, layers and/or frequencies
- Serve multiple users based on their requirement and demand through dynamic self-organizing user service management
- Interruption times of the order of a few milliseconds for both inter-RAT and intra-RAT handovers
- Reduce the operation cost from the perspective of operators
- The implementation of futuristic wireless network techniques such as C-RAN, NFV and SON comprising the proposed 3SH_RRP network architecture is summarized

Cloud-RAN (C-RAN): C-RAN is a centralized, cloud computing based new cellular network architecture that has the ability to support current and future wireless communication standards. By separating the Baseband Units (BBUs) from the radio access units and migrating BBUs to the cloud forming a BBU pool for centralized processing. C-RAN provides several advantages compared to the conventional RANs such as scalability and flexibility of further deployment of plenty of Remote Radio Heads (RRHs). The C-RAN architecture virtualizes the BBU functionality and services in a centralized HSS pool that effectively manage on-demand resource allocation, mobility and interference control for a large number of interfaces using programmable software layers

Network Function Virtualization (NFV): It is new way to design, deploy and manage network services. It is designed to consolidate and deliver the networking components needed to support a fully virtualized infrastructure including virtual servers, storage and even other networks. It utilizes standard IT virtualization technologies that run on high-volume service, switch and storage hardware to virtualize network functions. It is applicable to any data plane processing or control plane function in both wired and wireless network infrastructures. This approach allows the deployment of network functions in data centers to leverage the traffic load through virtualization techniques.

Self Organizing Network (SON): Self-organizing network is an emerging architecture where the network intelligence is centralized in software-based controller that maintains a global view of the network. SON governs a network including the planning, set up and maintenance activities. SON solution comprises three building blocks: self-configuration, self-optimization and self-healing. Self-configuration automates the integration of a new radio access point into the network by auto connection and auto configuration. After installation, self-optimization tunes the network with the help of end-user device and base station measurements. This is different from self-planning, which is a dynamic re-computation of the network plan following changes in capacity, traffic monitoring or optimization. It enables network managers to configure, manage, secure and optimize network resources very quickly via dynamic, automated Software Defined Network (SDN) programs, by which they can rewrite themselves due to the independence of the programs on the proprietary software. SDN simplifies network design and operations because instructions are provided by SDN controllers instead of multiple, vendor-specific devices and protocols.

User Equipment (UE): Multi-radio, multicarrier Software Defined Radio(SDR)Device comprising all software needed for communication with a mobile network.

Radio Heads/Remote Radio Heads (RH/RRH): The RRH incorporates a large number of digital interfacing and processing functions t also includes high-performance, efficient, and frequency-agile analog functions, all packaged into a low-weight (9.7 Kg) device with a small mechanical footprint. The RRHs transmit the RF signals to UEs in the downlink or forward the baseband signals from UEs to the BBU pool for further processing in the uplink.

The BBU pool: Is composed of BBUs which operate as virtual base stations to process baseband signals and optimize the network resource allocation. Considering different demands on network performance and system implement complexity, the BBU assignment for each RRH could be implemented in a centralized or distributed manner depending on different resource management in BBU pool. It provides the means to selectively turn RRHs on/off in line with the traffic fluctuations in different scenarios.

Home Subscriber Server (HSS): The HSS or User Profile Server Function (UPSF) is a master user database that supports the IMS network entities that actually handle calls. It contains the subscription-related information (subscriber profiles), performs authentication and authorization of the user and can provide information about the subscriber’s location and IP information.

Implementation of 3SH_RRP using LLR_WFD: In this proposed research, UE specific Log Likelihood Ratio Weight Factor Distribution (LLR_WFD) algorithm is loaded in SON. 3SH_RRP uses the LLR_WFD algorithm to select the best wireless access network for secured and seamless inter-RAT handover in a heterogeneous environment. For a smooth handover and fast re-authentication, a prior information (threshold values) about new network (to be handed over) is required. We define the threshold limit as:

$$\Delta = P_{handoff} - P_{Min\,unablewhere,}$$

Where:

$P_{min\text{-}usable}$ = The minimum usable signal level.

$P_{handoff}$ = The threshold received signal at which handover will be initiated. We define our handover situations by optimizing the Δ i.e., Δ = too large it leads to too many handovers and Δ = to small it leads to too many lost calls. The value of Δ depends on the environment, expected mobile speeds and time required to perform the handoff.

SON using the pre-historical statistics (threshold value), fine tunes the network and resolves the problem by reconfiguring by itself without user interventions or equipments. SON maintains all pre-requisites and provides best configuration, service provisioning for users. Cloud_RAN is supported by SON for controlling the BBU(Base Band Unit), Spectrum allocation, Frequency management, etc. LLR_WFD algorithm computes and decides whether the handover process is necessary for the UE to achieve the required QoS (Quality of Service). Thus, the decision to trigger a handover is a crucial component in the design process of handover, since the success and the efficiency of the handover, to a large extent, depends on the accuracy and timeliness of the decision.

Let us assume the UE decides to initiate a handover. UE senses the broadcasts from its neighboring/adjacent RH/RRH. It generates the Measurement Report of its nearest RH/RRH. UE initiate handover request and forwards Measurement Report based on its neighboring/adjacent BS list. MR constitutes the input parameters such Bandwidth (B_w) Power level (S_L), Security (P_L) and RSSI value (R_S) etc., Using these input parameters procured from the UE, the weight factors are calculated using the weight factor distribution process. The weight factor distribution algorithm takes the parameters of UE as inputs and generates weight factors according to an application specified demands. The weight factors are calculated in order to find the levels of the parameters needed to achieve better Quality of Service.

Consider that the battery power level of the UE is Pw, where, $0 < P_W < 1$, ($P_w = 0$ means the battery power runs out and = 1 means the battery has the maximum power). Let the weight factors of the four network parameters such as available bandwidth, security, power consumption and RSSI value be ,W_B, W_P,W_S and W_R respectively (where = W_P 1 and $W_B+W_P)+W_S+W_R = 1$). Let the importance levels (high, medium, low and none) be indicated using ,I_H , I_M, I_L and 0, respectively (their values are decided by the mobile system designer and $0 < I_H < I_M <, I_L < 1$). Let the numbers for different importance levels specified by the user be indicated as N_H, N_M, N_L and where $N_H+N_M+N_L+N_N = 3$ (since the total number of the network parameters that a user could specify is three). Let the weight factors of the four importance levels, after adjustment to user preferences and battery power level be WI_H, WI_M, WI_L andWI_N , respectively. i.e.:

$$\left(N_H \times WI_H\right) + \left(N_M \times WI_M\right) + \left(N_L \times WI_L\right) + \left(N_N \times WI_N\right) = P_w \tag{1}$$

$$WI_M = WI_H \times \frac{I_M}{I_H} \tag{2}$$

$$WI_L = WI_H \times \frac{I_L}{I_H} \tag{3}$$

$$WI_N = 0 \tag{4}$$

$$P_w\left(N_H \times WI_H\right) + \left(N_M \times WI_H \times \frac{I_M}{I_H}\right) + \left(N_L \times WI_H \times \frac{I_L}{I_H}\right) \tag{5}$$

The weights of four importance levels are calculated by using the following equations:

$$WI_H = \frac{I_H / P_W}{\left(N_H \times I_H\right) + \left(N_M \times I_M\right) + \left(N_L \times I_L\right)} \tag{6}$$

$$WI_M = \frac{I_M / P_W}{\left(N_H \times I_H\right) + \left(N_M \times I_M\right) + \left(N_L \times I_L\right)} \tag{7}$$

$$WI_L = \frac{I_L / P_W}{\left(N_H \times I_H\right) + \left(N_M \times I_M\right) + \left(N_L \times I_L\right)} \tag{8}$$

$$WI_N = 0 \quad (9)$$

From these equations the weight factor levels of each parameter is calculated. These weight factors are given as the input to the Log Likelihood Ratio algorithm loaded in SON. An essential tool for parametric change detection methods is the logarithm of the likelihood ratio:

$$L_X = \log\frac{p\partial(y)}{p\partial(x)} \quad (10)$$

Obviously, Lx is positive if the observation $p\partial(y)$ more likely conforms to the distribution after change, than to the distribution before change $p\partial(x)$ and negative in the opposite case. The distribution for the $p\partial(x)$ is taken here is the normal distribution in order to find the mean and variance for the distribution of the values. The values of X here are taken from the weight factors and W_B ,W_p, W_S and W_R here are considered as the X_1 ,X_2 ,X_3 and X_4 such that the mean (μ) and variance (σ) are calculated:

$$\mu = \frac{\sum_{i=1}^{n} Xi}{n} \quad (11)$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(xi-\mu)^2}{n}} \quad (12)$$

Here, the value of n is 4 as we have considered four parameters. The value of μ and σ are calculated and it is given to the normal distribution function to find the $p\partial(x)$.The value of $p\partial(x)$ is given as:

$$p\partial(x) = \prod_{i=1}^{n}\frac{1}{\sigma\sqrt{2\pi}}e2\left[\frac{x1-\mu}{\sigma}\right] \quad (13)$$

After finding the $p\partial(x)$, the value is substituted in the denominator of the Log Likelihood ratio function Lx. As the UE moves away from the current RH/RRH towards a target RH/RRH, the parameters at the various instants are taken into consideration. Let the new instant parameters are assumed to be y_1 ,y_2 ,$y_3$and y_4. Now, the $p\partial(Y)$ is calculated by the above process and the value has been substituted at the numerator of Lx. If the numerator value is high, then the log likelihood ratio function gives the negative value. Thus the LLR process proves that there is degradation in the Quality of Service and decides that there is a need for the handover process in the UE.

Initially, the UE which needs to perform handover is connected with a current RH/RRH. UE receives the Measurement Report (M_R) from the nearby RH/RRH. The UE audits the MR that belongs to each RH/RRH for data relevance. List of parameters that are part of the MR are (B_w,S_L, P_L, R_S), i.e., parameters for choosing RH/RRH includes Bandwidth, Security level , Power Level and RSSI(Received Signal Strength Indicator). MR is the value reported from the UE that contain information about channel quality. Measurement report is forwarded to the core network. MR assist the core network in making handover and power control decisions. In the core network, LLR_WFD loaded in SON is triggered, the Log Likelihood process using the MR received decides to which RH/RRH the UE has to be switched to. Thus, the LLR process selects the best network in the direction towards which the UE is travelling through. The weight parameters are taken into consideration and cost for the weight factors are to be calculated. The cost for the weight factors are calculated by the formula:

$$C_f = C\begin{pmatrix}\left(W_B \times B^o\right) + \left(W_s \times S^o\right) \\ +\left(W_p \times P^o\right) + \left(W_R \times R^o\right)\end{pmatrix} \quad (14)$$

Where B^o S^o, p^o and R^o stands for the available bandwidth, security level, power level, RSSI value. The normalized cost factor is calculated from the obtained value:

$$N_{cf} = \frac{W_B \times \left(1/B^o\right)}{\max\left(1/B^o\right)} + \frac{W_s \times \left(1/s^o\right)}{\max\left(1/s^o\right)} + \frac{w_p \times \left(1/p^o\right)}{\max\left(1/p^o\right)} \quad (15)$$

From this value, the cost factor of the persisting network can be found. The cost and the weight factors of the other networks are calculated by the LLR_WFD process loaded in SON. The network with the minimum cost is selected as the handover target BBU. After selecting optimal BBU, SON updates the selected BBU in BBU pool regerading its decision. The same is forwarded from SON to the UE. Upon receiving the request on target RH/RRH, UE initates handover process in advance and performs rapid re-authentication successfully as per the steps referred under "Handover and Authentication/Re-Authentication Procedure" section. Neverthless, Inter-RAT handover is achieved from UE to target RH/RRH successfully. In C-RAN, provisioning as per the user requirement network assisted Handover and re-authentication mechanism enables UE to perform seamless HO for higher QoS and higher QoE

Handover and authentication/re-authentication procedure: Handover and Authentication procedure in SON based 3SH_RRP network involves the following steps:

Step 1: User Equipment (UE) decides to initiate a handover. UE senses the broadcasts from its neighboring/adjacent RH/RRH. It generates the Measurement Report (MR) of its nearest RH/RRH. UE initiate handover request and forwards Measurement Report based on its neighboring/adjacent BS list. MR constitutes the weight parameters such as (B_W,S_L, P_L,R_S) i.e., weight factors includes bandwidth (in terms of frequency), security level, power Level and RSSI(Received Signal Strength Indicator). These factors are considered for evaluating and choosing the appropriate Base Station to which the UE can perform handover. UE initiate handover request. ie., UE sends a probe_request with MR to the core network (C_RAN consisting virtual BBU pool).

Step 2: UE gets registered to SON. SON triggers 3SH-RRP. SON initiates 3SH-RRP protocol considering MR factors evolved for each BBU from multiple RH/RRH.

Step 3 : SON auto-configures and tunes the network with respect to UE's MR. SON using the pre-historical data or statistical data along with maximum likelihood estimation (3SH_RRP process) maximizes the capability of deciding the most optimal Base band unit (BBU) to which the UE can perform HO. 3SH_RRP process initiates a simple light-weight computational process to identify using the weight factors (w_B,w_P,w_S,w_R) estimates and computes the maximum log likelihood ratio of choosing the best BBU as per the UEs requirement for HO.

Step4: Using 3SH_RRP computation, the best BBU is chosen as per the UEs requirement for HO. SON finds the best BBU for UE's HO using the 3SH_RRP process. Optimal Base band unit (BBU) selected.

Step 5: SON notifies through response indicating the BBU to which UE needs to handover. Response is sent on best BBU found by SON to the UE.

Step 6: UE notifies the selected RH/RRH to make the HO readiness:

- Step 6.1: Additionally, UE sends a response to SON on its HO acceptance regarding the selected BBU

Step 7: SON upon receiving the response of UE's readiness for HO, sends a request to at Home Subscriber Server (HSS) server to verify if the selected BBU has all the services approved for resource allocation for the UE. HSS verifies resource allocation for UE.

Step 8: Upon successful verification, HSS updates SON with authentication protocol (appropriate to BBU) for HO. After verification approval, HSS finds the appropriate authentication protocol of the selected BBU from the Authentication center. Authentication Protocol of each service providers are maintained in their Authentication center. All these are hosted and maintained in HSS server. HSS updates SON on the Authentication protocol for the selected BBU.

Step 9: SON forwards the response to UE to make readiness for authentication for the selected BBU.

Step 10: Right now, UE has physically handed over to the new BBU, but yet to perform the authentication. UE performs Inter-RAT handover from the current RH/RRH to the selected RH/RRH and gets completely detached from the current RH/RRH. Thus, the Inter-RAT handover is achieved from the UE to the selected RH/RRH successfully. Once the Inter-RAT handover from the UE to the target RH/RRH is successfully completed, authentication process is initiated at the serving RH/RRH.

Step 11: UE receives the response on authentication protocol to be triggered from SON. UE initiates the selected BBUs Authentication protocol and UE sends a authentication approval request to SON. UE initiates selected BBUs Authentication protocol .

Step 12: UE forwards authentication approval request to SON.

Step 13: SON receives the authentication approval request from UE. Using the existing secured tunnel established between SON and HSS for communication, SON forwards the request to HSS. HSS receives the authentication or re-approval request from SON. HSS performs authentication or re-authentication verification for the UE.

Step 14: The HSS sends the authentication or re-authentication approval response directly to the UE. Re-authentication successfully complete .

Step 15: UE indicates new RH/RRH on successful authentication or re_authentication approval.

Step 16: Resource requested by UE is then allocated via the new RH/RRH. UE is services with requested resources via new RH/RRH.

The flow model that illustrates various stages involved in 3SH_RRP scheme is referred in Fig.1.

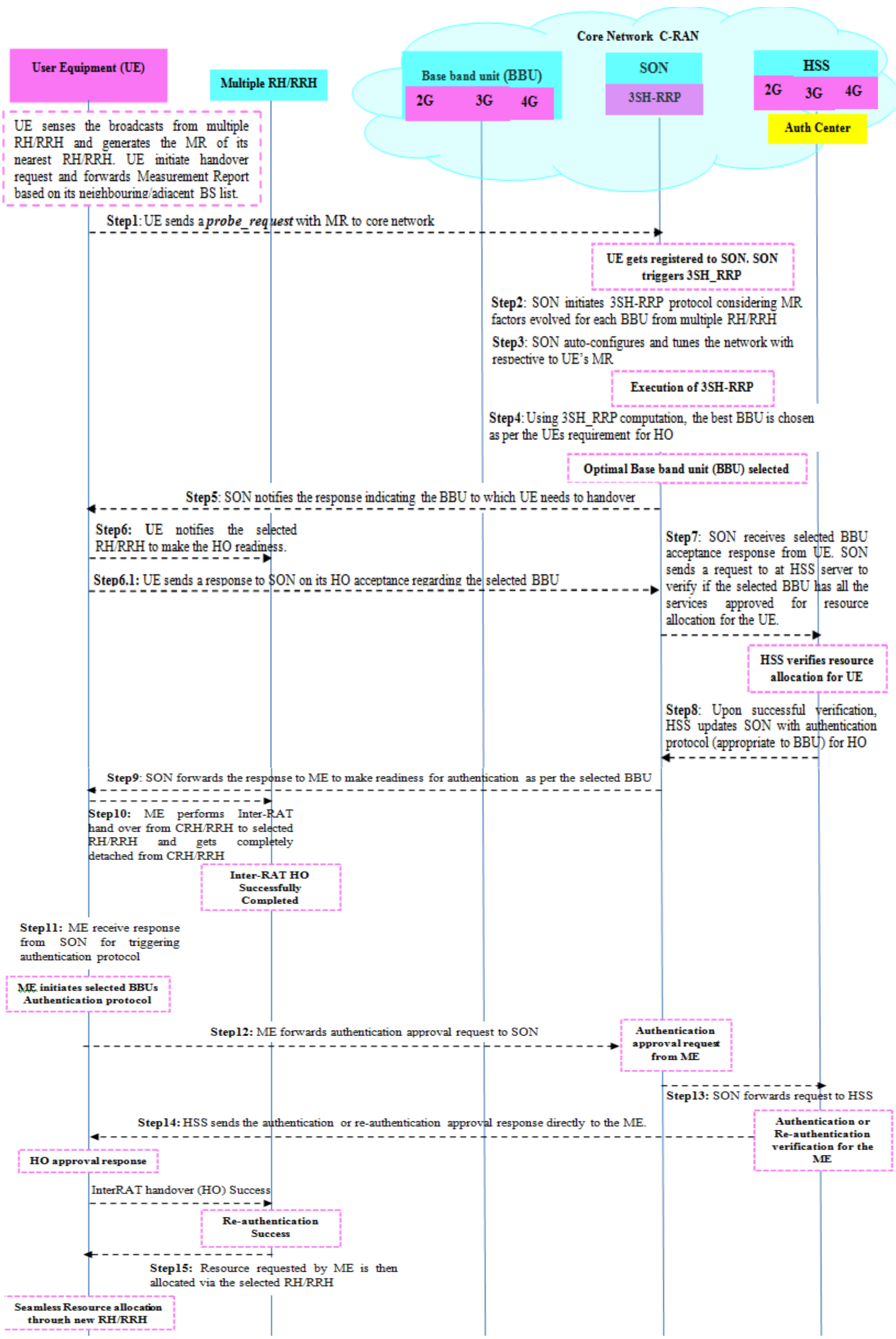

Fig. 1: Handover procedure for basic handover scenario in 3SH-RRP

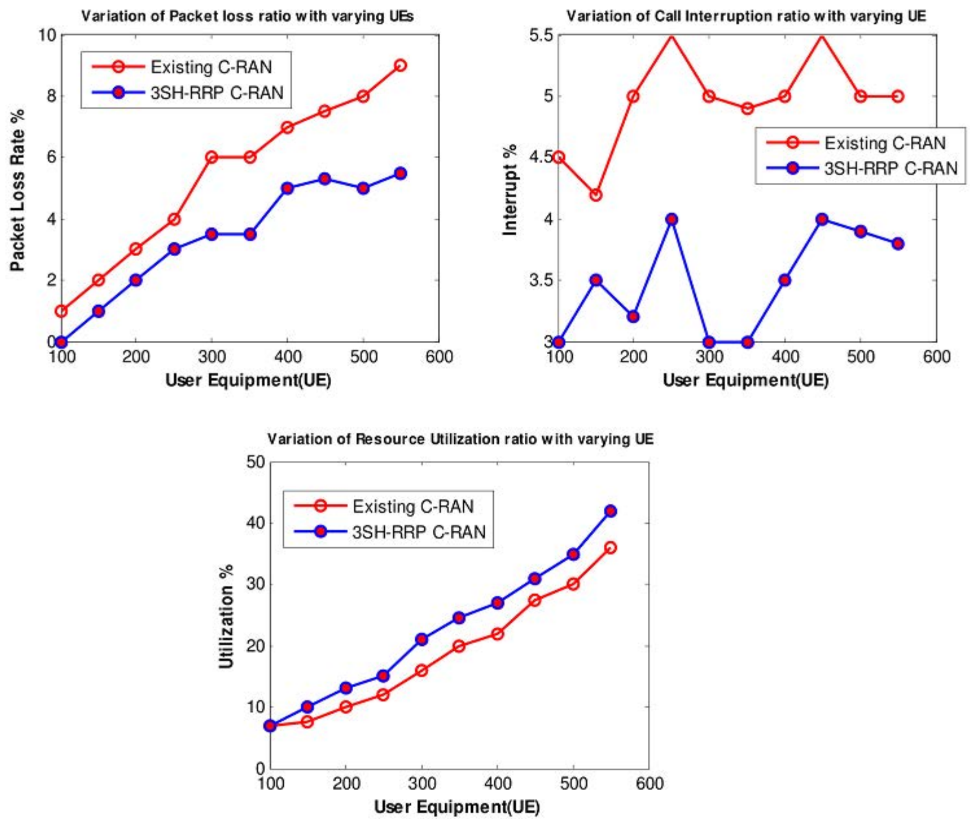

Fig: 2a: Variation of packet loss ratio with varying UEs; b) Variation of call interruption ratio with varying UEs ;c) Variation of resource utilization ratio with varying UEs

RESULTS AND DISCUSSION

Simulation and experimental analysis: In this study, we present a simulation-based investigation of the proposed 3SH_RRP approach in Heterogeneous Network scenarios by relying on the OMNET++ with Simu-LTE network simulation package. We have modeled a Cloud_RAN with SON setup in OMNET++ network model simulator. To simulate the test bed, we constructed an access network of LTE and LTE advanced. Then, a special UE device is constructed in a simulation model in which the SDR stack is customized such that the UE understands the multi-radio concept i.e., the UE can listen to the control channels of all radios in the presence of a current network (existing UE doesn't have this support and this consideration is assumed as a concept that would be incorporated for future wireless network using CRAN architecture supporting Inter_RAT). Model considered for the test bed assumes user with a mobile UE device is currently connected to a GPRS/EDGE real time low bandwidth audio/video session (typically a Skype application) and is moving across the network in a vehicle at a speed of 40-120 Km/h. Now, the UE during its movement is able to sense its nearby 3G, 4G LTE signal strength and has the capability to listen and measure the signal strength through control channels. In OMNET++, this functionality is implemented in the user equipment stack by customizing its SDR stack using C++ code, to monitor all the broadcasts of multiple networks under a single service provider environment (within single service provider, the HO happens between 2G, 3G and LTE) (Fig. 2). Other functionalities that belong to the simulation test bed setup constitute the SON which is customized in Simu_LTE. The proposed 3SH_RRP module developed using C++ is integrated by loading and configuring into SON module. We conducted simulation experiments to evaluate the performance of the proposed architecture. The simulation results were then compared against similar results produced by the existing C-RAN (Wang *et al.*, 2014) supporting multi-RATs systems. We assume these systems running with varying levels of UE density. The input rate of new calls and handover calls is proportional to the expected number of UE in the range between 100 and 550. For every simulation run a number of performance metrics were measured for the 21500 sec of simulation.

Packet loss rate: Figure 2(a) shows that the packet loss rate in existing C-RAN is slightly greater than 3SH-RRP scheme. We assume this effect results mainly from a higher hit rate in those cases where the existing C-RAN system is used, when the number of UE attempts to transmit simultaneously, the mechanism to manage the contention was lagging. Where as in the proposed 3SH-RRP scheme where SON based LLR_WFD is used, the time the signaling protocols spend traveling to and from UE and C-RAN core network is decreased through intelligent decision making on selecting the most appropriate BBU for HO and re-authentication during inter_RAT , which in turns decreases collisions between packets in the MAC layer. 3SH-RRP is capable of reserving bandwidth,which further reduces collisions and packet loss.

Call interruption ratio: Figure 2b shows that even at high UE, the proposed 3SH-RRP system can achieve lower call interruption ratio. This is because in proposed scheme manages bandwidth utilization during multiple UE call inter-RATs through effective re-authentication (by increasing the likelihood ratio for best BBU selection during inter-RAT) preventing system from large call interruption (to and fro communication is overall reduced). Whereas in the existing C-RAN system, the call interruption rate increases as the number of UE increases. In all of our simulations, for performance metrics, an 80% hit rate was used with UE density varying between 100 to 500 in the considered network scenario. As far as the accuracy is concerned, the hit rate should be evaluated based on its real-time performance.

Utilization ratio: The resource utilization ratio demonstrated in Fig. 2c. shows that the cost of achieving higher handoff ratio in 3SH-RRP system is quite low. For the existing C-RAN system, the slope of resource utilization rate is ascending prior to descending with 250 nodes and resumes its uptrend again with 300 nodes. The reason for this is because the increased number of admitted calls may result in unacceptably high handoff call dropping rates due to insufficient resources for handoff calls. However, effective resource handling through LLR-WFD overshadows the overall improvement in 3SH-RRP.

CONCLUSION

In this study, we have proposed a SON based simple light-weight seamless handover rapid re-authentication protocol for end-to-end seamless handover across heterogeneous wireless access networks. The proposed handover approach gives a simple but effective solution using C-RAN architecture. It solves the problem of the higher delay in the current handover design. Aim of the proposed 3SH-RRP is to improve traffic steering and mobility management based on user perception and mobility prediction during handover with limited unnecessary consumption of network resources. Although the benefits of 3SH-RRP are clear and reasonable through simulation results, analysis and implementing in practical networks still need in-depth research, considering practical constrains of the heterogeneous links.

REFERENCES

Andrews, J.G., H. Claussen, M. Dohler, S. Rangan and M.C. Reed, 2012. Femtocells: Past, present and future. Sel. Areas Commun. IEEE. J., 30: 497-508.

Balasubramanian, A., M. Ratul and V. Arun, 2010. Augmenting mobile 3G using WiFi. Proceedings of the 8th Annual International Conference on Mobile Systems, Applications and Services, June 15-18, 2010, San Francisco, CA., USA., pp: 209-222.

Chow, L., N. Bambos and J. Singh, 2014. Channel exploration for wireless media streaming with handoff and rebuffering control. Proceedings of the 2014 IEEE International Conference on Communications (ICC), June 10-14, 2014, IEEE, Sydney, NSW., Australia, pp: 2282-2288.

Ghosh, A., N. Mangalvedhe, R. Ratasuk, B. Mondal and M. Cudak *et al.*, 2012. Heterogeneous cellular networks: From theory to practice. Commun. Mag. IEEE., 50: 54-64.

Hussein, Y.S., B.M. Ali, P. Varahram and A. Sali, 2011. Enhanced handover mechanism in Long Term Evolution (LTE) networks. Sci. Res. Essays, 6: 5138-5152.

Sarddar, D., T. Jana, T. Patra, U. Biswas and M.K. Naskar, 2010. Fast handoff mechanism in WLANs based on neighbor graph information. Proceedings of the 1st International Conference on Parallel Distributed and Grid Computing, October 28-30, 2010, Solan, pp: 334-338.

Shooshtari, A.N., 2011. Optimizing handover performance in LTE networks containing relays. MSc Thesis, School of Electrical Engineering, Espoo, Finland.

Sthapit, P. and J.Y. Pyun, 2014. Handover strategies in beacon-enabled mobile sensor network. Intl. J. Distrib. Sensor Netw., Vol. 2014,

Wang, R., H. Hu and X. Yang, 2014. Potentials and challenges of C-RAN supporting Multi-RATs toward 5G mobile networks. Access IEEE., 2: 1187-1195.

Yan, X., Y.A. Sekercioglu and S. Narayanan, 2010. A survey of vertical handover decision algorithms in fourth generation heterogeneous wireless networks. Comput. Networks, 54: 1848-1863.

Yen, L.H., J.J. Su, K.L. Huang, C.C. Tseng and K.M. Liao, 2013. Crossover node discovery for IEEE 802.11 s wireless mesh networks. Proceedings of the 2013 IEEE International Conference on Communications (ICC), June 9-13, 2013, IEEE, Budapest, Hungary, pp: 6432-6437.