Handover Management in SDN-based Mobile Networks

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*Abstract***— In this paper we discuss the evolution of mobility management mechanisms in mobile networks. We emphasize problems with current mobility management approaches in case of very high dense and heterogeneous networks. The main contribution of the paper is a discussion on how the Software-Defined Networking (SDN) technology can be applied in mobile networks in order to efficiently handle mobility in the context of future mobile networks (5G) or evolved LTE. The discussion addresses the most important problems related to mobility management like preservation of session continuity and scalability of handovers in very dense mobile networks. Three variants of SDN usage in order to handle mobility are described and compared in this paper. The most advanced of these variants shows how mobility management mechanisms can be easily integrated with autonomic management mechanisms, providing much more advanced functionality than is provided now by the SON approach. Such mechanisms increase robustness of the handover and optimize the usage of wireless and wired mobile network resources.**

***Index Terms* - mobility management, SDN, 5G, LTE, SON**

I. INTRODUCTION

In recent years the enormous growth of mobile networks is observed. Such networks provide now world-wide coverage. Originally the main goal of creation of mobile networks was to provide voice services. Right now the main goal is to provide high speed access to Internet for mobile network users'. Such kind of access is required to use advanced services like high quality video, mobile cloud etc. With the aim of fulfilling these demands new mobile networks technologies like UMTS, HSPA, and LTE were developed.

The most critical part of all mobile networks is RAN (Radio Access Network). The overall capacity of RAN can be increased by the usage of relatively small cells due to higher frequency reuse factor and higher SNR (Signal to Noise Ratio) as a result of lower attenuation of the radio signal in shorter links. Whereas small cells are highly desirable because of the increased capacity, from the mobility management point of view such approach creates a serious problem; fast moving users can trigger many handovers that have to be handled in a very short time. Such handovers therefore have to be fast and the handover mechanism has to be scalable. This is an important goal of ongoing works on 5G mobile networks. In such networks there is commonly considered a completely new approach to mobility management based on the SDN paradigm.

In general the mobility management covers issues related to both, terminal idle-state (tracking and updating mobile nodes location for paging) and the connected-state (handovers). In this paper we will focus on the handover mechanism only, ignoring the idle-state mobility. The main goal of the paper is to discuss how SDN can be applied in order to efficiently handle the connected-state mobility in dense mobile networks.

The paper is organized as follows: Section II describes the problem of handover management, Section III consists of short description of existing approaches used for handover implementation, and Section IV describes the ways in which SDN can be used for mobility management in SDN. Section V concludes the paper.

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II. MOBILITY MANAGEMENT FOUNDATIONS

The mobility management deals with two major tasks, namely location management such as maintaining the redirection information; and handover control, such as when and how to trigger the handover, how to route the user's packets to the visiting place and how to identify and binding the applications' sessions, when to release the resources occupied by the previous path etc. The term handover (or handoff) in mobile networks refers to the process of transferring an ongoing voice call or data session from one wireless node (or node sector) to another one. In general, handover management involves two functions: handover decision and handover execution. The latter normally has three phases, handover preparation, handover execution and handover completion. The basic purpose of handover management is to maintain the session continuity from the point of view of applications, while accepting relatively short brakes of the physical connection.

The most common handover is hard handover (the break-before-make approach). In UMTS there exists also other variant of handovers, namely soft and softer handovers which lies on establishment of a new connection before the old one is broken (the make-before-brake approach). In the further part of the paper we will focus on hard handovers only. Moreover we will analyse handovers for data sessions only, because starting from LTE the classical voice calls based on TDM switches are no more supported. LTE supports hard handovers only and has only IP based interfaces. In case of hard handover the key issue is minimization of the time when the connection between the mobile node and the network is broken.

Typically the handover is based on measurements of the signal strength made by mobile nodes. The nodes measure the strength of the received signal of the serving and neighbouring base stations. Such measurements reports are periodically sent to the mobile network which takes decision about the handover and prepares all network nodes and the mobile node for it. The decision about the handover is taken when the handover condition described by (1) has been meet for the duration of time equal or longer than value of the Time-To-Trigger (TTT) [2]

$$RSRP_{Target} - RSRP_{Source} > O_s - O_n + H_{off} + H_s \quad (1)$$

where $RSRP_{Target}$, $RSRP_{Source}$ are respectively the received signal strength of the neighbouring and serving cell; O_s and O_n are specific offsets of serving and neighbouring cells (configured by the operator parameter), H_s is the handover hysteresis parameter and H_{off} is a parameter specific for each pair of network cells. The main role of the H_s parameter is to include the different load of base stations in the decision (load balancing). The quality of handovers is evaluated by following statistics: Radio Link Failures (RLF), Handover Failures (HOF) and Handover Ping-Pong (HPP) [2]. The role of the TTT parameter is to reduce HPP; unfortunately too high value of this parameter can lead to increased number of HOF and/or RLF. The proper selection of the discussed above parameters is not an easy task, moreover it can be base station dependent. In order to solve this problem and other problems of RAN configuration, the Self-Organizing Networks (SON) concept, described in 3GPP LTE Releases 8-11 [1], has been introduced. This concept lies on real-time management mechanism enabling automations of certain network management operations, so called self-* management functions [18]. The list of SON functions, include mobility robustness and handover optimization, load balancing, inter-cell interference coordination, coverage and capacity optimization, energy savings and cell outage detection and compensation. The problem of coordination of conflicting several SON functions is still subject of intensive research. Being aware of this problem 3GPP started to work on SON Coordination Management [19].

At present there are also considered much more advanced handover procedures. In such procedures more information about the terminal (location, speed and direction, traffic demands) as well as more information about the network state is used. Moreover such optimization involves also the 'core' part of the network (EPC) [20].

III. Existing Mobility Management Approaches

A. X2 based handover procedure in LTE

In LTE there are several handover scenarios, dependent on involved network devices. In Fig.1 a distributed LTE handover scenario, that is based on X2 interface between the radio stations (eNodeBs), is presented. Using X2 interface makes this approach a distributed one. The handover procedure is composed of following three phases: handover preparation, handover execution and handover completion.

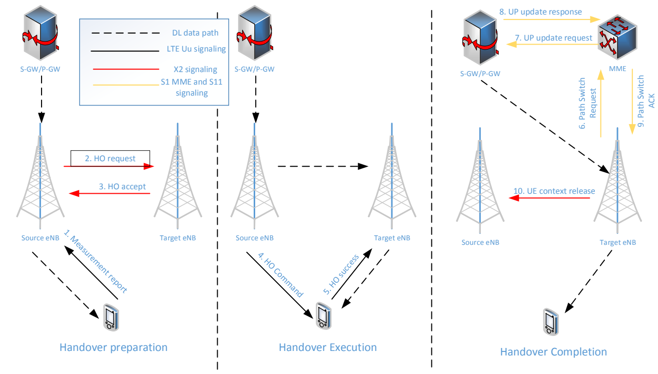

Figure 1. Intra-frequency X2 based handover in LTE

In Phase 1, when the handover decision is taken, on the basis of a mobile node's report sent to serving eNodeB (Source eNodeB), the system has to switch the radio link of the mobile node from one eNodeB (Source eNodeB) to another eNodeB (Target eNodeB). In some cases (network topology dependent) also S-GW (Serving-Gateway), a network device which handles user's data stream (part of the data plane) also has to be changed. This process is handled by the MME (Mobility Management Entity), a device which is a part of LTE control plane and is responsible for mobility management. In some cases not only multiple S-GW but also multiple MMEs can also be involved in handover handling in order to modify paths (tunnels) used by users. In 3GPP networks the GTP (GPRS Tunnelling Protocol) [3] is used in that context. It applies tunnelling to support packet forwarding over network devices, which do not have mobility specific functionality. In LTE the GTP protocol is used to establish tunnels for terminals, between S-GW and P-GW (Packet Data Network Gateway), and between S-GW and MME. Users' traffic is encapsulated and sent through GTP tunnels using the GTP-U protocol. The GTP-C protocol is used for GTP tunnels maintenance.

The generic handover procedure (a message sequence chart) in LTE is presented in Fig. 2. It has to be noted that every control/management message exchange adds to the handover procedure time related to sending the message and obtaining acknowledgement, which contributes to handover latency by the round-trip-time required for such handshake and consumes network resources. In case that the handover decision is taken the Handover Request message is sent to TeNB (Target eNodeB), which should reply by Handover Acknowledgment message. In response SeNB (Source eNodeB) sends to the mobile node the Handover Command and delivers buffered user's packets to TeNB using the X2 interface. After completion it sends to the mobile node information about the uplink channel and waits for the Handover Confirm message. After that the TeNB sends Path Switch Request to the MME, which triggers MME-SGW information exchange and ends with Path Switch Request Acknowledge. The completion phase lies on sending from TeNB to SeNB the Release Resource command. The execution of the command has no impact on the user's session break time.

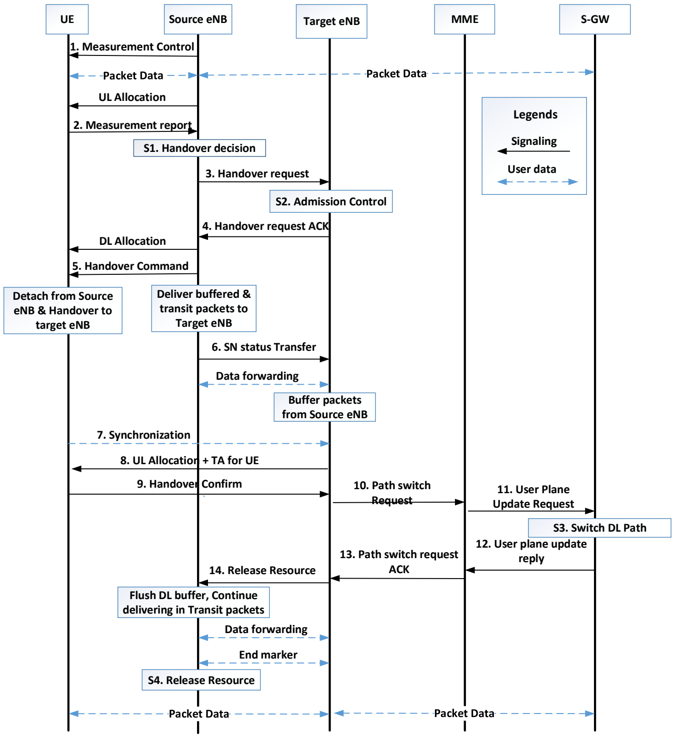

Figure 2. Handover signaling in LTE

B. Handovers in IP networks

In the latest generations of mobile networks and probably in the future ones the IP protocol will be the only one used on every interface except CPRI (Common Public Radio Interface) [25]). The added value of such approach is simplification of the inter-system (so-called vertical) handover (WiFi, WiMax, and LTE). IETF working group MIP is working on IP based mobility and has proposed Mobile Internet Protocol for IPv4 and IPv6 based networks (MIPv4 and MIPv6 respectively) [4][5] as the main protocols for supporting mobility in IP networks, i.e. maintaining the connectivity to the Internet. The main goal of Mobile IP is to allow for location-independent routing of IP packets. Mobile IP operations involved during the handover process are movement detection, IP address re-configuration and location update. To every mobile node there is assigned a Care-of-Address (CoA) which is used for identification of a node in its home network address associated with a tunnel to its Home Agent (HA), which forwards all packets to this node. MIP is designed to support global mobility in IP networks, which is the mobility between separate MAP (Mobility Anchor Point) domains. MIP specifies how a mobile node registers with its HA and how the HA routes traffic to the mobile node through the tunnel. In MIPv6, the mobile node sends location updates to any node it corresponds each time it changes location. Thus causes a lot of signaling traffic and consumes a lot of resources.

Seeing some shortages of MIP in some particular cases, such as high signaling load related to the process of huge number of handovers in dense networks, high handover latency as well as number of packet loss [17], various enhancements to MIP have been already proposed, namely Proxy MIP (PMIPv6) [6], Hierarchical MIP (HMIPv6) [7] and Fast MIP (FMIPv6) [8].

Proxy MIP (PMIPv6) is the only network based mobility protocol standardized by IETF. It has been proposed to provide a common and access independent mobile core networks with different access technologies such as 4G, WiMAX, and WLAN. It shares many properties with MIP, but due to PMIP the host can change its point of attachment to the Internet while maintaining the same IP address – there is no need to support this protocol at the mobile node. PMIP is one of two mobile protocols supported by LTE (the second one is GTP). It supports Selective IP Traffic Offload (SIPTO) [13].

Hierarchical MIP (HMIPv6) [7] is an enhanced version of MIPv6, which was developed in order to reduce the signaling traffic in case of handover within the same MAP domain. In HMIPv6, the mobility within a domain is managed more efficient without exchanging signaling message with HA. This approach reduces handovers latency and packet loss ratio since intra-domain handovers are performed locally.

Fast handovers for Mobile IPv6 (FMIPv6) [8] goal is to reduce the handover latency. During the handover process, there is a period that MN (Mobile Node) is unable to send or receive packets because of link switching delay, time processing message, IP protocol operations, etc. The handover latency consists of time to detect movement, re-configuration address IP and binding update. FMIP proposes a make-before-break approach when a MN changes its Point of Attachment (PoA). It means the connectivity to a new PoA will be established before it breaks with the old PoA. This mechanism is similar to soft handover in UMTS network. Once fast HO process is completed, the MN will continue the MIPv6 procedure to inform HA and correspondent nodes about its new location.

The mentioned above approaches are deployed in a centralized manner in which all users' traffic have to traverse through a centralized mobility anchor (Home Agent in MIPv6 or localized mobility anchor in PMIPv6). As the number of network devices increases as well as traffic volume, such centralized architectures may face several issues such as scalability, reliability, etc. Therefore, a novel mobility management mechanism – Distributed Mobility Management (DMM) [9] has been proposed. It is based on a quick and local triggering of handover. In DMM, the mobility anchor is located at the access router level; it is responsible for locally handover (within the same MAP domain) to avoid unnecessary traffic to centralized gateway.

In general, in IP networks there is no separation of control and data planes, therefore in the centralized case data and control plane operations have to be centralized. There are two exceptions: LTE and FLIP (Flat IP mobility management concept), which uses the distributed data plane and distributed control (DHT based) for IP networks [16]. The simulations have shown benefits of such approach over MIP.

In the context of this paper it is worth to note that the basic goal of all IETF mobility approaches is to cope with the necessity of IP address change caused by the mobility of nodes.

IV. HANDOVER MANAGEMENT IN SDN

Software-Defined Networking (SDN) [10] is relatively a new data networking concept and is still under development.

Its original properties lie on: separation of data and control planes and centralization (at least logical) of the control plane (the data plane is distributed). It has to be noted that in SDN the IP header of packets is no longer used directly for packets routing. In SDN the forwarding decisions are focused on data flows (streams of IP packets). The flow can be identified by several fields in packet header(s). An important property of SDN is a high level of programmability of the control plane, which can be programmed by an operator or user nearly from scratch. It implies easy customization of network functions and easy addition of new control or management functions.

In the context of mobile networks the separation of control and data planes as well as flow oriented operations and flexible handling of IP header are of premium importance - the IP addresses have only local meaning and the controller (using the OpenFlow protocol) defines the rules which are used to forward each flow identified by mostly the five tuple (source address, destination address, source port, destination port and protocol). The SDN controller can dynamically change the forwarding rules for each flow by appropriate update of forwarding tables of SDN switches. This behavior can be directly driven by SDN applications but is also of premium importance in case of mobility – in the past in 3GPP mobile systems we had no possibility for direct manipulation of routing and we solved this problem using GTP tunnels. The separation of data and control planes enables hybrid mode of mobility mechanism deployment in which the data plane is distributed and handles intensive users' traffic whereas much smaller in volume control plane traffic is centralized. Such centralization of forwarding decisions combined with a dynamic analysis of network load can be nicely used for traffic engineering, enabling more efficient usage of network resources and providing higher level of QoS than that, which can be provided in classical IP networks. It has to be noted however that such centralized approach comes with at least two problems: scalability and reliability of the control plane – a single controller is becoming a single point of failure. Another interesting possibility in the context of mobility that is offered by SDN is related to flow-based operations. SDN gives the ability to handle mobility not only per user but also per flow basis. Such approach can contribute significantly to load balancing of the radio and the fixed part of the mobile network.

The centralized SDN concept harmonizes well with the Centralized-RAN concept, which is seen as 5G network technology [11], but on the other hand it has to be noted that the latest trend in handover handling lies in full distribution of handover decisions (cf. DMM or FLIP concepts described in Section III). Unfortunately, SDN exists so far as centralized approach (in the context of control plane) based on a single controller and work on SDN with multiple controllers is in progress yet. Such ongoing work is actually performed for fixed networks without any support for handovers or mobility management.

It has to be noted however that in order to efficiently handle mobility the OpenFlow protocol has to be updated accordingly. It has been originally created for fixed networks and provides neither mechanisms nor protocols for handling of mobile networks specific functions, like collecting of mobile nodes' reports and configuring or monitoring physical layer of mobile network's base stations. In order to apply SDN to wireless networks the base stations (eNodeB) or PoA have to support the OpenFlow protocol. Relatively simple OpenFlow switch should be added to these devices in order to be able to communicate with controllers and to benefit from SDN properties.

The ONF (Open Network Foundation) organization has noted the importance of application of SDN in mobile networks and started to work on this topic by creating Wireless & Mobility working Group [24]. The preliminary ideas lie on incorporating of IEEE 802.21 Media-Independent Handover (MIH) [21], IEEE 802.16r concerning Small Cell Backhaul and high decentralization of enhanced P/S-GWs concepts. In [22] a short outline of using SDN in solving such mobile network problems like inter-cell interference coordination (ICIC), Coordinated Multi-point transmission reception (COMP), mobile traffic optimization or Access Network Discovery and Selection Function (ANDSF) has been described. The main novelty here lies on the usage of global network information (i.e. information not only limited to RAN) to optimize some control or management decisions including those that are already defined as SON functions and much more. It has to be noted however that in this approach there is no clear distinction between the control and management planes.

There are also other research concepts that use SDN with some extensions for wireless and mobile networks, for example CloudMac [14] and OpenRoads [15].

There is no doubt that in order to use SDN the functionality should cover much more than forwarding only and that such functions or used protocols have to be standardized. In SDN-based mobile networks the controller has to include MME and PCRF (Policy and Charging Rules Function) functionality in order to handle data transfer and handle mobility in the whole network, moreover it has to handle mobility management in the idle and connected state. It can also control COMP (Coordinated Multi-point transmission reception) therefore it should impact the way in which data are scheduled over the wireless interface. Some of these functions are radio interface technology dependent. It is not intended in this paper to describe all such functions; they can be implemented in many different manners. What is however common in the SDN based approach is the centralization (global or semi-global) of control and real-time management (autonomic) functions in the controller and reduction of intelligence of base stations and other nodes (S-GWs/P-GWs) of the mobile network. The benefits of the approach are the possibility of the usage of cross-layer global/local information in order to take coordinated control or management decisions and lower cost of wireless nodes. The problem with this approach lies on scalability and reliability.

Below a short comparative analysis of three different variants of SDN usage in mobile networks is presented. In all these variants the data plane is distributed and the SDN controller has the ability to direct controlling of both, the wireless nodes and the data transmission, so there is no more backhauling like it exists in present mobile networks, in which there is split of the network into RAN and Core (like in GSM/GPRS, UMTS or LTE). We don't see any benefit in creation of separate SDN controllers for the radio part and the core part of the network.

A. Centralized SDN

In the first variant of mobile network based on SDN, only logically single controller exists, it can be however implemented as a cloud. This approach requires many high quality control links, which provides deterministic and low delay communication with all the data plane nodes, including radio nodes and the controller. Another requirements are related with the capability of the SDN controller to handle many network nodes (scalability issue). The last big drawback is related to the reliability of such approach. On the good side is that there is no need to exchange the handover related information among several control nodes, the controller exchanges such information only with the RAN node that actually handles the data session and the one that will handle it after handover execution and switches. The control operations are therefore minimized. Moreover the handover decisions can be based on a global network view and take into account many important parameters like radio network load, wired links load, etc. More cross-layer and end-to-end benefits will come if more information will be handled by the controller.

This variant, presented in Fig. 3, probably never will be deployed due to mentioned drawbacks, even in cloud based Centralized-RAN.

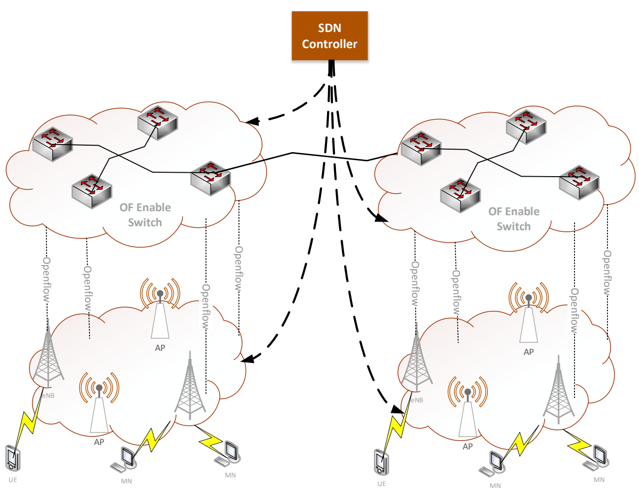

Figure 3. Centralized SDN approach

For this variant analysis we use a modified variant of the message sequence chart presented in Fig.2. The controller has to have MME, PCRF and some eNodeB functionalities in order to handle the handover. In the connected-state mobility, enhanced controller has to periodically collect and analyze mobile nodes' reports (as well as the information about the network state, users' requirements, etc.) in order to take the decision about handovers. In case such decision is taken the controller has to change the forwarding rules of the involved switches for a specific flows or for all flows of the handled mobile node. The handover process requires no support from mobile nodes – their IP address is unchanged after handover. There is of course necessary to transfer packets that are queued in the old wireless network node to a new one. The whole handover procedure is much faster and simpler than MIP. The number of exchanged messages can be also significantly reduced in comparison to LTE (Fig. 2). This issue has been already outlined in [23]. A hypothetical message sequence chart for this case is presented in Fig. 4. In this figure we keep the same message numbers as in Fig. 2.

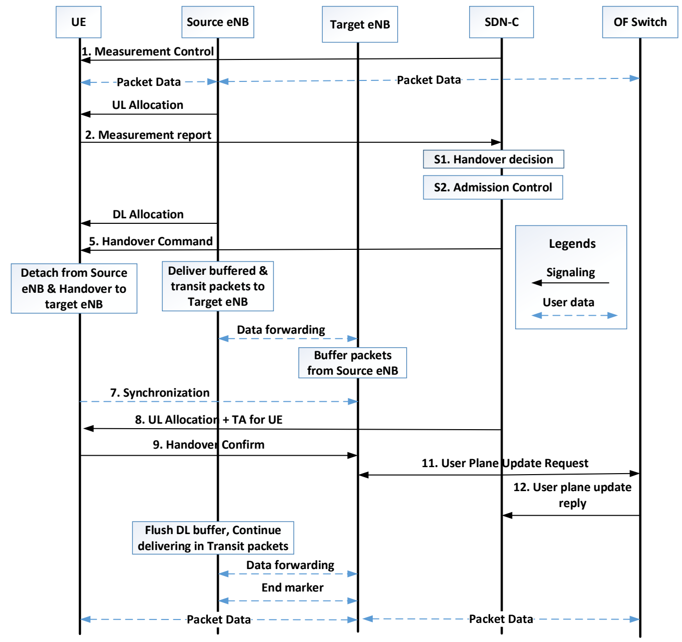

Figure 4. Message sequence chart for handover in centralized SDN

Due to the integration of handover control functions of eNodeBs and MME in this variant there is no need to exchange messages 3/4 (handshake), 6, and 10/13 (handshake) and 14 of Fig. 2. There is however need to send (possible simultaneously) OpenFlow commands in order to update flow switching tables of those switches that are involved in the path change procedure. As a result, the handover procedure will eliminate 2xRTT (round trip time) required to send messages between different base stations and 1xRTT between the mobile node and MME. In case of proactive approach to path setup (in advance setup of new paths) no additional delay is added for paths setup in comparison to Fig. 2 (messages 11 and 12).

B. Semi-centralized SDN

In the semi-centralized approach there are multiple SDN controllers that typically serve independent geographical regions (see Fig. 5). In such approach the network is split into domains of which each is served by a single SDN controller. Inside the domain the behavior of such controllers is exactly the same as in the centralized case. There has to be however added new functionalites related to handling of inter-domain handovers.

In order to handle such handovers every radio node should broadcast information about its domain membership. If the controller which is actually serving the data session obtains a measurement report from a mobile node, which indicates an inter-domain handover it will pass the appropriate message, containing information of user's sessions as well as additional data about the user and old domain status, to new user's domain controller. This new controller will perform all the operations related to the handover. The old controller will perform slave role transmitting messages to the terminal and ending the data session according to new controller's requests. Such approach is relatively simple and a bit similar to handover in which several MMEs are involved. It has to be noted however that in this scenario no global network view is provided – the view of the network is limited to two domains only. The number of inter-domain handovers can be correlated with the specifics of the served area; therefore the domains, i.e. their size and topology, should be carefully designed. The number and size of controller domains may have important impact on number of inter-domain handovers; moreover due to additional information exchange such handovers will have higher latency than intra-domain handovers.

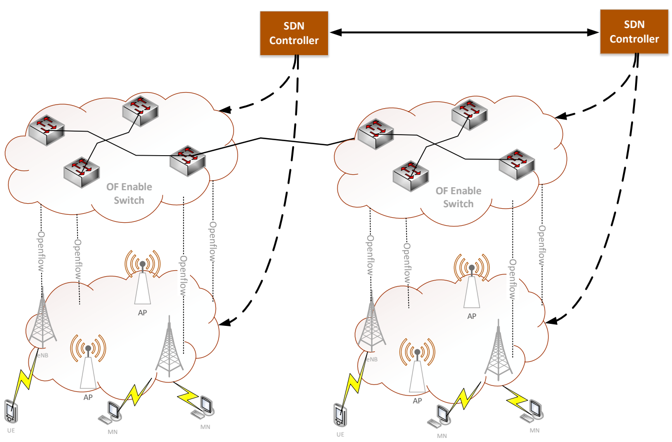

Figure 5. Semi-centralized approach

The message sequence in such variant is dependent on the detailed implementation of the controller functions and is left for further studies. A rough analysis suggests that the communication between controllers in order to change data paths and exchange new radio links parameters should take one controller-to-controller RTT (if messages are aggregated).

C. Hierarchical SDN

The hierarchical SDN designed for mobility handling is an evolution of the semi-centralized approach. It lies on multiple layers of controllers. For the sake of simplicity it can be assumed that there are only two layers of controllers; the lower layer of controllers is composed of distributed controllers like in the previous variant, however there exists also a controller at the higher level of the controllers' hierarchy (see Fig. 6). This controller is connected to all controllers of the lower layer and plays master role in the control plane. It has global network view therefore it can optimize radio and fixed resources in a global way. The upper layer controller if used for handling of inter-domain handovers has to pass additional information between handover domains. The benefit of this approach is that inter-domain operations are based on a global network view, due to additional information exchange between controllers.

The drawbacks of this approach lies on a bit more complex information exchange that in the semi-centralized case and includes pretty intensive information exchange between this controller and the lower layer controllers. The higher level controller (master) can be involved in the handover procedure, providing global optimization of all handovers, however additional information exchange between this controller and lower layer controllers would slowdown the handover procedure.

A reasonable approach in such hierarchical approach lies on handover handling in a semi-centralized manner, like in the previously described variant, but with usage of the master controller to tune the handover parameters in a similar way as it is done in SON handover optimization. That way the master controller performs much slower operations and is involved only indirectly in the handover procedure. It can be said that the master controller performs the role of real-time network manager. The double scale of operations is justified by slower changes of some network parameters (for example network load) and increased stability of the adaptive mechanisms that are based on the control loop mechanism.

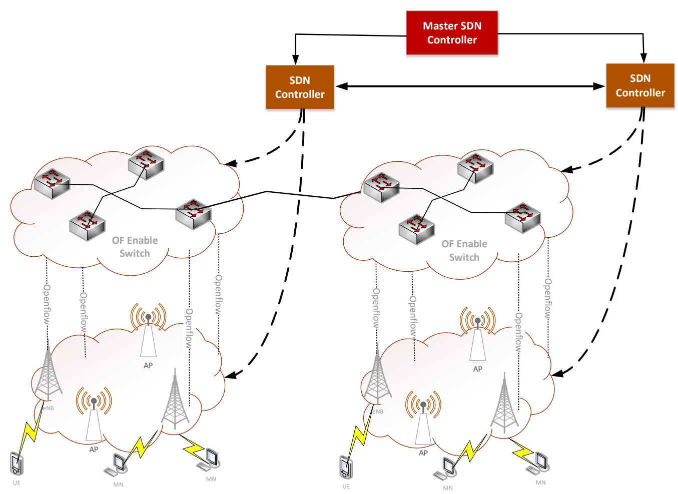

Figure 6. Hierarchical approach

In this concept, some SON functions in their advanced form are already included. The concept shows nice integration of control plane operations and so-called autonomic management paradigm.

It has to be noted that such hierarchical SDN approach has been already proposed in FP7 CROWD project [12] which integrates mobility management and MAC control. Moreover, the authors expect possibility to use the proposed approach for interference mitigation, WLAN optimization, LTE access selection, RAN energy consumption minimization and load balancing. In CROWD there are so-called CLC and CRC controllers, the first of them is a local SDN controller and the second one is global. CLC takes fast local decisions (for so called districts) whereas the global one is slower, but works on the overall network. In CROWD the SDN controllers are not only responsible for handovers only, but they are also used for other purposes like scheduling, load balancing, power control, backhaul management, access technology selection, etc. These mechanisms are optimized together with handovers. Some of such operations are controlled by CRC, moreover CRC is used for policy based management and interaction with network operator. Such holistic approach provides multiple profits but it has to be mentioned that it is very complex and software based implementations may in practice raise serious performance issues. The obvious profit of this software implementation is easy possibility of functionality upgrade.

V. CONCLUSIONS

In this paper we presented benefits of using SDN in mobile networks for connected-state mobility management. The profits lie on the lack of need to handle the change of IP addresses of mobile nodes, direct operations on data flows (no need for tunnels creation), centralized or semi-centralized handover decisions that can be based on multiple criterions in a way that optimize the usage of the network resources and last but not least faster handover operations.

The SDN concept is contradictory to some handover related concepts which lie on the distribution of the handover decisions in order to cope with scalability issue and fast handover handling – it uses distributed data plane but centralized or semi-centralized control plane. As we indicated in the centralized approach it is possible to reduce the number of messages that are needed for handover handling in SDN enabled LTE-EPC. Moreover, the handover decisions based on multiple input parameters and SDN native possibility to control data forwarding can jointly optimize usage of radio as well as transmission resources. The centralized control based approach is not scalable and demands many fiber links. The controller can for sure handle hundreds or more wireless nodes, but not country-wide network, so splitting the network into handover related domains, i.e. semi-centralized approach is a solution to this problem. In the latter approach the inter-domain handover requires more information exchange and therefore its handling takes more time. Moreover the global network view is lost. The hierarchical approach solves this problem at least partially (only averaged global information is used).

The presented concepts for handover management can easily and natively incorporate the functionality of so-called LTE SON and go much beyond – it can optimize jointly radio and fixed network resources, providing end-to-end optimization. In order to speed up deployment of such concepts it is highly desirable to define addition SDN protocols which will handle as well as connected and idle state of mobile nodes and cope with physical layer of the radio technology used.

The work presents some comparisons of different variants of SDN applied to mobility management. In the future more detailed information exchange between nodes, including security mechanisms and simulations of the analyzed concepts will be done.

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