WLAN Offload and IP Flow Mobility in the Evolved Packet Core

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Abstract—3GPP introduced a multi-access 3GPP system, Evolved Packet System, that allows heterogeneous access networks (GERAN, UTRAN, E-UTRAN, WLAN etc.) to connect to a common packet core, the Evolved Packet Core (EPC). However, the specifications made no provision for terminals that can connect to two access networks simultaneously. Mobile terminals with multi-mode capabilities are becoming commonly available, with most of the terminals having support for WLAN and 2G/3G networks. 3GPP specified a solution for how the operator can offload traffic to WLAN and how to achieve IP flow mobility. IP flow mobility enables operators to route flows belonging to the same user through 3GPP and non-3GPP (WLAN) accesses at the same time. Their solution is however based on DSMIPv6, a client-based protocol that would require modification of the terminal. This paper proposes to use PMIPv6, a network-based mobility protocol that requires minimum modification at the terminals, to achieve WLAN offload and IP flow mobility.

Index Terms—EPC, IP flow mobility, DSMIPv6, PMIPv6

I. INTRODUCTION

Mobile terminals with multi-mode capabilities are becoming commonly available, with most of them having support for WLAN and 2G/3G networks. With this capability the demand for bandwidth intensive services such as IPTV, Video on demand etc. are posing tremendous load on the operators’ networks. This usually leads to operators constantly seeking new ways to reduce the traffic load on their networks and also looking for alternative solutions for lowering the cost of providing bandwidth intensive services.

With WLAN being commonly available (homes, campuses, hotspots). 3rd Generation Partnership Project (3GPP) [1] specified a mechanism for allowing operators to offload traffic to WLAN via IP flow mobility. With an IP flow mobility enabled network, operators can selectively offload user traffic to WLAN accesses, for example routing best effort FTP file transfer over WLAN, and keeping the more QoS demanding services over their cellular network. It is therefore of interest to provide an optimum solution for how to achieve WLAN offload and IP flow mobility in Next Generation Networks.

3GPP specified the use of two mobility protocols to achieve mobility between 3GPP (GERAN, UTRAN, E-UTRAN) and non-3GPP (WLAN, WiMAX) accesses in the Evolved Packet Core (EPC) [1]. Client-based mobility protocol (DSMIPv6) [1] and network-based mobility protocol (PMIPv6) [1]. They also proposed a solution for how to achieve WLAN offload and IP flow mobility [2] in EPC based on DSMIPv6, but left the use of PMIPv6, as an open issue that requires further study. This paper proposes to use PMIPv6 to achieve IP flow mobility.

In the remainder of the paper a basic overview of the EPC is given, followed by background information and problems within the literature. A proposed framework is then given followed by the conclusions.

II. EVOLVED PACKET CORE

3GPP introduced a multi-access 3GPP system, the Evolved Packet System, in release 8 of their specifications. The EPS allows heterogeneous access networks connectivity to a common packet core, the EPC. The heterogeneous access networks are, 3GPP accesses (GERAN, UTRAN, E-UTRAN) and non-3GPP accesses (WLAN, WiMAX). The non-roaming architecture of the EPC is shown in Figure 1 and consists of the following functional network entities:

- Serving Gateway (S GW): Local anchor for inter eNodeB mobility [1]. It also terminates the interface towards E-UTRAN accesses.
- Packet Data Network Gateway (PDN GW): Provides connectivity to external IP networks and is the anchor for mobility between 3GPP and non-3GPP networks.
- Policy and Charging Rules Function (PCRF): Policy engine that is in charge of QoS control and charging.
- Evolved Packet Data Gateway (ePDG): Provides connectivity to untrusted non-3GPP access networks (e.g. WLAN in hotspots).

Figure 1: Simplified Non-Roaming Architecture of the Evolved Packet Core [1]

III. MOBILITY MANAGEMENT IN EPC

A. Inter-System Mobility

Two types of mobility approaches are specified for inter-system mobility between 3GPP and non-3GPP accesses in
the EPC, namely network-based mobility and client-based mobility [1]. With network-based mobility, the network provides the User Equipment (UE) with mobility services by ensuring that the appropriate mobility signalling is exchanged in the core network, for session continuity. The network-based mobility approach uses the Internet Engineering Task Force (IETF) protocol, PMIPv6. PMIPv6 are used on the following interfaces in EPC:
- S2a interface between the PDN GW and the Access gateway of the trusted non-3GPP networks.
- S2b interface between the PDN GW and the ePDG for the untrusted non-3GPP networks.
- S5 interface between the PDN GW and the S GW. When PMIPv6 is used, the PDN GW acts as the Local Mobility Anchor (LMA) and the S GW, Access Gateway and ePDG acts as Mobile Access Gateways (MAGs).

The client-based mobility approach uses the IETF specified protocol, DSMIPv6, and is only implemented on one interface in the EPC, the S2c interface. Client-based mobility assumes that the UE has functionality to detect movement as well as to exchange mobility signalling with the network so that IP level session continuity is maintained. When DSMIPv6 is used it requires some modification on the UE to support the DSMIPv6 protocol.

B. IP Flow Mobility Concept

The level of granularity for access network connectivity and inter-system mobility over the EPC are based on a per PDN connection [3] (A PDN connection in EPC is a logical connection between the UE and the IP network the UE is connected to). This means that if a handover occurs between two networks, all the IP flows belonging to that PDN connection will be moved to the target access. Thus, if inter-system mobility occurs between a 3GPP and a non-3GPP network for example WLAN, IP flows that may have high QoS requirements, for example VoIP, will be moved to WLAN. Transmitting all the IP flows over WLAN can have a negative effect on the IP flows that require a specific QoS.

3GPP then specified the concept of IP flow mobility. IP flow mobility enables a finer granularity for access network connectivity and inter-system mobility by allowing individual treatment of IP flows within a PDN connection [3]. This means that if a handover occurs between two access networks and the UE is connected to both access networks simultaneously, some IP flows of the PDN connection may be routed through one access while the other IP flows, belonging to the same PDN connection, are routed through the other access, simultaneously [3].

IV. PROBLEM STATEMENT

In release 10 of the 3GPP specifications, a solution for WLAN offload and IP flow mobility [2] was proposed. The solution is based on DSMIPv6. As was mentioned above, in order to use DSMIPv6 some enhancements are required on the UE to support the DSMIPv6 protocol. This requires a massive amount of software logic and processing in the UE [4]. Using PMIPv6 on the other hand, has no impacts on the UE at all, instead the network is responsible to handle mobility management on behalf of the UE.

V. RELATED WORK

Trung et al. [4] proposed a PMIPv6 scheme to achieve IP flow mobility.

Loureiro et al. [5] proposed a solution for IP flow mobility for both DSMIPv6 and PMIPv6. They introduced a Policy Routing Architecture that is used to signal routing rules between the UE and the network infrastructure. No implementation of their proposal was performed.

Ahmed et al. [6] analyzed the solutions proposed by 3GPP for WLAN offload and IP flow mobility. They recognized issues within the 3GPP specifications and proposed possible enhancements, but no implementation work was performed.

VI. PROPOSED FRAMEWORK

The proposed framework, figure 2, is based on the PMIPv6 interfaces (S5 and S2a) as discussed in section III. The proposed framework would enable a network-based solution for how to achieve WLAN offload and IP Flow mobility in the EPC environment.

VII. CONCLUSION

A network based solution for WLAN offload and IP flow mobility would be optimum for both the operators’ networks and the UE. For the operators, introducing WLAN into their networks would increase their network capacity and help with load balancing, and for the UE no enhancements are required.

VIII. REFERENCES

[3] 3GPP TR 23.861 v1.3.0, Multi access PDN connectivity and IP flow mobility (Release 9)

Charna John received her BSc (Eng) degree in 2010 from the University of Cape Town and is presently studying towards her Master of Science degree at the same institution. Her research interests include mobility management and future core networks.