System Enhancements for Accessing Broadcast Services in All-IP Networks

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I. Motivation

The "All IP Network" (AIPN) in wireless communications has been a topic thoroughly discussed in the last decade both in academia and in standardization fora such as 3GPP [1]. One of the benefits of the AIPN paradigm is the possibility to introduce in the network new technologies with minimal extensions to the core network (hence reducing capital expenditures). Generally, the enabler of this feature is the use of IP router functionalities collocated in the base station providing the radio access, in a distributed fashion.

On the other hand, the integration of broadcast services in an AIPN appears to be more challenging as the broadcast services rely on a central entity acting as content provider and solutions may require synchronized delivery of the data packets at the radio interface (see e.g. evolved Multimedia Broadcast Multicast Service - eMBMS – as defined in [4] and [5]). The deployment of this central entity may indeed require core network extensions (Figure 1 shows that eMBMS specific functionalities – BM-SC and MBMS-GW – which are required in the core network to implement broadcast services).

A possible alternative approach to better exploit the benefits of AIPN for broadcasting, is the definition of interworking between the functionalities providing broadcast services and the All-IP networks. Interworking enables provisioning of service to the user over different access systems, e.g. via 3GPP eMBMS broadcast channels in E-UTRAN or via WiFi unicast channels. Depending e.g. on the user scenario, network load conditions, and radio conditions, the access system can be dynamically changed in a way that is transparent to the user.

II. all-IP and eMBMS in 3GPP architecture

The architecture adopted by 3GPP to apply the AIPN paradigm [2, 3] is described first, whereby IP connectivity to the user terminal is provided by means of Packet Data Network Gateway (PGW; acting as access router or mobility anchor depending on the access technology selected by the user equipment (UE)) and Evolved Packet Data Gateway (ePDG; IPSec tunnel end-point when the user is connected to a non-3GPP access), see Figure 1.

Then the eMBMS architecture is described [4, 5] in terms of functional elements and the reference interfaces, both at radio access and core network side. Broadcast packets are sent from the content server to the MBMS gateway (MBMS-GW) which acts as the IP multicast source and routes the multicast packets to the radio access nodes for synchronized broadcasting.

III. Broadcast service Scenarios

Two possible scenarios have been identified where the 3GPP elements implementing the AIPN can interwork with broadcast-specific functionalities to improve the system performance:

1. **User counting scenario**: the numbers of UEs subscribed to the broadcast service available in the area is low. The system may hence decide to stop the provisioning of the broadcast service through the broadcast channel and deliver it in a unicast fashion in order to optimize resources usage.
2. **Retention priority handling**: the number of services that are expected to be delivered using the broadcast channel is too high and some service needs to be delivered using unicast connectivity. In this case the system prioritizes the services and transmits over the broadcast channel only services with higher priority. Services which are not transmitted through the broadcast channel are transmitted in a unicast fashion.

When selecting unicast transmission, the service may be delivered in the same access system providing the broadcast service (if supported by the technology, e.g. eMBMS broadcast over E-UTRAN), or it can be delivered using a different access technology such as e.g. WiFi.

IV. Interworking solutions for Traffic Offload

In this presentation we consider the eMBMS architecture as example of a broadcast system and the 3GPP AIPN architecture featuring support for non-3GPP access (e.g. WiFi). Both scenarios identified above can be addressed by performing interworking between non-3GPP access and eMBMS functionality. Two possible interworking solutions are proposed and analyzed in the presentation:

1. **Reusing existing interfaces**: the traffic is sent by the eMBMS content synchronization and

distribution function to the PGW which in turn sends it to the UE connected to the non-3GPP access. Such traffic can be routed using IP unicast or IP multicast.

2. **Defining a new interface** connecting the ePDG (or the WLAN access network directly if the ePDG is not required) to the IP multicast distribution point (MBMS-GW) of MBMS user plane data.

Both approaches have benefits and disadvantages which depend on the underlying access network characteristics (e.g. if multicast routing protocol is deployed or not).

V. CONCLUSIONS

The presentation outlines the All-IP network solution and the eMBMS architecture defined by 3GPP and proposes two possible solutions of interworking between the two architectures. The solution reusing existing interfaces has limited impact on the current architecture but requires that the broadcast service is sent through the public Internet, which is not controlled by the mobile network operator and may have performance characteristics that affect the delivery of the broadcast service. Such limitation does not affect the solution based on a new interface between ePDG and MBMS-GW as the traffic is delivered through the network controlled by the mobile network operator.

VI. REFERENCES

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[2] 3GPP TS 23.401. "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access". Version 10.3.0. http://www.3gpp.org/ftp/specs/html-info/23401.htm. .

[3] 3GPP TS 23.402. "Architecture enhancements for non-3GPP accesses". Version 10.3.0. http://www.3gpp.org/ftp/specs/html-info/23402.htm.

[4] 3GPP TS 36.440. "General aspects and principles for interfaces supporting Multimedia Broadcast Multicast Service (MBMS) within E-UTRAN" Version 10.0.1. http://www.3gpp.org/ftp/specs/html-info/36440.htm

[5] 3GPP TS 23.246. "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description" Version 10.0.0. http://www.3gpp.org/ftp/specs/html-info/23246.htm

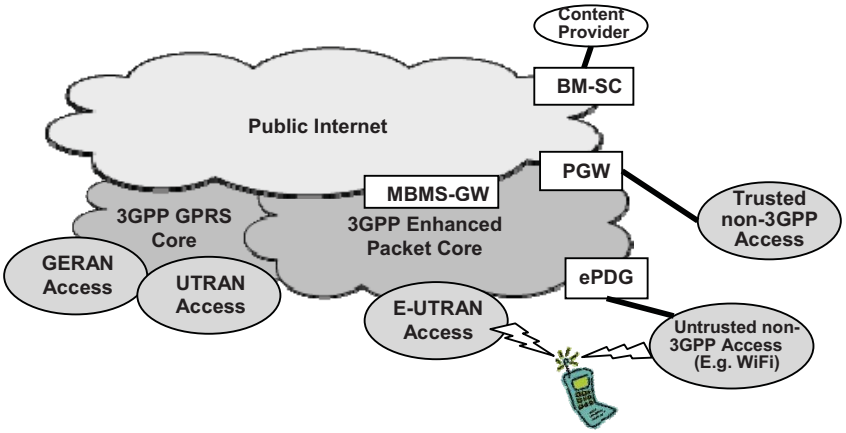

Figure 1: 3GPP AIPN architecture