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SOLUTIONS FOR OPTIMIZATION OF MOBILE BROADCASTING IN 5G NETWORKS

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Right now there are processes that will determine the future of television: cable and Internet channels lead the audience of broadcast giants - people have the opportunity to watch only what they want; on the Internet you can now go out and through the TV, while from the smartphone you can always watch your favorite channels and programs, while in transport or walking down the street.

Mobile networks are able and gradually take over the ability to provide broadcast services to a wide audience. As for the development of cellular networks, it is believed that by 2022 the turnover of the global mobile ecosystem will reach $ 4.6 trillion and will account for 5% of global GDP. By 2025, the industry will use 5.9 billion unique mobile subscribers, or 71% of the expected population of the Earth [1]. Of these, 5 billion will consume data traffic (compare with 3.3 billion in 2017) [1]. 5G will become a network that provides the maximum comfort for user's interaction and opens up wide access to the Internet of things with ultra-high data rates, extremely short delay, the ability to process mass connections and an unprecedented level of reliability.

However, to ensure that the "tsunami" of multimedia traffic does not overflow the mobile networks, enabling subscribers to receive the best QoE, it is necessary to develop new more advanced technologies for delivering heavy and also popular data to subscribers.

5G-XCast project is aimed at developing a new ecosystem within the 5G, which will reduce the cost of content delivery for the operator and the content provider and without deteriorating the quality. 5G-Xcast is a 5GPPP Phase II project focused on Broadcast and Multicast Communication Enablers For the Fifth Generation of Wireless Systems **[**2**]**. The main objectives of the project is to design a dynamically adaptable 5G network architecture enabling seamlessly switching between different modes (unicast, multicast and broadcast) depending on the conditions to provide unprecedented opportunity for the future media delivery with the best quality of user experience.

Within the project the QoE estimation scheme was proposed (Fig. 1).

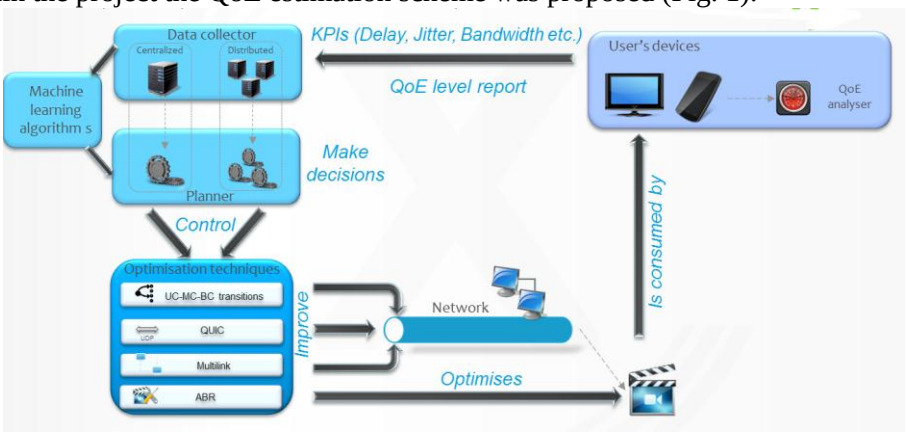

Figure 1 – Quality of Experience – 5G-Xcast project conceptual view

For the proposed scheme (Fig. 1), the choice of the form of a regression or multivariate model, that is, finding an analytical expression that reflects in a best way the Key Quality Indicators (KQI) with a Key performance indicators (KPI), is as follows:

$$\hat{Y} = f(x_1, x_2, x_3, ..., x_n), \quad (1)$$

where $\hat{Y}$ – effective sign-function (KQI); $x_1, x_2, x_3, ..., x_n$ – factor marks.

Once determined deviations of certain KQIs from the norm, it is necessary to optimize the content delivery to end users.

As you can see from the Fig. 1 for optimization of the network several methods can be used. The outcome of the planning phase results in a collection of activities aiming at improving network

performance and content properties; these activities are carried out by resorting to specific optimisation techniques:

1. MooD. **Multimedia Broadcast Multicast Services** (**MBMS**) [3] operation on demand (MooD) enables switching between unicast and broadcast. MooD was standardized in Rel'12. In Rel'14, the MBMS control information in LTE radio network can be changed within 10 milliseconds. As usual, it is up to the network configuration to find an optimal balance between signalling overhead and desirable performance [4].

2. QUIC. Quick UPD internet connection (QUIC) provides a framing structure which allows the HTTP2 semantics to be used over UDP [5]. It is therefore reasonable to consider whether elements of QUIC could provide the basis for delivering HTTP2 over multicast [6, 7]. Within the 5G-Xcast project QUIC was considered as the basis for encapsulating content and could provide a simpler alternative to NORM, FLUTE and ROUTE and since it maps onto HTTP2 so well, but it merits further consideration [4].

3. Multilink. Multilink (ML) is a set of different technologies (wireline and wireless), since the key reference scenario will be the exploitation of different heterogeneous wireless links for improving service delivery [4]. The benefits of using ML can be listed as follows: reducing the overall bandwidth; increasing the delivery reliability and availability of the service; increase the mobility reliability; seamless transition between different service areas (for example broadcast/multicast and unicast) [8].

4. Adaptive Bitrate Streaming. In unicast, ABR is done by the UE MiddleWare (MW) requesting the relevant bitrate piece/segment/part using HTTP GET from the Content Provider [9]. When the goodput to that UE drops, the MW will request lower bitrate content piece. The Content Provider either in real time for live content or offline (e.g for some VoD content) sends the next segment according to the different bitrate in that HTTP GET.

5. mABR. Mobile ABR (mABR) removes a serious load from the Operator backbone, but it also enhances the QoE [10]. Indeed, the Home Gateway acts as a proxy for the end user, serving directly the chunks. Similarly to the CDN Edge streaming concept presented before, the player adapts the bitrate in relation with the locally available throughput, increasing the session bitrate.

CONCLUSIONS

There is a growing demand from operators to deploy converged video delivery solutions across all their networks (fixed and mobile) and across all the screens, to save on operational and equipment costs and to increase QoE. The Internet is replacing vertically-integrated delivery platforms. the main role of a content delivery framework within 5G is to deliver this type of content as efficiently as possible. For this purpose within 5G-Xcast project there was proposed QoE estimation model. For the optimization of the content delivery several techniques can be used. They are QUIC, MooD, ML, ABR and mABR. Each technology has it's own benefits and limitations, that were considered within the 5G-Xcast.

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