Wireless Access Mechanisms and Architecture Definition in the MEDIEVAL Project

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***Abstract*—Wireless network access and the exchange of multimedia flows over the Internet are becoming more and more pervasive in the everyday life. However, simple technological advances in terms of improved network capacity cannot satisfy the increasing demand of such services, since a paradigm shift from the current Internet architecture is required. The EU FP7 MEDIEVAL project tackles this issue by addressing novel architectural frameworks and viable strategies to efficiently deliver video services in a wireless Internet context. This paper reviews the currently ongoing activities of the project for what concerns wireless access, in particular the identification of useful techniques for the considered access technologies (WLAN and LTE-A) and the general definition of architectural schemes to efficiently support video flows.**

I. Introduction

During these last years, a joint evolution of demand and offer for multimedia content over wireless has taken place. On the one hand, the diffusion of new mobile devices which combine multimedia features and Internet connectivity, yet realized with different access techniques, has reached high penetration rates worldwide. Nowadays, wireless networks include smart phones, netbooks, or other small and portable devices all equipped with multimedia encoding and decoding capabilities. On the other hand, multimedia content exchange is starting to dominate the Internet traffic, with applications for watching on-line videos, exchanging user-generated video content, or video-chatting that impose constraints in terms of latency and data transmission reliability. However, the current Internet and its wireless extensions do not glue these two sides of the evolution well together. Since they were designed having in mind a different paradigm for content exchange, demand and offer of multimedia content are still mismatched in terms of provided Quality of Service (QoS) and Quality of Experience (QoE) for the end users.

More in general, the explosion of multimedia content demand actually poses several challenges in terms of efficient *delivery* of this content throughout the network to the end user. In this spirit, the main goal of the EU project MultimEDia transport for mobIlE Video AppLications (MEDIEVAL) [1] is to tailor future architecture for the wireless Internet in order to support enhanced multimedia support, as described in [2]. In particular, this paper deals with the issues more specifically related to wireless access. The main reference scenario of the project consists of an operator supporting connectivity through heterogeneous access technologies, and whose network architecture needs to be optimized for video transport. Thus, the focus of this paper is to describe the architectural solutions envisioned to provide enhanced video delivery in the last (wireless) hop, mainly focusing on existing access techniques.

According to how they make use of the wireless medium, we can classify access techniques into *contention-based*, such as the IEEE 802.11 standards for Wireless Local Area Networks (WLANs) [3], and *coordination-based*, e.g., the Long Term Evolution Advanced (LTE-A) of the Universal Mobile Telecommunications System (UMTS) [4].

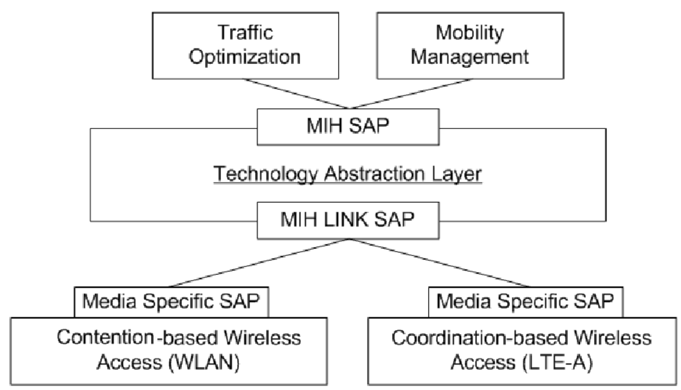

Fig. 1. MEDIEVAL Wireless Access Architecture and Cross-layer Design

For each access category, the project aims at developing novel mechanisms to enhance video transmission over wireless access, allowing adequate QoS support and enabling cross-layer optimization in the interaction with upper layers. The analyzed methodologies include algorithms for packet prioritization and selection, and strategies to improve the actual bandwidth that can be extracted from the wireless medium such as *jumbo frames*.

In the literature, several works focus on cross-layer optimization techniques adopted to improve multimedia transmission over wireless channel: in [5] is presented an approach that combines the flexibility and programmability of application layer adaptations with low delay and bandwidth efficiency of link layer techniques, while in [6] are shown the significant improvements that can be obtained by deploying a joint application-layer adaptive packetization and prioritized scheduling along with MAC-layer retransmission strategy.

The MEDIEVAL architecture encompasses the cross-layer optimization through enabling mechanisms for the different layers to talk between them. In this sense, a cross-layer signalling is implemented between the lower layers and the video application and services, as well as with mobility services. An example of this cross-layering can be seen as follows: information gathered into Media Specific SAP (Service Access Point) such as video services characterization (that is, bit rate guarantees, priority, tolerated delay/jitter/packet dropping), together with link quality indications perceived by all the LTE subscribers, are used to generate a utility function that is associated to each user, and will be used to optimally allocate the LTE wireless resources. Another example of cross-layer interaction as listed previously is packet marking. The video services or transport optimization components insert some specific marking in the Internet Protocol (IP) header of each video packet, based on video coding and avoiding deep packet inspection at the wireless access level. According to some pre-defined signalled agreement and on the wireless access type, each packet is processed individually, which results in forwarding the packet on the wireless link, prioritizing it or even dropping it if the available bandwidth on the wireless link is not sufficient.

The rest of this paper is organized as follows. In Section II we discuss optimization techniques for contention based wireless access which are currently proposed and under evaluation in the MEDIEVAL project, whereas in Section III we describe such techniques for coordination based wireless access. Then, in Section IV a description of the abstraction layer is provided along with a novel transmission technique represented by the usage of jumbo frames to increase system throughput. In Section V we discuss the implementation of IEEE 802.21 [7] within the project. Finally, we conclude in Section VI.

II. Enhanced Contention-based Wireless Access

MEDIEVAL focuses on extending two aspects of current IEEE 802.11 technologies. On the one hand, to leverage the maximum bandwidth achievable by the technology, optimal configuration of the Medium Access Control (MAC) parameters of the stations and access points is required. In order to configure appropriately the MAC layer parameters, a similar approach to the one presented in [8] will be followed. On the other hand, MEDIEVAL focuses on cross layer interactions and multicast, hence the second point of optimization is the cross-layer packet marking to be able to better queue flows with different QoS and perform group-cast.

The increasing trend on video distribution over the Internet and the use of wireless distribution systems to connect different multimedia commodities within the home environment have triggered the IEEE 802.11 Working group to extend current functionality of Wireless LAN specifications to tackle the distribution of video streams. One of the key points of video distribution on wireless environments is the use of multicast; however, current multicast realizations over WLANs are extremely unreliable, due to the lack of ACK mechanisms. To increase their reliability, it is necessary to deploy a new set of MAC mechanisms while still remaining compatible with legacy IEEE 802.11 stations [3]. This is the aim of the upcoming IEEE 802.11aa specification [9], which basically defines two main functionalities with reference to video transmission: improved multicast transmission modes, namely Direct multicast Service (DMS) and Group-cast with Retries (GCR) Service, and Improved video service differentiation by extending the Enhanced Distributed Channel Access (EDCA) mechanisms to provide a Stream Classification Service (SCS).

The former corresponds to the new functionality to increase the reliability of multicast transmissions in Wireless LAN environments. The DMS, introduced in the IEEE 802.11v draft standard [10], transforms multicast flows in a set of unicast flows. In this way, an access point (AP) will retransmit a given frame until an ACK is received or the retransmission limit is exceeded, in which case the frame is discarded. This mechanism exchanges throughput for reliability because of the need for individually transmitting multicast frames which could be critical, e.g., I frames in a Moving Pictures Expert Group (MPEG) stream. The GCR Services extends the (ACK) policy of DMS with two new mechanisms for multicast:

Unsolicited Retry: The AP will retransmit a frame several times to increase the probability of correct reception at the stations. Again in this case, some resources are wasted to improve the successful delivery rate which may be required for real-time flows.

Block ACK: This is an extension of the Block ACK defined in IEEE 802.11e for group addressed frames [11]. There, the sender transmitted a burst of data frames and explicitly requested an ACK to the receiving station. In 802.11aa, the request, represented by a modified Block ACK Request (BAR) control frame, is sent by the AP and contains a sorted list of the multicast group members. Then, each station can recognize the multicast group it belongs to and replies with individual Block ACKs in the proper order. Thus, throughput is decreased due to the control frame exchange to reduce unnecessary retransmissions, but reliability is increased.

With respect to the multicast extensions defined in IEEE 802.11aa, one of the objectives of the MEDIEVAL project is to implement the mechanism which allows an AP to switch dynamically between the GCR-DMS, GCR-Unsolicited-Retry or GCR-Block-ACK delivery modes, taking into account that only one delivery mode may be active at any given time for each GCR group address. Based on preliminary simulation results, the choice of groupcast mechanism requires a careful assessment of the usage scenario since in terms of performance achievable or reliability of the transmission, there is no clear winner. Hence, based on the number of receivers, the bitrate of the transmission and the number of background stations, one mechanism is more suitable than others. This assessment is one of the objectives of the MEDIEVAL project.

Finally, the IEEE 802.11aa specification also defines a new differentiation service which extends standard EDCA queues. The SCS increases the granularity of the service differentiation already provided by 802.11e for audio and video. IEEE 802.11aa introduces two additional queues within the EDCA Access Categories (ACs): one for audio and one for video, in order to support prioritizing mechanisms between queues and to differentiate video streams. In addition to the intra AC prioritization, packets are tagged with their drop eligibility which defines a different maximum number of (short and long) retries. The availability of additional access categories and the drop eligibility bit can also be used to enforce the graceful degradation of the video quality in case of bandwidth shortage. This approach requires the definition of an internal interface configuring the MAC parameters of IEEE 802.11, i.e., EDCA queue, minimum and maximum congestion window, Transmission Opportunity limit, Arbitration Inter-Frame Space (AIFS), as well as the multicast mechanisms defined by 802.11aa with their parameters (number of retries or the requested stations in a BAR). These parameters affect both the APs and the stations according to the upper layers requests. It is also necessary to provide an information service to indicate the upper layers with the available multicast capabilities so that they can monitor the mechanism being used and decide the optimal configuration.

It is worth mentioning that none of the novel mechanisms proposed in 802.11aa is supported by available implementations of the IEEE 802.11 standard. Moreover, management mechanisms at the hardware/MAC level do not permit to handle either ACKs or Block ACKs for multicast and broadcast frames. Therefore, with the current 802.11 standard, multicast traffic cannot be converted into unicast at MAC layer nor (Block) ACKs, as well as there are no means to force unsolicited retransmissions. The previous considerations result in difficulties to implement such mechanisms in order to evaluate their performance in real-life conditions and understanding the resulting tradeoffs and design criteria. However, the project is expected to shed light on these issues through quantitative evaluations, e.g., by means of simulation.

III. Enhanced coordination-based wireless access

Among coordination-based access, the main focus of the project is on LTE-A. In this context, a first task to be performed by LTE-A wireless access is to gather channel measurements performed at lower layers and inform the related decision entities about them. E.g., knowing the load of the cell at network level or the quality of the links perceived by the mobile terminal improves the decision-making algorithms in the upper layers entities. Then, a novel medium access strategy will be applied, taking into account the characteristics of video flows and identifying techniques to interact with upper layers, to design access techniques, which are aware of the video content delivery in a network-wide perspective. In particular, allocation strategies, proposed at MAC level, exploit the cross-layer techniques to allocate as many users as the LTE-A wireless channel can admit, trying not to affect the perceived QoE by the end users. Moreover, equipment capabilities announced at network attachment, must be exploited to improve the bandwidth occupation of the video signal flowing in the last wireless hop of the network. Then, based on the information received through the abstract interface, the control plane instructs the user plane entities to select and transmit towards the air interface only those video frames which are adapted to the receiving device capabilities. This operation is accomplished before video frames enter in the wireless access technology protocols, then such information is received when the User Equipment (UE) connects to the network, and can be correlated with some pre-defined coding levels of the video signal to determine the optimal quality level corresponding to the equipment. The frame level of each video packet is marked by the application or service layer in the IP header and it is provided to the transmitting entities, which then prioritize or even drop the video packets, thus reducing the bandwidth occupation in the downstream nodes, especially in the last wireless hop. The statistics related to this filtering are reported at the wireless network entry node, e.g., the base station. In the case of multicast sessions, further correlation is maintained to handle the knowledge of the users who joined the service.

In LTE-Advanced, multicast mainly means to support and extend the evolved Multimedia Broadcast and multicast Services (eMBMS) Bearer service specified in the LTE standards [12]. The objective of the MBMS is to enable point-to-multipoint communications over the radio interface (or Access Stratum), allowing resources to be shared in the network. In the LTE-A model, this means supporting some specific logical channels. The first channel is the Multicast Control Channel (MCCH), which is dedicated to the broadcast of MBMS control and scheduling information in the cell. The second channel, the Multicast Traffic Channel (MTCH) is used for transferring the data packets. There is one MTCH per session, received by all the Mobile Terminals interested in the session. MEDIEVAL plans to support some level of QoS for this channel, in order to improve the efficiency of the video frames transfer. In the physical (PHY) layer, the MCCH and MTCH are mapped on a specific physical channel, the MCH. In the MTCH, multicast data are transported in an unacknowledged mode radio bearer, as usually defined for streaming flows in the 3GPP QoS (Quality of Service) architecture. The handling of multicast flow has disappeared in the transition between MBMS and eMBMS, mostly due to business causes and deployment costs. In the LTE and LTE-A systems, only broadcast sessions are proposed. In MEDIEVAL, the plan is to re-introduce the multicast sessions, which are essential to some of the user services providing video delivery identified in the project, while improving their overall management. This has a strong impact since it implies supporting some specific MBMS procedures in the control part of the Access Stratum (AS). In particular, MEDIEVAL plans to simplify the multicast session start and stop procedures at the eNodeB and the associated mobile notification. Another important feature is the counting of listening mobiles in each cell by the eNodeB. This information is interesting to trigger the multicast session if needed, or move the flow back to a point-to-point bearer if only one user in the cell is listening. To avoid disturbing other types of traffic (e.g., voice) that could take place simultaneously, it is important to establish a coordinated control of unicast and multicast communications in a cell providing the MBMS service. Supporting multicast and video traffic in eMBMS influences also the way the data traffic is handled in the LTE-A interfaces. In the eNodeB, they must be able to forward the IP multicast packets towards the multicast bearers in the air interface and enable the reception of the packets in the mobile. The impact is expected also on the configuration of the radio access, to take into account the spectrum usage and the resource allocation. Multicast flows require bandwidth reservation based on the dedicated eMBMS Bearer parameters received from upper layers and the worst CQI (Channel Quality Indicator) of multicast clients measured in the lower layers. This results in a bad spectrum usage because users with a robust link underutilize the bandwidth resources. The proposed solution combines H.264/SVC (Scalable Video Coding) together with cross-layer optimization to dynamically tune the QoE for each user according to the channel feedback.

Ns-3 network simulator [13] is the simulation tool used for validating the proposed optimization approaches for LTE networks. A basic description of the protocol stack entities can be found in [14], while the whole framework can be downloaded and executed in [15].

IV. Abstracted mechanisms

To achieve efficient video transport in heterogeneous networks, high transparency and seamless intercommunication within the system components is needed, able to operate in both types of wireless technologies. This is accomplished by a set of functions defined in the abstraction layer, together with some ad-hoc features designed to further enhance the video flows transfer over the air. In the following, we present a key concept of the MEDIEVAL design, the abstraction layer and its mutual interactions with the transport and mobility layers.

Abstraction Layer: The abstraction layer is the heart of video delivery optimization process, as it provides the means for the interaction between the radio access network and upper layers in order to accomplish cross layer functionalities and underlying technologies transparency. This twofold goal is realized by using abstract interfaces defined to establish a functional connection with both upper and lower layers: video transport and mobility management on the one hand, wireless access on the other hand. This interfaces are designed in such a way that they provide a common functionality regardless of the specific underlying technology. In the following we present the different interfaces and functionalities provided by the abstraction layer.

Transport Optimization: This abstract interface provides the upper layers with information and configuration mechanisms regarding the video characteristics available at the lower wireless technologies in an abstract way, translating generic video parameters into video specific extensions defined by the underlying heterogeneous technologies.

The objective of this cross-layer interface is to enable an efficient and optimized video transport by providing information about the availability of the wireless accesses and the dynamic variations of the radio channel, and informing about specific jumbo frame functionalities such as aggregating non-related traffic (or traffic from different flows), as well as providing indications necessary for the transport of jumbo frames, such as frame size and queue delay. Then, it enables transport alternatives (other than User Datagram Protocol (UDP) and Transmission Control Protocol (TCP)) such as multicast and, upon request, it reports information about the Mobile Nodes (MNs) capabilities such as the size of the screen, the list of available network interfaces, active links and flows, or the counting of session receivers in the case of multicast. Moreover, it receives information to enhance the configuration of the wireless access: flow requirements (for QoS and multicast mechanism), flow identification, marking criteria, configuration parameters for multicast and jumbo frames procedures.

The use of this information at the transport layer allows the operator or video service provider to implement smart optimizations such as: *i)* design evolved cross-layer algorithms and mechanisms between the video services and the network layer and to dynamical optimization of video services with suitable network support, *ii)* develop new procedures and algorithms to better adjust the video streaming taking into account the network dependencies or *iii)* improve cross-layer communication in order to have Forward Error Correction (FEC) mechanisms in a joint coordination between the wireless access module and the service layer controller.

Then, we achieve an end-to-end interface through the transport optimization layer and, at the same time, a dynamic cross-layer interface targeting video improvements and content delivery. This will provide support to video coding: FEC/Automatic Repeat reQuest (ARQ) [16], Available Bit Rate (ABR), scheduling, transcoding according to device capability and QoS availability. Other important features to be addressed are the Process Priority settings (marked packet for prioritization and selection), the indication of jumbo frames availability, the quality of the link information provisioning, and the support of signal split across multiple channels.

Mobility Management: This functionality interacts with the mobility management mechanisms by reporting abstracted parameters from the wireless accesses and forwarding downwards the received commands relative to interface or flow mobility. The objective of this cross-layer interface is to extend the media-independent signalling functionalities provided by IEEE 802.21 and support extra mobility functionalities and video aware services to optimize the user experience while performing handover. Hence, in order to provide a better mobile user experience within a network, the Media Independent Handover Function (MIHF) will support flow mobility (identification of flows, flow granularity at the primitive level) and new mobility protocols which work as MIH Users and that are not currently contemplated in the standard, such as Distributed Mobility Management (DMM) approaches.

One of the most interesting functionalities offered by IEEE 802.21 is its ability to provide dynamic and static information, through the Media Independent Event and Information Services. In order to enable mobility decisions, information about link quality and QoS levels must be provided to the mobility management entities, along with static or semi-static information regarding the video specific features implemented in the network, such as signalling the availability of surrounding access networks, Point of Access (PoA) link layer parameters, PoA capabilities (IP multicast, mobility scheme support, jumbo frames support), upper layers capabilities (video services supported, transport optimization mechanisms available), and availability of multicast support in the network.

The above interfaces represent the exchange of information between the higher layers and the media abstraction provided by the abstraction layer. In order to be able to actually work with the real technology, the abstraction layer talks with the underlying technologies through media dependent abstract interfaces, which are in charge of gathering the technology measurements to inform the upper layers transparently and dynamically about the current radio conditions.

Although the role of the abstraction layer may appear as a simple translator of media independent events/commands/information, this layer is designed as an intelligent module able to provide also extra-functionality apart of translating between abstracted and media specific languages. The novel functionality included in the abstraction layer is called the Abstract QoS Mapper. The objective of this module with the abstraction layer is to provide a comprehensive mechanism for the higher layers to be able to map their requirements in terms of QoS or even QoE to a set of abstract parameters that the lower layers can understand. In this way, the higher layers will provide through the video transport interface, the flow requirements in terms of QoS and multicast. By using this information, the flow requirements are mapped to a certain traffic class or general protocol parameters that will be translated so that the specific technology can be configured accordingly.

Finally, in the following sub-section we present the concept of jumbo frames, which is another generic technology that is being investigated for video delivery optimization.

Jumbo frames: Jumbo frames, or jumbograms, are packets with a size larger than 1500 bytes, where 1500 bytes is the normal Ethernet size being used since its creation (around the 80s). The major benefit of using a larger frame size is that, when compared with a lower one, the same amount of information can be sent in fewer packets (i.e., less fragmentation occurs). Each frame, both when sending or receiving, requires CPU processing and has header overhead associated, thus fewer frames will require less CPU processing and generate less overhead, as well as increased throughput.

The mechanisms designed within the MEDIEVAL project will consider a flexible approach and therefore will aim to have a negligible impact in the current or upcoming network developments. Also, the deployment of jumbo frames in this manner requires that some important issues are tackled. One of these issues is the mobility experienced by terminals which can seriously impact and alter conditions such as packet loss, which highly impact the usage of larger frames. Also, considering the number of users associated to the same AP, the usage of greater Maximum Transmission Unit (MTU) sizes can cause fairness issues in multi-user environments. As such, the development of new resource allocation through, for example, channel hopping, is required. Otherwise, jumbo ability can be emulated at higher layers of the protocol stack, impacting only queues at the lower layers.

The usage of jumbo frames considers not only the last hop towards mobile users (which is wireless), but also the full path from mobile users to the content provider. This means that different media will be crossed at different points of the network, which need to be aware of jumbo frames. However, the wireless part, due to its inherent operation constraints and changing conditions of the wireless medium, provides the most challenging part for the development of performance-increase mechanisms. As such, the usage of jumbo frames is being addressed in the wireless environment, so this means the last hop, between MN and the Point of Attachment (PoA). In order to simplify things, evaluation will contemplate the PoA acting as a Point of Service (PoS), in order not to mix wireless jumbo frames, with wired jumbo frames.

V. IEEE 802.21 IN MEDIEVAL

The IEEE 802.21 Media Independent Handover (MIH) [17] is a standard that aims to facilitate and optimize handover procedures between different access technologies. It adds an abstraction layer (in the form of the Media Independent Handover Function (MIHF)) that abstracts the different link technologies to high-level entities, here deemed MIH-Users. This abstraction is achieved through the provision of a set of services: the Media Independent Handover Event (MIES) service, which allows MIH-Users to receive events about link conditions, the Media Independent Command Service (MICS) which enables MIH-Users to exercise control over the links and the Media Independent Information Service (MIIS) which provides network information that can be used for optimal handover candidate selection. These services can be accessed remotely between MIH-enabled entities via the MIH Protocol, enabling the network and Mobile Terminals to exchange media independent information with which network management and handover control can be optimized.

The role of IEEE 802.21 in MEDIEVAL is to provide media independent interfaces to the decision entities in the architecture, towards control of the network access links, while facilitating handover procedures. The events, command and information defined in the protocol provides the common interaction fabric with which the different aspects (video services, wireless technologies, mobility and traffic optimization) can interact, in order to provide an enhanced mobile video experience in wireless environments.

The MEDIEVAL project plans to implement IEEE 802.21 through Open Dot Twenty ONE (ODTONE) [18], which is an open-source operating system independent implementation of IEEE802.21. It is written in C++ using Boost libraries, allowing the support of several mechanisms such as portable datatypes, networking and low-level I/O in different platforms (i.e., Microsoft Windows, Linux and Android). ODTONE implements the standardized MIH services (MIES, MICS and MIIS), which are managed in the MIHF. ODTONE is able to work both in a local or remote way, through the usage of the MIH Protocol, which is able to be carried over UDP or TCP. To support its design, ODTONE provides a MIH Protocol library which can be included in any MIH-User code, or link layer management code. In this way, the existing link layer software or driver mechanisms implemented need only to include the MIH Protocol library, besides adding MIH processing behaviour. Similarly, high level entities just require the inclusion of the same library and the ability to process the received messages. ODTONE also provides an implementation of the Information Elements Basic Schema (IEBS) in binary and Resource Description Framework (RDF), which can be used for creating MIIS Servers.

IEEE 802.21 standard defines reference models for IEEE (i.e., 802.3, 802.11 and 802.16), 3GPP and 3GPP2 technologies. For these technologies it provides a direct mapping for the link events, commands and parameters that are available for MIH-Users to interact with links. However, later developments of cellular technologies, such as 3GPP LTE-A, provide meaningful differences which were not considered by 802.21. As such, in the project, we are developing a mapping between 802.21 parameters and LTE-A parameters [19] with the objective to replace the existing mapping between 802.21 and UMTS parameters. For a detailed explanation, see [17]. As an example, in Tables I and II a list of measurement and configuration parameters is provided in order to define the services to be handled in the LTE-A Media Specific SAP to perform an efficient protocol extension; in fact, dynamic channel information such as Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ) are reported to higher layers, whereas UE physical capabilities and system resource usage attributes are exchanged in the lower layers for radio access purposes. Then, such information might be integrated into standardized MIES to extend the protocol capabilities, in the same way as parameters listed in Table II can be used to to configure the air interface, or Access Stratum, based on information received from the upper layers (MICS).

Information Elements (IEs) provide a scheme of information residing within an Information Server, which can be used to find information regarding specific PoAs. This optimizes the process of handover candidate selection by providing

Reported to RRC and upper layers	Executed but not reported	To be reported
RSRP	UE, eNodeB: PHY	(*)
RSRQ	eNode: MAC/RLC (*)	UE capabilities

TABLE I
LTE-A MEASUREMENT PARAMETERS

RRM	MAC/PHY	RRM $\rightarrow$ MAC/PHY
RLC Mode	Spectrum Info	e2e Bearer Specs
HARQ	Transmission Mode	(**)
Buffer Size (**)	Transceiver Specs	

TABLE II
LTE-A CONFIGURATION PARAMETERS

information on supported capabilities, which can be used by mobility management to retrieve information about specific PoAs. As video becomes a core aspect of the MEDIEVAL project, we have provided different degrees of video-awareness into 802.21. For wireless access mechanisms, we are adding a set of new IEs that provide video-related capabilities within networks such as MBMS support, jumbo frames support, and Content Delivery Network (CDN) support.

To better support the integration of video-awareness into the mobility and wireless decision processes within the MEDIEVAL project, we are revising the set of standard events and commands defined in the IEEE 802.21 standard, empowering them with parameters that are able to provide information about video related features. For example, we are providing commands and parameters that enable network decision entities to control video applications to alter video streaming parameters in order to better adjust to radio conditions. Currently, these commands and parameters are still under definition according to the cross-layer mechanisms defined between network control processes and video application services.

VI. CONCLUSIONS

This paper presented the concepts for the wireless access component in the network architecture designed for the EU project MEDIEVAL. The wireless access part of the architecture aims at optimizing the last hop for video flows, with target access technologies classified in contention-based techniques, such as WLAN, and coordination-based techniques, such as LTE-A. Several cross-layer functions and enhancements have been proposed within this architecture. In the WLAN side, the upcoming IEEE 802.11aa amendment will improve the multimedia transmissions by increasing their reliability, enhancing the multicast support or introducing frame prioritization and graceful degradation of the video quality. In LTE-A, the objective is to introduce multicast sessions in the eMBMS framework, frame selection and prioritization in the radio interface, optimized medium access strategies or innovative relaying techniques. In both types of technologies, the reporting of measurements such as link quality or cell load plans to enable the operation of cross-layer algorithms in the video transport or mobility management modules of the network architecture. To achieve an efficient cross-layer communication with heterogeneous access, an abstraction layer has been introduced which hides the specifics of each technology to the upper layers, by the usage of generic parameters and primitives. This layer is based on an extension of the MIH services offered in the IEEE 802.21 standard. Another generic technology under study introduces the concept of jumbo frames in the wireless access, where packets have sizes larger than the usual MTU values. Future work on all these functionalities will consist in developing the generic cross-layer signaling flows and scenarios, and deriving an extended set of primitives between the wireless access technologies, the abstraction layer and the video transport and mobility modules. These techniques and optimization algorithms will be evaluated more precisely using our enhanced simulators. Most of them will be ported and tested against a real-time testbed equipped with WLAN cards and drivers, an experimental LTE software radio platform and the upper layers components acting as MIH Users.

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