

AN INTEROPERABLE MULTIMEDIA DELIVERY FRAMEWORK FOR SCALABLE VIDEO CODING BASED ON MPEG-21 DIGITAL ITEM ADAPTATION*

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ABSTRACT

In this paper we present an interoperable multimedia delivery framework for scalable video coding based on MPEG-21 Digital Item Adaptation (DIA). It can be used to transmit scalable video contents within heterogeneous usage environments where the properties of the usage environment (e.g., terminal/network capabilities) may change dynamically during the streaming session. The usage environment is signaled by interoperable description formats provided by the DIA standard. Additionally, the adaptation itself is done by exploiting the standard's generic adaptation approach, i.e., independent of the actual coding format. Thus, the overall framework is also applicable for other scalable coding formats.

Index Terms— Multimedia Streaming, Heterogeneous Environments, Universal Multimedia Access, Scalable Video Coding, MPEG-21 Digital Item Adaptation

1. INTRODUCTION

Streaming of multimedia (i.e., audio-visual) content over heterogeneous, best-effort networks such as the Internet causes still many issues as the bandwidth may fluctuate during the transmission and receiving terminals may have different capabilities. The desire to access multimedia content with Quality of Service (QoS) guarantees anywhere, anytime, and with any device is generally referred to as Universal Multimedia Access (UMA) for which interoperable description formats have been defined as part of MPEG-21 Digital Item Adaptation (DIA) [1].

In this context we have developed a test-bed for the streaming of scalable multimedia contents that adapts the scalable bitstream independent of the actual coding format and according to the usage environment conditions (e.g., terminal/network capabilities) signaled by the receiving terminal. Furthermore, the test-bed allows for dynamic

adaptation, e.g., changing the bitrate or framerate during transmission which may be used to simulate bandwidth fluctuations. To evaluate the performance of the test-bed, experimental measurements have been performed for the adaptation of ISO/ITU-T's Scalable Video Coding (SVC) [2] based on JSVM 9.1 [3] utilizing the generic MPEG-21 DIA metadata-based adaptation approach and have been compared with measurements for an SVC-specific adaptation approach [4]. The results show that the generic MPEG-21 DIA metadata-based adaptation approach clearly outperforms the SVC-specific adaptation approach.

The remainder of this paper is organized as follows: The test-bed is introduced in Section 2 and its main features are discussed and Section 3 concludes the paper.

2. TEST-BED

The high-level architecture of our test-bed is depicted in Figure 1. The test-bed consists of a streaming server and a number of possibly heterogeneous streaming clients, the server as well as the clients are DIA enabled. The implementation comprises VideoLAN's VLC media player [5] which can be used as both, streaming server and client, and which has been extended to support SVC. Furthermore, the MPEG-21 DIA functionality has been incorporated into the VLC.

The *MPEG-21 DIA-enabled Streaming Client* has been implemented in a portable way with the intention to make it available on as many devices as possible. It extends the VLC with the *MPEG-21 DIA Client*, which provides the capabilities to transmit the MPEG-21 DIA metadata to the server in order to set up a streaming session tailored to the requirements of the client.

The *MPEG-21 DIA-enabled Streaming Server* extends the VLC with the *MPEG-21 DIA Interface*, which is utilized to receive the MPEG-21 metadata for the streaming sessions from the clients. Furthermore, the streaming server comprises the *Adaptation Decision-Taking Engine*

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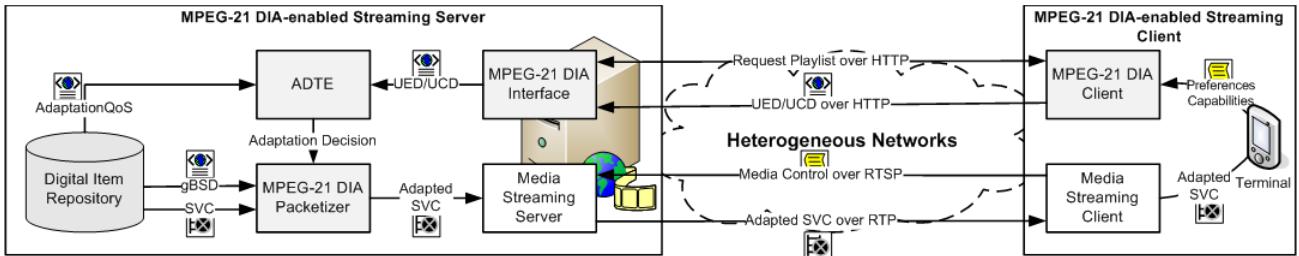


Figure 1. High-level Architecture of the Test-Bed for Interoperable Streaming of Scalable Multimedia Contents [4].

(ADTE), which takes the *adaptation decision* based on the metadata provided by the client, and the *MPEG-21 DIA Packetizer*, which performs the adaptation of the SVC content during the streaming sessions.

At the beginning of a streaming session, the MPEG-21 DIA Client initiates a request to retrieve the list of available *Digital Items* (DIs). The client sets up a session by providing the ID of the desired DI. Furthermore, the client provides the preferences of the user as well as the capabilities of the client's terminal and possible network capability restrictions to the server formatted as an *MPEG-21 DIA Usage Environment Description* (UED) and a *Universal Constraint Description* (UCD) [1]. The communication steps between the MPEG-21 DIA Client and the MPEG-21 DIA Interface are performed utilizing the *Hypertext Transfer Protocol* (HTTP).

After the setup of the streaming session, the client receives a *Real-Time Streaming Protocol* (RTSP) URL from the server which allows the client to start the streaming session. Furthermore, the client may send updates of the UED/UCD during the streaming session in order to simulate changes in the usage environment which leads to a dynamic change of the adaptation process while the bitstream is consumed at the terminal.

At the server, the MPEG-21 DIA Interface receives the UED/UCD and passes this information together with the media stream's *MPEG-21 DIA AdaptationQoS* description to the ADTE. The ADTE takes the adaptation decision by matching the information contained in the UED/UCD against the *AdaptationQoS* description, which provides the adaptation capabilities of the requested SVC bitstream. The output of the ADTE, i.e., the adaptation decision, provides the adaptation parameters for the *MPEG-21 DIA Packetizer*. The packetizer adapts the SVC bitstream in a coding format independent way by utilizing the generic adaptation approach specified in *MPEG-21 DIA*. Finally, the adapted SVC access units are passed to the actual *Media Streaming Server* which transmits the SVC bitstream to the client utilizing the *Real-Time Transport Protocol* (RTP) as soon as the RTSP streaming request from the client is received.

If an updated UED/UCD is received from the client during a streaming session, the UED/UCD is forwarded to the ADTE and, consequently, a new adaptation decision is

provided and is utilized by the packetizer to perform the adaptation process. As the adaptation at the server is performed on an access unit basis, the dynamically changed adaptation parameters are utilized as soon as a new access unit is processed by the packetizer.

Due to space constraints, for further details about the test-bed the reader is referred to [4]. Additionally, background information of the used *MPEG-21 DIA* metadata-based adaptation approach can be found in [6].

3. CONCLUSION

In this paper we have presented an interoperable multimedia delivery framework based on the open standards for Scalable Video Coding and *MPEG-21 Digital Item Adaptation*. By utilizing these open standards interoperability is guaranteed and, thus, contributing to the overall vision of Universal Multimedia Access. The framework works due to the support of *MPEG-21 DIA* independent of the underlying coding scheme and can hence be utilized for scalable coding formats other than SVC. Furthermore, experimental performance measurements [4] have shown that the generic *MPEG-21 DIA*-based adaptation approach can very well compete with codec-specific adaptation approaches.

4. REFERENCES

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