Real-time Multimedia Streaming in Unstructured Peer-to-Peer Networks

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With the introduction of social networks like Facebook, Google+, and Twitter, the ways of sharing impressions of events has changed. We try to go a step further than social networks do. We offer the possibility to share events live with friends and colleagues. Our approach is based on semantic search in unstructured peer-to-peer (P2P) networks for querying content in mobile ad hoc networks and dynamic adaptive streaming over HTTP for the actual delivery of the real-time media impressions.

Keywords—Peer-to-Peer; Semantic Search; Live Multimedia Streaming; Mobile

I. Introduction

Social networks have become pervasive and the possible ways of sharing multimedia content increases monotonically. Facebook, Google+, Twitter, etc. allow us to keep our friends and colleagues posted to our activities. The EU project SocialSensor adds a new dimension to social interactions by providing the possibility to share social activities in real-time with friends and colleagues using our mobile device [1]. This could be a film festival, rock festival, or any other activity, that one might want to share with friends in real-time. Therefore, our approach allows sharing of multimedia content using peer-to-peer (P2P) technology and provides the possibility of offloading the recorded stream to an external server.

In order to provide the possibility of sharing and searching multimedia content in unstructured P2P networks we employ two key techniques, namely, semantic search in unstructured P2P networks (S2P2P) [2] and Dynamic Adaptive Streaming over HTTP (DASH) standardized by the ISO/IEC MPEG [3]. The P2P search is used to find multimedia according to a given semantic description. MPEG-DASH is used to stream the selected content. Furthermore, we use the Video LAN Client (VLC) [4] with the MPEG-DASH plugin in order to playback the DASH compliant content [5].

II. Semantic P2P Search And Live Streaming with MPEG-DASH

In the following sections we briefly describe the semantic-driven k-walker P2P search and MPEG-DASH, which is utilized to stream the recorded live content in P2P mode.

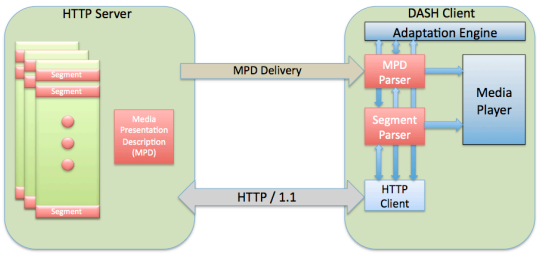

Figure 1. Scope of the MPEG-DASH standard [2].

A. Semantic Search in Unstructured P2P Networks

In S2P2P, each peer maintains its observation on the semantics of received queries (demands) and data information (supplies), as well as a local view on the network topology. Each peer, when forwarding a query, disseminates its known data information to a selected set of remote peers by taking advantage of query-piggybacked data. That is, each peer locally observes the query and item semantics, also known as local view on the semantic overlay of the P2P network, during the k-walker search of each query it receives or issues. For routing a query, each peer, instead of merely introducing an immediate neighbor, suggests a query routing path consisting of a sequence of peers with expertise on topics which are semantically equivalent or sufficiently similar to the query topic. This is achieved by a path suggestion heuristics that iteratively applies Dijkstras algorithm in a greedy manner. Each iteration of the heuristics manages to detect one more expert peer and augments the current path suggestion with the shortest path from its tail to the detected expert peer. That is, inspired by the literature on gossiping in P2P networks, the optimal expertise-based routing path per query is collaboratively determined by peers as the shortest path with the maximal number of peers, which are actually known to have semantic expertise for the considered query topics. In particular, the collaborative path adjustments by peers on this path are done in order to maximize the gain of the total answer for the query (within the time-to-live of the respective query walker). This allows us to find content according to a semantic description within an unstructured P2P network.

B. MPEG-DASH for Live Media Streaming in P2P Networks

MPEG-DASH is a pull-based streaming approach utilizing HTTP which implies that the client has to request the video content from a source implementing a conventional HTTP

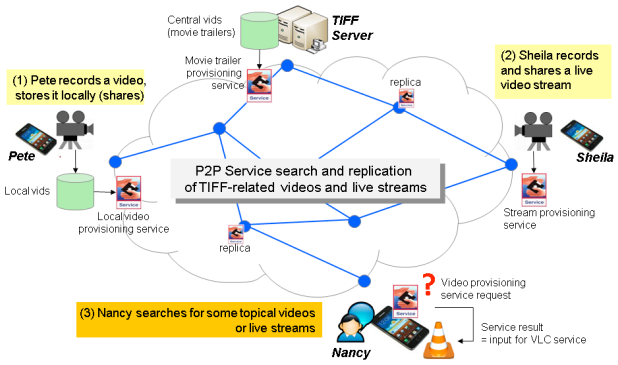

Figure 2 Use case scenario for the TIFF.

server. The dynamic and adaptive part of MPEG-DASH is concerned with the adaptation of the multimedia stream to provide the user with a high viewing experience. Therefore, the dynamically changing network parameters, and the buffer fill state are used to determine whether the current representation should be changed. Figure 1 illustrates the scope (red parts) of the MPEG-DASH standard [3] which defines the Media Presentation Description (MPD) and the segment formats only. The adaptation engine is solely within the client which decreases the complexity on the server, i.e., the server does neither monitor the network conditions nor require a feedback loop to adapt the streaming session to context changes (e.g., bandwidth fluctuations). The adaptation engine and the control heuristics are left undefined in order to allow industry and researchers to come up with their solutions.

For our P2P live streaming we use MPEG-DASH for describing the recently recorded live stream. Thus, when the query for the semantic P2P search reveals the desired multimedia content, the URL to the peer and multimedia content is used to retrieve the MPD. In the case, that the MPD describes live content its type is *dynamic*, which states that the MPD does only describe the available representations without mentioning the segments. In order to allow for the playback of MPEG-DASH compliant live streams we provide an extended version of the MPEG-DASH plugin for VLC. This plugin is responsible for selecting the appropriate segments by calculating the corresponding segment number by the use of the timestamp carried by the MPD. Furthermore, our P2P live streaming using MPEG-DASH provides the possibility to adapt the quality of the multimedia content during recording. Additionally, it supports peer-assisted streaming [6] where each client announces that it provides some segments of the multimedia content by adding itself to the *BaseURL* in the MPD at the source. Furthermore, we provide the possibility to upload the recorded live stream to an external server for on-demand purposes.

III. Use Case Scenario

Figure 2 depicts the Thessaloniki Film Festival (TIFF) as use case for our mobile application in the context of the SocialSensor project. Our mobile application provides the possibility of sharing and experiencing multimedia. It allows visitors of the TIFF to create an unstructured ad hoc P2P network with Android-based mobile devices (smartphones, tablets). Furthermore, movie trailers, live feeds, and the respective media provisioning services are available by a dedicated TIFF server (cf. Figure 2). Additionally, some multimedia content may already be stored on their own local mobile devices with a possible connection to some private or public cloud. In our case, we assume that the multimedia content and the services are already semantically annotated, directly by the organizers or indirectly by the users with tags from a gradually evolving tag cloud or concepts from an ontology represented in the OWL 2 Web Ontology Language.

Furthermore, Figure 2 shows three persons interacting with the unstructured P2P network that they have joined during the TIFF. Pete (1) records a video and stores it locally. Sheila's (2) intention is to share some of her personal impressions by using our mobile application and providing a live stream of a movie presentation. In the meantime, Nancy (3) searches for multimedia content of a certain topic. As Nancy prefers to avoid crowded places she selects the live stream offered by Sheila that fits her semantic query. Additionally, other persons may have access to the movie trailers, live streams, and recorded multimedia content by utilizing the peer's Internet connections and, thus, combining dynamic adaptive live streaming with semantic P2P search.

IV. Demo Description

In the demonstration, we show that empowered by the mobile semantic P2P and MPEG-DASH components for Android our mobile TIFF application enables users to, for example, initiate or join a mobile ad hoc network of other users in order to efficiently search for, seamlessly share, and experience relevant multimedia content or even live recordings by users within the group. We will demonstrate this innovative functionality of our application with multiple mobile devices on site.

Acknowledgment

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