Multimedia Service Composition: A Brave New Topic

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1. INTRODUCTION

The recent advances in multimedia hardware, networking infrastructure, computer vision processing, speech processing and programming language technologies more and more allow to construct large-scale distributed multimedia applications such as tele-immersive collaborative environments, surveillance systems with multi-arrays of cameras, multi-arrays surround sound systems and streaming applications with hundreds of flows, distributed over LANs or WANs (e.g. [1], [2]). However, all these systems are still being built and programmed as monolithic and 'proof of concept' systems. Less attention is being paid to build these large-scale distributed multimedia systems in a scalable, easy-programmable and flexible service-oriented manner, with a maximum of possible reusability of common components. This has to change; otherwise the multimedia community will either require very large teams to build large-scale systems (see e.g. the Coliseum system from HP [1]) or will have to validate novel approaches on insignificantly small systems with two to three 640 by 480 pixel video streams.

To advance the state of the art in construction of sophisticated large-scale multimedia systems, and avoid the above discussed situation, we want to create synergies between two relevant communities: the multimedia community that has an excellent understanding of the various media types, their description, processing and networking behaviors, and the Web community that has an excellent understanding of services, their description, semantics and behaviors in large-scale systems. The two communities meet in the special session on "multimedia service composition" during the ACM Multimedia 2004 conference, and discuss service composition concepts, well-known in the Web community, as one of the main approaches to advance construction of large-scale distributed multimedia services and applications in a scalable, easy-programmable, and efficient manner.

2. PROBLEM DESCRIPTION

Service composition, orchestrations and choreography of services are concepts strongly discussed and researched within service-oriented architectures in the Web community today, e.g. [3], [4], [5]. Simple Web services promise to take over an essential part of every-day's responsibilities and their composition is expected to extend their benefits to even more complex tasks, workflows and value chains. Besides the efficient provisioning and improved reusability of individual components, the move from data-driven to service-driven architectures promises to open up a whole new field of value adding applications built on top of these basic components and innovative business models for content-, service- and network-providers.

Also the multimedia community currently is on the move from monolithic multimedia applications towards more flexible solutions, which can be provided between content providers and clients or even peer-to-peer over the network. But whereas the multimedia community effectively handles semantic content data and provides sophisticated standards for media coding accompanied with meta-data descriptions (e.g. MPEG-7, MPEG-21), the useful concepts from Web services research did not yet make a broad impact on multimedia systems development. Still many distributed multimedia applications are being built monolithically supported with some flexibility from (a) middleware systems to run the same application software on different platforms, (b) from multimedia protocols, and (c) from multimedia operating systems supporting soft real time scheduling. On the other hand, Web-based service concepts and constructs are invariant to new data types heavily explored in the multimedia community. The benefit of bringing together novel Web-based service oriented concepts and the sophisticated handling and processing of multimedia data and annotations thus is mutual.

Since most complex multimedia workflows consist of several individual steps and prototype systems become huge, the composition of basic, reusable services to facilitate more complex goals is mission critical. We will illustrate the importance of the multimedia service composition problem with the example of an advanced audio conferencing system within an international company, which has multiple sites in different countries:

Let us assume that (a) different sites tune in at different times to converse about different projects, (b) different sites speak different languages, (c) multiple conversations go on at the same time, and (d) multiple audio formats are deployed at different sites. To provide a customized real-time audio delivery at each site, we will need to apply (a) scheduling and synchronization services, (b) multiple trans-

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lation services, (c) mixing and switching services, and (d) transcoding services to different streams depending on the number of sites, involved languages, formats, number of conversations, etc. If we have for instance only two sites, one site in USA, the other in Germany, and only one conversation goes on using different audio formats, the audio streaming needs to go only through a chain of translation and transcoding services. On the other hand, if we consider more sites (e.g. USA, Japan, Germany), with two parallel conversations (one between USA, Japan and Germany and the other one between USA and Japan), but with the same audio formats, the audio streams also need to use switching, mixing and translation services in parallel. Note that the number of services through which the audio streams may go can be even larger, depending on the complexity of the situation and context. To implement this customizable audio conferencing system in a cost-effective and efficient manner, considering human, computing and networking resources, it is of crucial importance that the multimedia services are dynamically and easily composable or even configurable for different situations [6].

In summary, the basic issues of discovering and selecting adequate services, customizing and executing them within a complex workflow are quite similar to what is currently discussed in the Web Services community. Thus, importing basic techniques and standards can be expected to result in an instant benefit for multimedia service design. However, unlike more static (and basically stateless) Web services frameworks, multimedia applications cannot simply compose a fixed chain of services for a specific application. Multimedia semantics will have a direct impact on composition frameworks. Not only may the meta-data change (like the media format after transcoding) and thus different services for further processing are needed, but services often have to be composed into more complex patterns (e.g. for synchronization of media streams) and also Quality of Service guarantees are more difficult to enforce.

Therefore, it is absolutely necessary to start exploring multimedia service composition problems as a specific topic, including components, meta-data descriptions and their mutual dependence within value-adding workflows. An especially important issue is the *interoperability support* for multimedia service composition ranging from *semantic-based discovery* of services, *consistency protocols* to compose services in a consistent fashion; *service routing* and *QoS support* during the composition process, to *meta-data expressions and representations* which include the Web semantics and sophisticated multimedia characteristics.

3. BRAVE NEW TOPIC SESSION GOAL

The major goal of this session is to raise awareness about the multimedia service composition problem. In doing so, we will not only benefit the community in getting a better grasp on complex applications, (meta-)data and the dependencies involved, but also can pave the way towards service-oriented multimedia applications design, and scalable, easy-programmable and flexible construction of large scale multimedia applications with maximum reusability.

To learn from Web concepts and bring to multimedia all that is useful, as well as to emphasize the differences and problems that multimedia service composition must solve outside of Web scope, topics need to be pursued such as

- integration of Web and multimedia service composition frameworks,
- service routing and aspects of distribution,
- role of service discovery in dynamic composition,
- semantic enhancements for discovery/selection, service capability ontologies
- service composition and meta-data representation,
- service interoperability and interface design,
- service level agreements and QoS issues,
- multimedia service personalization and customization,
- multimedia application decomposition and modeling,
- multimedia process workflows and service composition lifecycles.

In this special session we can only touch up on some of the topics. We will set the stage for the specific nature of composition problems in multimedia applications and present some first preliminary results and experiences when dealing with multimedia data. The session will also present important aspects of more general service composition frameworks from the networking and Web services composition research domain. Thus, we aim to show today's state of the art and discuss how approaches from the Web community can help to support solutions for multimedia service compositions. Especially, we anticipate that both communities will exploit the rich semantic information and flexibly support even more complex workflows.

4. REFERENCES

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