Multimedia Content Adaptation

David Knight
Brunel University, UK

Marios C Angelides
Brunel University, UK

INTRODUCTION

The previous decade has witnessed a wealth of advancements and trends in the field of communications and subsequently, multimedia access. Four main developments from the last few years have opened up the prospect for ubiquitous multimedia consumption: wireless communications and mobility, standardised multimedia content, interactive versus passive consumption and the Internet and the World Wide Web. While individual and isolated developments have produced modest boosts to this existing state of affairs, their combination and cross-fertilisation have resulted in today's complex but exciting landscape. In particular, we are beginning to see delivery of all types of data for all types of users in all types of conditions (Pereira & Burnett, 2003).

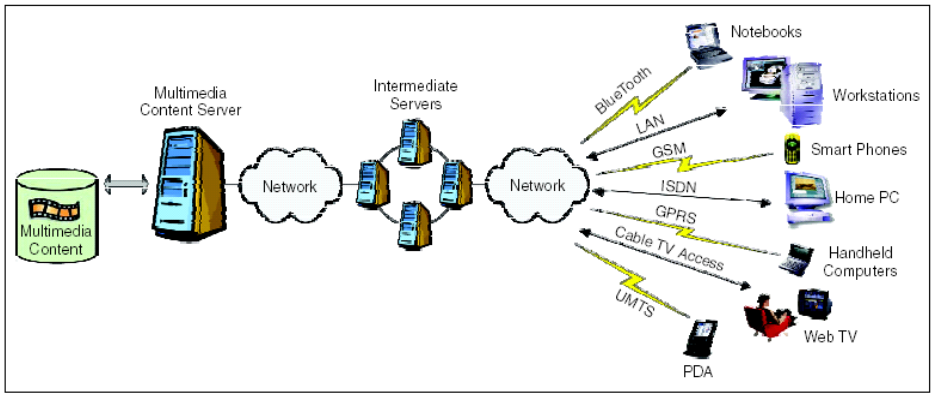
Compression, transport, and multimedia description are examples of individual technologies that are improving all the time. However, the lack of interoperable solutions across these spaces is holding back the deployment of advanced multimedia packaging and distribution applications. To enable transparent access to multimedia content, it is essential to have available not only the description of the content but also a description of its format and of the usage environment in order that content adaptation may be performed to provide the end-user with the best content experience for the content requested with the conditions available (Vetro, 2003).

In the following sections, we will look at the background of multimedia content adaptation, why do we require it and why are present solutions not adequate. We then go onto the main focus of the article, which describes the main themes of modern multimedia content adaptation, such as present day work that defines the area and overviews and descriptions of techniques used. We then look at what this research will lead to in the future and what we can expect in years to come. Finally, we conclude this article by reviewing what has been discussed.

BACKGROUND

More and more digital audio-visual content is now available online. Also more access networks are available for the same network different devices (with different resources) that are being introduced in the marketplace. Structured multimedia content (even if that structure is still limited) increasingly needs to be accessed from a diverse set of networks and terminals. The latter range (with increasing diversity) from gigabit Ethernet-connected workstations and Internet-enabled TV sets to mobile video-enabled terminals (Figure 1) (Pereira & Burnett, 2003).

Figure 1. Different terminals access multimedia content through different networks



Adaptation is becoming an increasingly important tool for resource and media management in distributed multimedia systems. Best-effort scheduling and worst-case reservation of resources are two extreme cases, neither of them well-suited to cope with large-scale, dynamic multimedia systems. The middle course can be met by a system that dynamically adapts its data, resource requirements, and processing components to achieve user satisfaction. Nevertheless, there is no agreement about questions concerning where, when, what and who should adapt (Bormans et al., 2003).

On deploying an adaptation technique, a lot of considerations have to be done with respect to how to realise the mechanism. Principally, it is always useful to make the technique as simple as possible, i.e., not to change too many layers in the application hierarchy. Changes of the system layer or the network layer are usually always quite problematic because deployment is rather difficult. Generally, one cannot say that adaptation technique *X* is the best and *Y* is the worst, as it highly depends on the application area.

The variety of delivery mechanisms to those terminals is also growing and currently these include satellite, radio broadcasting, cable, mobile, and copper using xDSL. At the end of the distribution path are the users, with different devices, preferences, locations, environments, needs, and possibly disabilities.

In addition the processing of the content to provide the best user experience may be performed at one location or distributed over various locations. The candidate locations are: the content server(s), any processing server(s) in the network, and the consumption terminal(s). The choice of the processing location(s) may be determined by several factors: transmission bandwidth, storage and computational capacity, acceptable latency, acceptable costs, and privacy and rights issues (see Figure 2).

Present adaptation technologies concerning content adaptation mainly focus on the adaptation of text documents. Therefore, one text document will be adapted on demand to the capabilities of different devices or applications. To fulfill this functionality the structure of the content must be separated from its presentation, i.e., the source document is structured using XML (Extensible Markup Language) and then dynamically processed to generate a presentation tailored to the available resources. One possible use case scenario will be to present the same information either on a standard Web browser or a WAP browser.

Efficient adaptation requires that the participating components know from each other and take advantage of adaptation steps done by other components, which needs standardised media, metadata, and communication. Several standardisation bodies (W3C, MPEG, and WAP) have already been established or are currently under development, which have recognised the need to create a framework that facilitates the efficient adaptation of content to the constraints and preferences of the receiving end.

MPEG-7 (ISO/IEC 15938-5:2002) provides tools for content description, whilst capability description and negotiation is provided for with CC/PP (Composite Capabilities/Preference Profiles, 2003) and UAProf (WAG User Agent Profile, 2001). MPEG-21 (ISO/IEC JTC 1/SC 29/WG 11), the "multimedia framework" includes Digital Item Adaptation (DIA), which enables standard communication of dynamic adaptation of both media resources and

Figure 2. Adaptation may be performed at different places