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Product Placement Platform for Personalised Advertising

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Abstract: **This paper proposes an integrated approach to personalised product placement involving advertisers, content distributors and viewers. This problem, which is a current challenge for media content producers and distributors, concerns the adaptation of the media content stream with personalised advertising in near real time. Our approach relies on a brokerage and product negotiation platform to match viewer profiles with products descriptions and relegates the actual product placement, *i.e.*, the product rendering process, to the viewer platform. In this scenario, advertisers create and describe product advertisement objects together with the intended target audience using Moving Picture Experts Group (MPEG) standards and a pre-defined metadata schema, while distributors perform viewer profiling and provide viewers with data streams, including personalised products.**

Keywords: Product Placement, Advertising, Profiling, Brokerage, Negotiation

1 INTRODUCTION

Near real time personalised advertising is a major research and technological challenge involving advertisers, media content distributors and end viewers [1][6][11]. On the one hand, advertisers want to place their ads in the viewer streams for the lowest price possible and, on the other hand, content distributors wish to sell places in their viewer streams for products matching the viewer profiles. In order to achieve this goal, distributors invite advertisers with products matching the viewer profiles for negotiation, chose those who are willing to pay more and, finally, send the negotiated products to the viewer platform.

This personalisation process must be seamless for the end viewer. Our proposal for personalised product placement integrates: (*i*) business-to-business (B2B) brokerage and product negotiation between advertisers and distributors; (*ii*) viewer profiling (on the distributor side); and (*iii*) product placement in the viewer stream (on the distributor and viewer sides).

In terms of contributions, we have so far designed and developed: (*i*) a brokerage and product negotiation platform where advertisers and distributors establish brokerage and product Service Level Agreements (SLA) to access to the corresponding services based on a distributed trust model; and (*ii*) a viewer profiling system on the distributor side which builds the profiles based on the viewer interactions (watched and/or rated programmes) and context (time).

To complete our vision, we still need to address two stages: (*i*) product creation and description; and (*ii*) product composition and rendering in the viewer platform. The rendering process is intended to take place at the viewer platform (set top box, computer with screen casting, *etc*.). In particular, the objects location (time and space) should defined in a scene graph document which is transmitted with the source video. This document would, then, be updated in accordance with the selected placements, and utilised by the set top box for the final decoding and rendering.

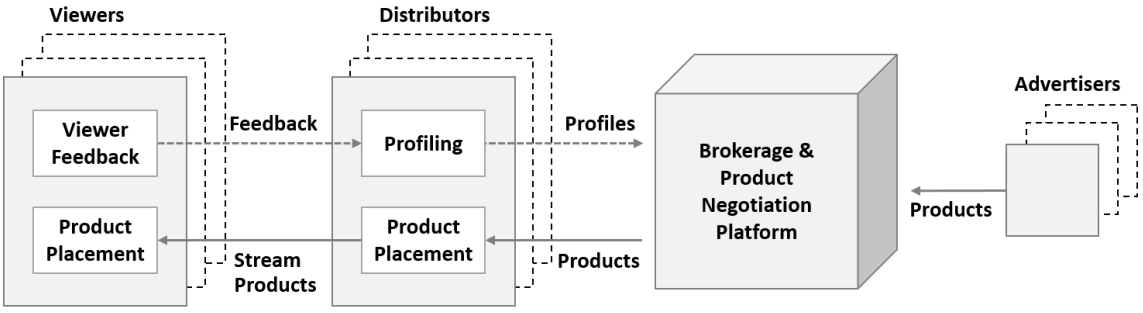

Figure 1: Figure caption

In terms of organisation, this document contains five sections. Section 2 is dedicated to the viewer profiling service. It introduces the most relevant viewer profiling concepts as well as describes the implemented algorithm. Section 3 describes

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our approach, including the platform architecture and services. Section 4 describes the proposed product placement mechanism. Finally, Section 5 enumerates the achievements and proposes future developments.

2 DATA MODELLING

In our first platform prototype, viewers, programmes and media objects are represented through taxonomies. In particular, viewers and programmes are represented by a taxonomy inspired in the BBC programme categories [7], ads use a taxonomy based on the Yellow Pages classified ads categories [8] and the advertised products are additionally classified using the United Nations Standard Products and Services Code (UNSPSC) taxonomy [9].

2.1 Viewer Profiling

The distributors or broadcasters, typically triple play operators, build viewer profiles base on the viewer generated data, which includes watched and rated programmes. In particular, dynamic viewer profiling, *i.e.*, the ability to build and update profiles based on the continuous stream of viewer interactions, can be addressed as stream mining [12]. Our profiling system builds dynamic viewer profiles using stream mining techniques based on the rated and watched programme events generated by the viewer.

In particular, the dynamic viewer profiling involves: (*i*) the creation of the initial reduced model based on the training dataset, using the Singular Value Decomposition Data Mining algorithm; and (*ii*) the continuous model update, utilising Stream Mining techniques to avoid re-building the model every time a new event occurs, resulting in an incremental user profiling learning methodology. Specifically, the stochastic gradient descent function, which is a well-known Machine Learning technique, was used for the model updating.

We build two viewer profile models: an implicit feedback positive model based on viewer watched programmes and an explicit feedback model based on viewer rated programmes, using the BBC programme categories taxonomy to facilitate the matching between products and viewers. The prediction is generated by a collaborative filter using the positive and rated models.

3 BROKERAGE & PRODUCT NEGOTIATION PLATFORM

Our brokerage and product negotiation platform is a multi-agent system structured in four layers that models the B2B processes involving advertisers and distributors: partner lookup, invitation and product negotiation [16]. Figure 2 displays the overall platform architecture composed of an interface, agreement, business and a market layer holding, for each registered business, one interface agent, one agreement agent, one business representative agent and multiple ephemeral delegate negotiation agents. In addition, the platform supports the creation of coalitions of advertisers, called virtual providers, to provide collections of products matching a given viewer profile.

Several types of negotiation protocols are implemented in the market layer, *e.g.*, different auction and contract net protocol variations. The behaviour of the business representative agents, including their negotiation strategies, is defined using the business process model and notation (BPMN) standard.

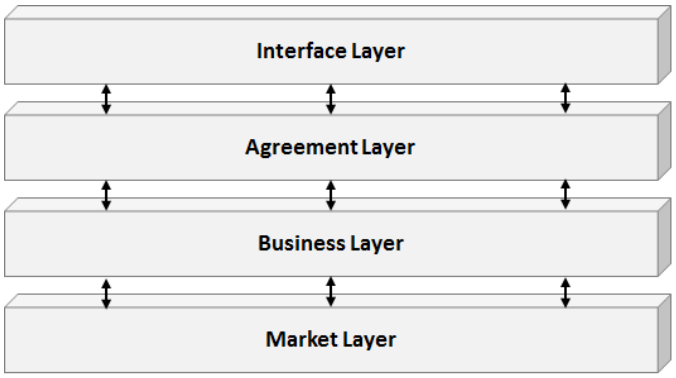

Figure 2: Brokerage Platform Architecture

The platform follows a Service Oriented Architecture (SOA) where all services provided are registered and classified, using a dedicated taxonomy, in the platform Universal Description, Discovery and Integration (UDDI) service registry.

The platform offers brokerage – partner and product lookup – and product negotiation – product selection – services to advertisers and distributors. The advertisers choose the products to negotiate with the distributors based on the viewer profiles, using the matching service.

The selection of relevant products for viewers is based on taxonomy matching between content profiles uses several technologies (see [6]). The personalisation of the source content can additionally adapt the video or audio according to the viewer context, *e.g.*, time, location and mobility factors. Media adaption can also consider the input and output devices, *e.g.*, the use of multi-screening, sensors for the recognition of user situations or several displays, including the viewpoint of objects in 3D.

3.1 Distributed Trust Model

The platform creates and maintains a distributed decentralised trust model, including self and partner models. Each entity (platform, distributor and advertiser) builds these local models based on their past common interactions, *i.e.*, the ratio of successful invitations, negotiations and fulfilled SLA. While distributors and advertisers hold a partial incomplete trust model of their counterparts, the platform is in a unique position as it keeps a global and complete trust model of all businesses. The platform and businesses use this model to support the partner lookup and invitation service as well as the SLA negotiation services.

3.2 Service Level Agreement Negotiation

Since the platform offers partner brokerage and product negotiation services (for single and collections of products), there are three types of SLA: brokerage SLA (bSLA), specifying the brokerage service terms, coalition SLA (cSLA),

specifying the terms of the provision of a collection of products from different providers trough the creation of a virtual provider, and resource SLA (rSLA), defining the terms under which the product is to be placed in the viewer stream. The platform negotiates and establishes Service Level Agreements (SLA) between advertisers and distributors regarding the products to be placed in the viewer streams [17]. Additionally, for each business registered in the platform, the bSLA defines the brokerage service provisioning terms under which the individual rSLA are established.

Figure 3 represents the hierarchical dependency between the different types of SLA. A bSLA (dark grey) defines the brokerage service terms accorded between a business (real or virtual) and the platform; a cSLA defines the terms governing a coalition of providers (medium grey virtual provider); an rSLA (lighter grey) establishes a resource provision contract. Thus, when two businesses (provider and consumer) establish a resource provision contract (rSLA), they must first fulfil the terms of their bSLA plus, in the case of a virtual provider, the established cSLA. In the case of rSLA, advertisers act as product providers and distributors as product consumers, in the case of cSLA, advertisers are product providers, whereas, in the case of bSLA, the platform is the service provider and the businesses (advertisers and distributors) are the consumers.

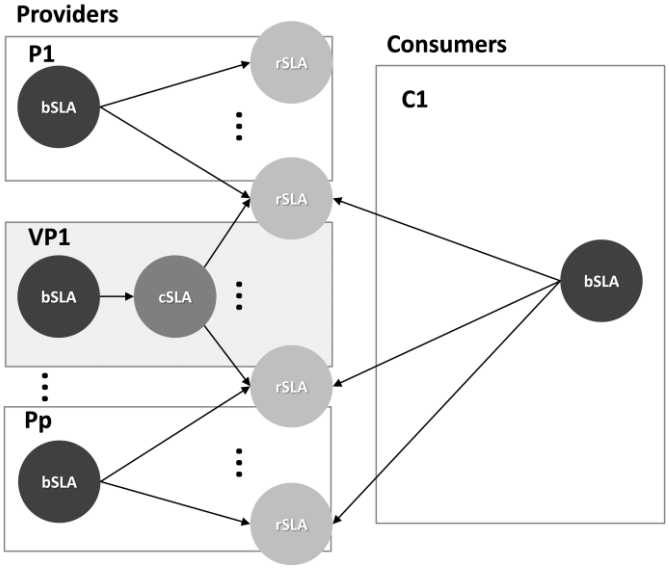

Figure 3: SLA Relationships

At the SLA level, the platform provides: (*i*) bSLA, cSLA and rSLA templates; (*ii*) bSLA (re)negotiation using the WS-Agreement bargain negotiation protocol; (*iii*) cSLA and rSLA negotiation follows the WS-Agreement Negotiation specification and adopts the Foundation for Physical Intelligent Agents (FIPA) Iterated Contract Net Interaction Protocol (FICNIP).

In terms of the business model, although all services are provided generically under the pay-per-use model, the celebrated rSLA remain latent till the products are placed, rendered and viewed by the viewer. Only then, the corresponding rSLA are enforced.

The negotiation of rSLA includes the duration of the product placement (number of frames), the trust between the potential business partners and the price. The (re)negotiation of bSLA considers the duration of the contract as well as the success and trust of the business in the platform.

Figure 4 describes the SLA life-cycle state: template SLA (Temp), partially instanced SLA (Inst), under negotiation SLA (Nego), under enforcement SLA (Enfo) and terminated SLA (Term). The state transitions are event-driven: (*i*) if a provider accepts a consumer invitation, the provider partially instances a SLA template (Temp to Inst); (*ii*) if the consumer initiates the negotiation, the provider and consumer try to define the SLA terms (Inst to Nego); (*iii*) if they reach an agreement, the SLA is established; (*iv*) if the service is actually provided, the SLA is enforced (Nego to Enfo); (*v*) if the SLA duration is reached, the SLA terminates (Nego to Term); (*vi*) if the SLA enforcement fails, the SLA terminates (Enfo to Term); and (*vii*) if the provider or consumer wishes to renegotiate the service, the SLA is renegotiated (Term to Nego).

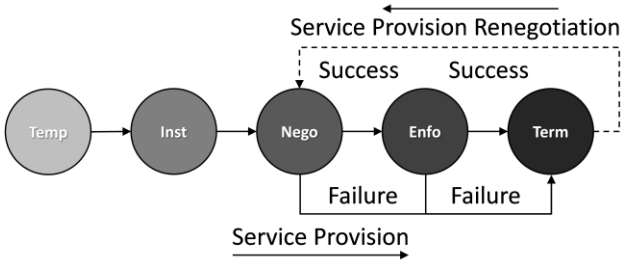

Figure 4: SLA Life Cycle

4 PRODUCT PLACEMENT

This work assumes that the video stream content is described using a standard metadata system (*e.g.*, MPEG-7). The metadata includes placements and descriptions of the object-based media to be traded and rendered into the final video stream in accordance with a scene graph document, which is delivered alongside the original source video. The proposed approach relies on object based media video technology, allowing media objects (audio or video) to be rendered into the source content. The rendering process is intended to take place at the viewer platform (set top box, computer with screen casting, etc.). In particular, the objects location (time and space) should defined in a scene graph document which is transmitted with the source video. This document would, then, be updated in accordance with the selected placements, and utilised by the set top box for the final decoding and rendering. The placement objects may be required subsequent image processing to match the object into the source video, for example for scaling and perspective, for colour balance, shadowing and reflectivity.

There are a number of use cases for object placement for personalisation in broadcast media. These include personalised documentaries, shows and education and training. The case presented in this paper is for personalised product placement. Targeted advertising has been a commercial venture for broadcast playouts for a number of years [1][20],

and product placement [4][21] has also been common practice in many territories. However, the proposal here allows for placements to be personalised to the end viewer. The viewer profile is instrumental in the selection of placement to be inserted in the programme playout.

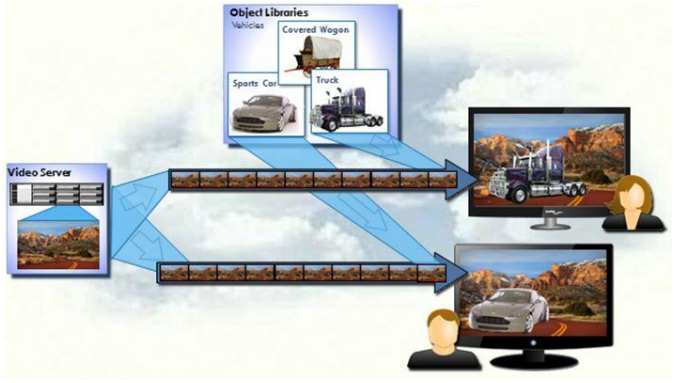

Figure 5: Product placement

Figure 5 represents the product placement process. The selection of products depends on (*i*) the viewer profile, (*ii*) the context of the source content, and (*iii*) the available candidate objects for placement. These last two items require an accurate description of the source content and the placements available under the form of metadata. So, the selection process is basically a three-way correlation of these items. Consequently, the selection process is heavily reliant on descriptive metadata for both the source content and externally produced placements.

4.1 Object Based Media

The proposed approach relies on object based media video technology [22][10]. Audio and video objects may be produced independently of the source content for selection at playout time and insertion into the content. Objects are rendered into the source, typically at the viewer platform (set top box, computer with screen casting, *etc.*). An alternative may be cloud rendering with the personalised stream transmitted to the viewer, although this is less flexible than rendering at the viewer's platform.

The objects location (time and space) should be defined in a scene graph document, which is transmitted with the source video. An example of scene graphing is Binary Interchange Format for Scenes, BIFS [23], as specified for MPEG-4 media [18]. However, we advocate that for further development for interactive and personalised media, a revised version of the standard should be considered.

4.2 Metadata

As discussed above, media items require a fine-grained description to allow placement objects to be accurately defined for the selection process. The source material will also require accurate description of the requirements and restrictions for any candidate placement for each placement opportunity in the source. This may also allow for the producer of the content to maintain an editorial integrity over the content and only allow placements which complement the source. For example, the placements should not contradict or detract from the plot of a screen play, *etc.*

Whilst there are a number of metadata standards currently utilised for broadcast content, for example European Broadcasting Union (EBU) Core [19], we advocate that content description needs for personalisation and user interaction need further extension and the most like standard is MPEG-7 [1][2].

The metadata includes placements and descriptions of the object-based media to be traded and rendered into the final video stream in accordance with a scene graph document which is delivered alongside the original source video.

4.3 Playout Operation

The scene graph originally specified for the source content would need updating to be received and interpreted by the user platform. The new scene graph contains data in accordance with the selected placements, and is utilised by the set top box for the final decoding and rendering.

The placement objects may require subsequent image processing to match the object into the source video, for example for scaling and perspective, for colour balance, shadowing and reflectivity. This work assumes that the video stream content is described using a standard metadata system (*e.g.*, MPEG-7).

4.4 Product Composition and Rendering

The viewer's platform (set top box, PC, dongle for casting, *etc*.) receives the source video and the selected object placements. The video objects may be static images or (more likely) short movie sections of the object (for example, a moving car, galloping horse, *etc.*) with transparent edges (*i.e.*, the alpha channel for transparency). Audio objects are audio files, typically MPEG Layer-3 Audio (MP3), Advanced audio Coding (AAC), *etc*. As these are received the viewer platform needs to assimilate these along with the scene graph document received. The scene graph document may be an overall document delivered to the user at the start of the video, or more likely, a continuing document updating the video playout. Consequently, standard codecs (H.264/5, VP9, MP3, AAC, *etc*.) are required to decode the objects. The objects are then correlated with the source video in terms of time and space. This time and spatial relationship is determined by the scene graph document and will be utilised by the viewer platform for object insertion. For example, audio objects will commence playing at a specific minute/second (or time code) off the source video, and their spatial location may be in respect of a 5.1 audio field; this location may vary as the object may move in a sound field space. Video objects will similarly be inserted at a specific time, and will be placed spatially in an *x*, *y* coordinate location. Again, this spatial location may move depending on the requirement for that object behaviour in the scene, for example the video object may undertake motion and so may be subject to motion-vector values as dictated by the scene graph.

The rendering of the objects into the playout (*i.e.*, the derived pixel array for the screen) is a standard video rendering operation. Standards for video rendering may need revision for this operation, and will be a major consideration for the research work.

5 CONCLUSIONS

We have designed and developed a viewer profiling service for data streams, which builds automatically the viewer profiles, and an electronic brokerage and product negotiation platform which returns, based on the viewer profiles, personalised products to be placed into the viewer stream. In order to materialise our vision for near real time personalised product placement, we are in the way to implement the last component: the proposed product placement approach.

The outcome of this work has been applied to other scenarios than advertising, *e.g.*, to generate personalised Electronic Programme Guides (EPG) [7].

In terms of future developments, we intend to explore the possibility of enabling user interactivity, *i.e.*, update the scene graph based on the user feedback by re-rendering the objects in different positions. If this information is fed to a number of connected group-member viewers, a collaborative interactive activity may be realised. The personalisation, in this case, would be in accordance with a range of connected users. Consequently, we intend to introduce the concept of group profiling to enable the selection of a relevant colection of placements for a number of viewers based on the virtual provider concept, *e.g.*, a group simultaneously viewing group-personalised content. We envisage the application of the latter approach to personalised documentaries & informational content, personalised training/education or entertainment & gaming shows and content.

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