MPEG-21 UD: A SOLUTION FOR HORIZONTAL INTEGRATION OF MEDIA RECOMMENDATION SYSTEMS

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ABSTRACT

Nowadays the amount of contents and services available on the Internet is awesome. This availability has had the merit to greatly enrich the multimedia user experience. Nevertheless, it has made the ability to match his/her needs more and more complex. Consequently, in recent years market-leading search engines have been augmented with "recommendation systems". By interacting with a given application, a specific user can receive tailored contents/services thus experiencing an enhanced fruition. Nevertheless, if the user is not satisfied, he/she is forced to open a different application which will possibly recommend different contents/services. By moving from an application to another one, no information about historical activity of the user are exploited: each application "vertically" provides its recommendations. Consequently, the user may experience a fragmented and deteriorated fruition. The MPEG-21 "User Description" (MPEG-21 UD) standard formalizes interoperability between different recommendation systems. By exploiting the availability of standard descriptions, a given application can integrate "horizontally" recommendations from different sources, thus making more fluid and satisfactory the user experience.

INTRODUCTION

Nowadays, the availability of large-scale data poses serious limitations in terms of usability. According to Kosner (1), in the last few years, an overwhelming growth in the number of services and multimedia contents accessible on the Web has been observed. Together, the amount of smart devices and Internet users has reached an impressive size. A recent study by Cisco (2) argues that, by 2019, 5.2 billion global mobile users and 11.5 billion mobile-ready devices and connections will be foreseen.

In order to better match user needs and improve his/her experience, recommender systems can be adopted. By suggesting potentially interesting or useful items to users, these systems are aimed at addressing the information overload problem. Nevertheless, the accuracy of recommendations a user receives might strongly affect the quality of his/her experience. During an ordinary session, a generic user likely enjoys several contents and services. These might belong to different "domains", namely different items (e.g. "movies", "books" etc.) or genres (e.g. "action", "comedy", etc.). In addition, these contents might be provided by vertical and closed[1] systems, e.g. different departments of the same provider, or, by independent providers. So, in the attempt of satisfying user

[1] namely, not exposing standard interfaces

needs, these stakeholders (internal or external to a given company), “vertically” return to him/her distinct recommendations, i.e. recommendations not mutually related and restricted to specific and separated domains (e.g. Netflix suggests movies or TV series, Youtube suggests music songs, etc.). This vertical approach might impact on the overall quality of the user experience. It is clear that alternative solutions to these issues are needed: on one hand, new business models (which, to date, have been lacking) focused on “horizontal” agreements between different stakeholders are expected; on the other hand, exchanging standard information among these stakeholders should be taken into account.

Regarding the opportunity of testing new business models, two recent initiatives face the journalism challenges: *Instant Articles*[2] and *Digital News Initiative*[3]. In the former, Facebook aims to “*transform the way users read news articles*” and has signed up different media companies and publishers (BuzzFeed, the New York Times, National Geographic, NBC News and The Atlantic, BBC News, the Guardian, Bild and Spiegel). In the latter, “*Google will work hand in hand with news publishers and journalism organizations* (Les Echos, FAZ, The Financial Times, The Guardian, NRC Group, El Pais, La Stampa, Die Zeit) *to help develop more sustainable models for news*”. Both initiatives are aimed at merging services provided by multiple publishers. Nevertheless, in any of these initiatives there is an explicit task to ensure recommendations across different domains and/or partners. In the last few years, c*ross-domain* recommendation algorithms have been proposed to address the *cold-start* issue, thus improving accuracy, offering serendipity, and enhancing user models. See for example the works by Deng et al (3), Tobiias et al (4), Abel et al (5). A generic *mediation* mechanism for integrating user modelling data was proposed by Berkovsky et al (6). The mediation mechanism is aimed at facilitating interoperability between recommender systems thus providing more complete and usable recommendations to the users.

Bringing this approach further, the MPEG-21 User Description standard (MPEG-21 UD) (7) aims at ensuring the interoperability between recommendation engines of different stakeholders thus enhancing recommending accuracy and improving the user experience. MPEG-21 UD does not standardize the way in which recommendation engines work, i.e. algorithms adopted to generate the recommendations (e.g., collaborative and/or content-based filtering). Rather, it defines standard descriptions about a given user, his/her context, the services and/or the items he/she has enjoyed and other information that can be relevant for the purpose of recommendation. Additionally, by defining standard descriptions of the recommended items it allows for a more efficient cross-domain and cross-service integration of recommendations.

The rest of the paper is organized as follows: we first outline the basics of MPEG-21 UD standard; then we briefly describe two reference use cases, namely a Web based service involving news recommendations, and a personalized hybrid digital media service; finally we give some examples of standard descriptors before some concluding remarks.

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[2] “Introducing Instant Articles” - http://media.fb.com/2015/05/12/instantarticles/

[3] “Google offers cash support to Europe's news groups” - http://www.bbc.com/news/technology-32486019

MPEG-21 UD

A brief description of MPEG-21 UD is here provided. The formats and the interfaces across which the different and separate components exchange information are shown. In addition, the interoperability between different Recommendation Engines is highlighted.

Conceptual model

The aim of MPEG-21 UD is to enable the horizontal integration of Recommendation Services that provide standard, i.e. compatible, recommendations. By a proper integration of standard recommendations, a generic service provider can return to the user a richer and enhanced fruition thus greatly matching his/her needs. To achieve this goal, input/output data formats of a recommendation engine need to be modelled appropriately. Fig. 1 shows the model developed by MPEG-21 UD.

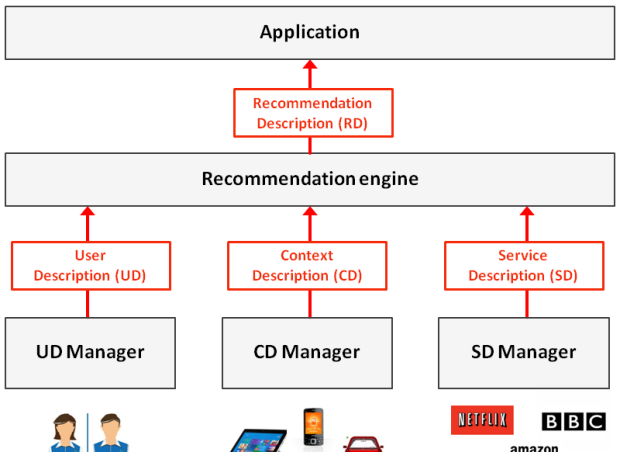

Fig. 1. Conceptual Model of MPEG-21 UD. UD/CD/SD/RD (red) indicate the formats specified by MPEG-UD. Description Managers, Recommendation Engine and Application (black) are out of the scope of the standard

The input formats include: (i) a Description of the User seeking recommendation (UD). UD descriptors contain e.g. static and dynamic information about the user, the history of the user's interactions, preferences, security settings regarding these information, etc.; (ii) a Description of the Context in which the User operates (CD). CD descriptors provide information about the user operational environment, such as the used device, physical position, temperature, humidity, sound level, etc.; (iii) a Description of Services offering content sought by the User (SD). SD descriptors contain information about the service (or a set of sub-services), that is offered to the end-user application (e.g. music tracks on demand, newscasts, etc) and the objects (e.g., multimedia items) offered by the service.

The output format, called Recommendation Description (RD), includes: (i) subsets of UD/CD/SD, which are the actual recommended items together with information about what role these items play in the recommendation; (ii) additional logical relations linking recommended items (e.g. a ranked list specifying a preference order of the recommended items and other similar structures); (iii) descriptive metadata related to the recommended items expressed using MPEG-21 DIDL (8) mechanism. RD descriptors include e.g. the recommended objects and the services by which they are provided (such as an audio interview provided by a broadcaster's website), descriptive information about the recommended items or additional logical relations among the recommended items.

In addition, Fig. 1 also shows other components that are out of the scope of MPEG21-UD, but play some specific roles in the model:

- UD/CD/SD Managers: entities that provide functionalities of filtering, accessing, storing, editing, updating and securing UD/CD/SD. Even the implementation of these Managers is out of the scope of MPEG-21 UD, their functionalities are

absolutely fundamental. For example, the UD Manager can ensure the authentication/authorization of the user accessing Web applications and/or IP-connected media devices. Additionally, leveraging the UD Manager, the user can actively and at any time choose of sharing (totally, partially or not at all) his/her personal data. He/she can actively and any time choose the Service(s) Provider(s) with whom his/her experience can be shared. In conclusion, the UD Manager allows for dynamically implementing his/her personal policies.

- Recommendation Engine: a process (or a set of processes) in charge of exploiting all available information contained in UD, CD and SD to produce a compact information, i.e. RD, for the enriched user experience. Since implementation details of the Recommendation Engine are out of the scope of MPEG-21 UD each service provider (e.g. a broadcaster) can implement internal logics without making it available to third parties, thus protecting proprietary information about e.g. developed algorithms. On the other hand, standard descriptions of the given recommendation can be exchanged.

According to the given overview, MPEG-21 UD allows for the opportunity, for a generic provider, of exploiting the availability of standard recommendations belonging to different Recommendation Engines. Further detail is given in the following subsection.

Implementing Interoperable Recommendation Engines with MPEG-21 UD

The opportunity for a content provider of horizontally integrating standard descriptions compliant to multiple and distinct recommendations is here highlighted. Let a given user start his/her fruition with a generic Service Provider, by using a whatever device and using an application client software (see Fig. 2). Without losing generality we here assume that appropriate mechanisms are put in place to ensure that the application is aware about the identity of the user, e.g. through the application of one of the several authentication schemes and protocols existing for generic platforms (SSO, CPA, etc). Once the application has received information about the user and his/her context, namely in UD and CD format, an external recommendation service is enquired. In fact even if the Service Provider can have its own internal Recommendation Engine, it can request the auxiliary functionalities of *n* different and external Recommendation Engines in order to enhance the user experience with richer information. According to the policies set by the user in terms of availability of his/her information to external applications, the Service Provider can forward UD, CD descriptions (or subsets of them) and its own SD description to these Engines. These Engines can adopt any internal logic to return to the Service Provider a set of standard recommendations, namely RD_1, RD_2,..., RD_n. At this point, according to an internal integration logic, the Service Provider can integrate the received items and return to the user an enhanced recommendation service.

USE CASES

This section contains a description of two real-life use cases to further illustrate how MPEG-21 UD can be adopted. As basically MPEG-21 UD is a set of metadata schemes, it is “agnostic” to the underlying technologies. The first use case represents a Web based service involving news recommendation. The second, a personalized service based on hybrid digital media distribution concepts. Some references to the standard descriptors (namely UD, CD, SD and RD) applicaple in the presented use cases are provided. Finally, an example of XML instance for RD is given.

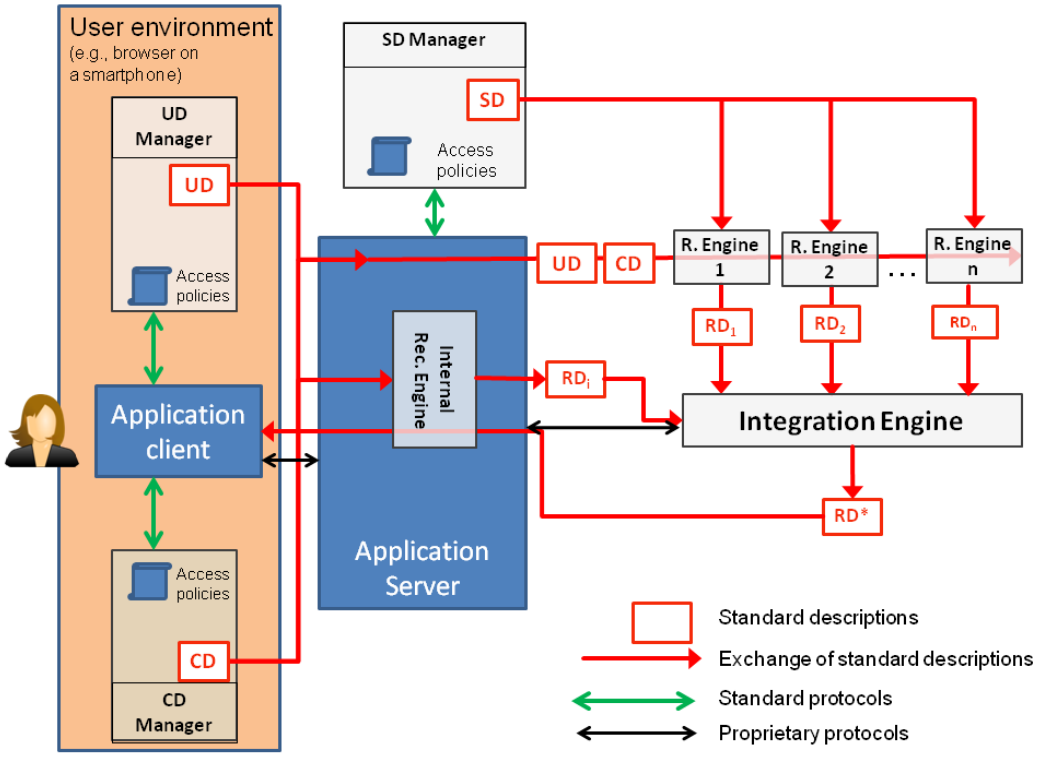

Fig. 2. MPEG-21 UD ensures the interoperability between different Recommendation Engines

Web-based news recommendation

The use of online news is an extremely popular phenomenon. However, the availability on a daily basis of a wide variety of information sources generates a disproportionately high amount of texts and videos that makes it impossible for users to read and/or watch everything that is published. News content recommendation aims at satisfying specific user's news interests, while minimizing efforts in searching for the desired information. There have been a number of services supporting recommendation of news items over the years, as reviewed by Özgöbek et al (9). However, news recommendation is a challenging task because of the high dynamicity of contents and users' interests. Also some news items may be linked with each other by complex relations, building a huge knowledge graph extremely difficult to navigate by the user. In view of these considerations, recommending the *right* content items to each individual user is a very complex process since it requires knowledge about the user, the items, temporal and contextual information. MPEG-21 UD can be effectively adopted to simplify the integration and interoperability of news recommendation services across the Web. Let us consider the following example. Alice is an investment broker. Due to her job, she is interested in finance news. She is also a contributing editor of a weblog about economy. Once authenticated, Alice interests can be inferred by the blog provider by processing her blog posts. This mechanism grants continuously updated data in real time (i.e. live), and allows to track down the Alice's personal profile, by interpreting blog post contents as a reasonably good approximation of her interests. Based on this profile, easily representable in MPEG-21 UD elements, any external recommendation engine can be run to identify relevant similarities and correlations between the content enjoyed or generated by Alice and professional

information items coming from online newspapers, press services, and online TV channels (i.e. SD elements). These are then returned in standard RD format to Alice's frontend application.

Hybrid digital media services

MPEG-21 UD can be effectively adopted for issuing specific recommendations across different media platforms. The Hybrid Broadcast Broadband TV, referred to as "HbbTV", is an initiative for hybrid digital TV. Based on an industry standard by ETSI (10), it aims at harmonising the broadcast and broadband delivery of multimedia contents to generic users. In order to enhance the user satisfaction (and thus decreasing his/her tendency to switch channels), the linear programming (delivered through broadcast) can be properly enriched with personalized contents (delivered through broadband) thus providing users with a more personalized and enhanced experience. The recommendation effectiveness strongly depends on how the recommended content is relevant for the specific user: his/her precise description (history, context, etc.) is absolutely needed. In this context MPEG-21 UD allows to leverage additional information derived by different services he/she has used on different platforms (e.g., Web) , increasing the base of information for the recommender system.

A specific use case can be exemplified as follows. In the morning, Alice usually reads economic news on the Web before going to work. Before accessing the Web, she authenticates herself on her favourite news provider. The authentication allows Alice to receive news hints in agreement with her standard profile. Alice always authenticates herself so that she can enjoy a personalized schedule. Afterwards, being also a commuter, she takes the car and keeps on enjoying the news from other services on her mobile. References to news read by Alice are saved in her standard UD profile. Once she has come back at home, Alice switches on the TV. The scheduled broadcast programme is dynamically replaced by the business top news. After some minutes, Alice receives an advertisement about the initial public offering of a promising high-tech company: the content provider has asked for a recommendation to an external economic news provider sending it Alice's standard data, and receiving the advertisement. In summary, the HbbTV platform has effectively used Alice's profile information (expressed in MPEG-21 UD – UD and CD) to provide targeted contents in a standard way, using MPEG-21 UD - RD. Similarly to HbbTV, tailored recommendations can be arranged for the Hybrid content radio (HCR), defined by the Digital Radio Platforms group, DRP (11), of the European Broadcasting Union in February 2014.

EXAMPLE OF STANDARD DESCRIPTIONS

Table 1 shows an example of some standard descriptions defined by MPEG-21 UD and applied to the use cases briefly described in the previous sections. With respect to the Web-based news recommendation use case, Alice authentication on the blog platform is registered in her UD information, as `UD:userID` element. Her role as an editor is described by the `UD:Specialty` element.

Finally, the outputs of a generic content-analysis tool of her posts are included in the `UD:UsageHistory` element. The list of multimedia items

UD	CD	SD	RD
UserID	GeographicLocation	Provider	List
Specialty		ServiceName	OrderedMember
UsageHistory			Rank

Table 1. Some descriptors of MPEG-21 UD.

recommended to Alice is described in the RD, by the `RD:List`. Items are ordered (`RD:OrderedMember`) by relevance w.r.t. Alice interests (`RD:Rank`) and are provided with information about Service delivering / publishing them, e.g. `SD:Provider` and `SD:ServiceName`. Similarly, these standard descriptions can be applied to the hybrid TV use case. In addition, in this use case Alice is driving her car thus changing her physical position. This information is described in the `CD:GeographicLocation`. Below a sample instance of RD is given.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<rd:RD xsi:schemaLocation=" urn:mpeg:mpeg-rd:2014:01-RD-NS MPEG-UD-RD-ver3.0.xsd "
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:media="http://search.yahoo.com/mrss/"
xmlns:dcterms="http://purl.org/dc/terms/" xmlns:mpeg7="urn:mpeg:mpeg7:schema:2004" xmlns:sd="urn:mpeg:mpeg-
ud:2014:01-SD-NS" xmlns:ud="urn:mpeg:mpeg-ud:2014:01-UD-NS" xmlns:didl="urn:mpeg:mpeg21:2002:02-DIDL-NS"
xmlns:fo="http://www.w3.org/1999/XSL/Format" xmlns:rd="urn:mpeg:mpeg-rd:2014:01-RD-NS">
  <rd:CompactUsageDescription>
    <rd:List> <!-- The recommendation engine provides a list of ranked items -->
      <rd:OrderedMember>
        <rd:SetElement resourceID="i662195">
          <rd:Resource>
            <rd:ServiceDescriptionFragment serviceID="HMN"> <!-- Reference to service provider -->
              <sd:ServiceGeneralInformation>
                <sd:ServiceName>HyperMediaNews</sd:ServiceName>
                <sd:ServiceProviderName>RAIRadiotelevisioneItaliana</sd:ServiceProviderName>
              </sd:ServiceGeneralInformation>
              <sd:ServiceTargetInformation/>
              <sd:IsServiceAvailable>true</sd:IsServiceAvailable>
              <sd:ServiceObjectsInformation>
                <sd:DigitalItem> <!-- The first item of the list being recommended -->
                  <didl:Descriptor> <! - MPEG-21 DIDL information related to the item -->
                  <didl:Statement mimeType="String">
                          <![CDATA[ Ad annunciarlo è il presidente Fiumefreddo …]]>
                    </didl:Statement>
                    </didl:Descriptor>
                    <didl:Component><didl:Resource mimeType="text/html"
ref="http://palermo.repubblica.it/cronaca/2015/05/20/news/riscossione_sicilia-114868233/?rss"/>
                    </didl:Component>
          <sd:CreationInformation><mpeg7:Title> <![CDATA[<media:title type="plain">Riscossione Sicilia, revocati 314
legali</media:title>]]></mpeg7:Title><mpeg7:Creator><mpeg7:Role href="Publisher"/><mpeg7:Agent
xsi:type="mpeg7:OrganizationType"><mpeg7:Name> <![CDATA[La Repubblica]]>
</mpeg7:Name></mpeg7:Agent></mpeg7:Creator><mpeg7:CreationCoordinates><mpeg7:Date><mpeg7:TimePoint>2015-05-
20T21:29:00</mpeg7:TimePoint></mpeg7:Date></mpeg7:CreationCoordinates>
          </sd:CreationInformation>
                  </sd:DigitalItem>
                </sd:ServiceObjectsInformation>
              </rd:ServiceDescriptionFragment></rd:Resource></rd:SetElement>
<rd:Rank>0.744872</rd:Rank> <!-- User preference rank of this item according to the recommender engine -->
</rd:OrderedMember></rd:List></rd:CompactUsageDescription></rd:RD>
```

CONCLUSIONS

To date, user fruition of media can be strongly affected by vertical and possibly redundant recommendations coming from different service providers. Furthermore, in order to improve accuracy and appropriateness of cross-domain recommendations, standard descriptions about a given user and her context are needed, as well as interoperability between different recommendation results. In this paper we have illustrated how the emerging standard MPEG-21 UD addresses these issues: by allowing for the integration of recommendations provided by different engines, and, by defining standard descriptions for the users, their context and the services providing potentially interesting (i.e. recommendable) items. Adopting MPEG-21 UD standard descriptions, a service provider can properly integrate multiple recommendations thus enhancing its service and, likely, improving the user experience. Two real-life use cases, namely a web based service involving news recommendations, and a personalized hybrid digital media service have been described to further illustrate the concept.

REFERENCES

1. A. W. Kosner, “The Appification Of Everything Will Transform The World’s 360 Million Websites.,” *Forbes*, 2012.
2. *Cisco VNI Global Mobile Data Traffic Forecast, 2014 - 2019*. Cisco, 2015.
3. Z. Deng, J. Sang, and C. Xu, “Personalized video recommendation based on cross-platform user modeling,” in *Multimedia and Expo (ICME), 2013 IEEE Intl. Conf. on*, 2013.
4. I. Fernandéz-Tobiias, I. Cantandor, M. Kaminskas, and F. Ricci, “Cross-domain Recommender Systems: A Survey of the State of the Art.,” in *Proc. of the 2nd Spanish Conf. on Information Retrieval*, 2012.
5. F. Abel, S. Araujo, Q. Gao, and G. J. Houben, “Analyzing Cross-System User Modeling on the Social Web,” in *Web Engineering*, Springer Berlin Heidelberg, 2011.
6. S. Berkovsky, T. Kuflik, and F. Ricci, “Mediation of User Models for Enhanced Personalization in Recommender Systems,” *User Model. User-Adapt. Interact.*, 2008.
7. ISO/IEC CD 21000-22: Information technology – Multimedia framework (MPEG-21) – Part 22: User Description,” 2015.
8. ISO/IEC 21000-2:2003 - Information technology -- Multimedia framework (MPEG-21) -- Part 2: Digital Item Declaration.
9. O. Özgöbek, J. A. Gulla, and R. C. Erdur, “A Survey on Challenges and Methods in News Recommendation,” in *WEBIST 2014 - Proc. of the 10th Intl. Conf. on Web Information Systems and Technologies*, 2014.
10. ETSI, *TS 102 796, Hybrid Broadcast Broadband TV*.
11. EBU Strategic Programme on *Digital Radio Platforms,* https://tech.ebu.ch/groups/drp