NoTube

Networks and ontologies for the transformation and unification of broadcasting and the Internet

FP7 – 231761

D6.4 NoTube Integrated System
3rd Prototype

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EXECUTIVE SUMMARY
This document represents a companion to the third and final release of the NoTube integrated platform developed in WP6 with references to the application scenario prototypes implemented in the scope of WP7.

Chapter 1 provides the updated document outline.

Chapter 2 briefly describes the general architecture and the integration approach as already detailed in the past issues of this document. The final version of the NoTube User Portal has been added and presented with single functionalities description and related screenshots. Then the main services categories envisaged in the project are presented including updated contributions from R&D achievements (from WP1 to WP5), namely: user profile related, metadata related (conversion, enrichment and recommendation), content-related (audio and video processing and ingestion services) and services annotation (semantic service brokerage).

Chapter 3 presents the internal evaluation plan in terms of actors, goals, target groups and methodology focusing on field-specific issues like legacy systems and data/privacy protection. Results have been elaborated and included.

Chapter 4 has been added to include the market and technology evaluation focusing on hardware devices, delivery models, standards and, more in general, market trends that have influenced Consortium’s work, setting the basis for future potential improvements or extensions of the platform by providing a high-level comparison with the architectural and technological achievements.

Chapter 5 draws the conclusions while Annex I includes detailed reporting of the internal evaluation results.
This document presents the NoTube platform in terms of general architecture and integration approach perspective, offering an overview of the platform services as well as an outlook of the technologies offered by the market at the time of reporting. The evaluation plan and results for the abovementioned topics are included too.

The broad lines of the integration vision, including topics described here and in the previous versions of this same document such as legacy systems, Service Provider-Home Ambient interdependency, security and privacy preservation etc., are demonstrated by the final prototyping phase.

The description of the individual prototypes is not part of the integrated system deliverable, but instead of WP7.a/b/c, as the core activity of each foreseen test case.

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<td>AMI</td>
<td>Ambient Intelligence</td>
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<tr>
<td>EPG</td>
<td>Electronic Program Guide</td>
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<td>NIC</td>
<td>News Item Container</td>
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<tr>
<td>LOD</td>
<td>Linked Open Data</td>
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<tr>
<td>OWL</td>
<td>Web Ontology Language</td>
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<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
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<tr>
<td>PVR</td>
<td>Personal Video Recording</td>
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<td>RDF</td>
<td>Resource Description Framework</td>
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<tr>
<td>SEE</td>
<td>Semantic Execution Environment</td>
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<tr>
<td>SKOS</td>
<td>Simple Knowledge Organisation System</td>
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<tr>
<td>SOA</td>
<td>Service-Oriented Architecture</td>
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<tr>
<td>SOAP</td>
<td>Simple Object Access Protocol</td>
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<tr>
<td>SPARQL</td>
<td>Simple Protocol and RDF Query Language</td>
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<tr>
<td>STB</td>
<td>Set-Top Box</td>
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<td>SWS</td>
<td>Semantic Web Services</td>
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<td>Web Services Description Language</td>
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<td>WSMO</td>
<td>Web Service Modeling Ontology</td>
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<tr>
<td>XML</td>
<td>eXtensible Markup Language</td>
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<td>TV-A</td>
<td>TV-Anytime</td>
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1. Introduction

1.1. Document Scope

The aim of this document is to present an overview of the final NoTube integrated platform. While deliverable D6.1 is focused on the general architecture, applied to the three foreseen use cases, D6.2 and D6.3 describe the NoTube platform in terms of available services and integration mapping with respect to the general architecture. This final release (D6.4) still provides a summarised, updated overview of the platform services but introduces also the platform evaluation results from the broadcasters’ and developers’ perspective as well as the market and technology analysis compared to the project technical achievements, in light of future exploitation and re-engineering plans.

This document represents a companion to the third release of the NoTube integrated prototypes (WP7.a/b/c). It provides a broad description of NoTube in terms of overall capabilities, including currently available services (WP1-5). NoTube services have been implemented following a generalisation process on requirements that emerged from individual application scenarios. Detailed technical information such input and output parameters, software dependencies, and entry points for implemented NoTube services is now maintained through the dedicated online tool SmartLink (WP5) that enables also the semantic annotation required by the Broker to perform its internal activities.

1.2. Document Outline

This document is composed of four main sections: Chapter 2 presents the NoTube platform integrated architecture, including an overview of the services developed in the scope of the R&D workpackages, grouped in 4 main categories: user oriented, metadata oriented, content oriented and semantic oriented. Chapter 3 provides a synopsis of the NoTube platform evaluation results targeting broadcasters and developers with highlighted pros and cons, potential weaknesses and related suggested mitigation actions. Chapter 4 introduces a market evaluation in terms of available devices, delivery models and standards with the aim of providing a quick comparison with NoTube technical achievements in its final iteration. Finally, Annex I presents the detailed survey results of the evaluation phase described in chapter 3.
2. NoTube Platform

2.1. Architecture Overview
The following picture provides the consolidated overview of the NoTube platform integration architecture reflecting the 3rd prototypes’ design.

![NoTube Platform Integration Architecture](image-url)

**Figure 1 – NoTube Platform Integration Architecture**

It is easy to refer to the general architecture depicted in D6.1 by means of colors, each one representing a service category. This color-coding approach has been adopted in the previous WP6 deliverables in order to effectively map the three prototypes’ internal modules onto the general platform architecture. Similarly the diagram above provides the overview of the platform’s integration architecture through the same color paradigm:
Front-End – Yellow color indicates every kind of GUI component interacting with the end-user, including multichannel delivery and the related devices (PC, Mobile, STB, etc.). It’s part of the Ambient Intelligence.

Application Logic – Includes the scenarios-specific implemented logic (Business Logic) and any potentially adopted Legacy System (i.e.: iFanzy in WP7.b)

User Profile – Refers to the «NoTube User», including the concept of user identity (local or remote, implemented through various standards such as OpenID) static details (i.e.: name, surname, age, sex, etc.), user activities collected from the chosen social networks, personal interests and the whole set of techniques adopted to guarantee the privacy preservation (i.e.: OAuth)

Metadata-Oriented Modules – Refers to several NoTube services that can be grouped in: recommendation services, enrichment services and metadata conversion services. Such tools are connected internal/external repositories (i.e.: Lupedia, DBPedia, IMDB, etc.) as the main working datasets.

Content-Oriented Modules – Refers to the NoTube’s services aimed at ingesting, processing and stream multimedia files (both audio and video). Similarly to the metadata-oriented modules, content-oriented modules are connected to internal/external contents (i.e.: broadcaster’s CMS, LOD MDB – Linked Open Data Media DB, FilmCrave1, etc.)

Services Annotation and Business Process Choreography – It deals with the semantic brokering techniques adopted to annotate services, compose and orchestrate them to implement specific goals in a seamless way.

2.2. Integration Approach

The integration of the three prototypes has been implemented in the scope of WP7 following a top-down approach basing on the following main actors:

- The NoTube user profile seamlessly connected to personal social aspects
- The available platform services providing: metadata conversions, recommendations, enrichment, content ingestion, processing and streaming
- The specific requirements coming from the individual application scenarios focusing on different topics (News, ads, social activities)
- The available semantic middleware capable of developing and providing services orchestration for specific goals

Each technical work package (WP1-5), in the scope of its internal R&D activities, worked towards the creation of a unified platform by providing a set of flexible solutions enabling different integration possibilities. In particular:

- Providing REST-based endpoints for the available services for direct invocation
- Annotating services using RDF in order to make them available to the semantic broker
- Defining a commonly agreed format for the input and output parameters with respect to a particular service category (i.e.: the recommenders, the enrichers, etc.)
- Designing metadata conversion services on top of the elaborated models tailored to the broadcaster’s environments and needs

1 http://en.wikipedia.org/wiki/FilmCrave
- Quickly developing custom functionalities to enable the prototyping of new ideas and features

In the same way WP7a, b, c leaders iteratively provided a list of updated formal and informal requirements that have been translated by the respective technical leaders, upon the WP6 supervision, into development actions supporting the described scenario and the requested functionalities.

In order to adhere to the designed platform, this activity triggered a lot of interactions between the use cases and the technical leaders driving the integration in the proper direction.

For the above reasons and due to the sometimes specific requirements of the three use cases the final technical choice for the services integration has been left to the prototypes' developers by always providing two options:
1. Leverage on the Business Process Choreography layer
2. Directly invoking the NoTube's platform services

The first solution is the most transparent for the application developer perspective since it provides a single entry point for accessing the NoTube services without having to know them all in detail, giving at the same time the possibility to quickly achieve the final goal.

The drawback from a user perspective could be the slower performance produced by the semantic engine overhead, although this heavily depends on the orchestration workflow required by the application.

On the semantic broker side, this approach leads to the need of collecting specific requirements for the requested goal, design the proper orchestration workflow, perform the semantic annotation of the involved services and develop the entry point.

The second solution envisages the direct invocation of the requested services from the application logic. The developer must have a clear understanding of the specific service input and output parameters and formats as well as the communication protocol adopted (REST-based, as a commonly agreed architecture choice).

There's no orchestration here although there could be some contexts where the overhead introduced by the semantic layer is not justified.

As a final consideration it is worth noticing that despite the level of freedom provided to the application developers for low level integration choices, the overall picture provided in the Figure 1 is the commonly shared approach when implementing the different solutions. In other words, every application scenario (present and future) is envisaged:
- To have a unique entry point for the user profile management, properly implementing the privacy protection mechanisms, and giving access to user details, preferences, interests, etc. This has been further achieved thanks to the implementation of the NoTube User Portal (front-end and back-end). Please see Section 2.3 for more details.
- To leverage on a set of platform services in the preferred way (directly or through the broker)
  - to get recommendations, enriched contents, etc. transparently taking care of external repositories and different data formats via metadata conversion services
  - to ingest, process and stream contents regardless of the final output channel

In this way it's possible to individually implement the business logic specific for the application, including the data exchanges with potentially existing CMS and repositories, even though the latter are fully enabled to be extended and empowered with NoTube capabilities. Moreover this approach enables use cases leaders to implement and customise the front-end for the desired application, including the support of different output devices. This aspect is supported also by the NoTube App concept introduced with the NoTube User Portal described later on.
Concerning the platform services the categorisation mentioned above and described in the previous issues of the deliverable still applies.

Here is a quick snapshot of the services groups:

- **User Profile**
  - Identity Management
  - Authentication with Privacy Preservation
  - User Interests Management
  - Activity Logging and Retrieval

- **Metadata**
  - Format Conversion
  - Enrichment
  - Recommendation

- **Content**
  - Audio Processing
  - Video Processing
  - Ingestion

Following the above picture, the next sections will provide a summarised, updated overview of such categories of platform services in light of the latest updates performed by WP1, 2, 3, 4 and 5. Please refer to the corresponding deliverables for more details about R&D activities and achievements.

### 2.3. NoTube User Portal

The NoTube User Portal provides the platform’s users with a single entry point both in terms of front-end, through a GUI that allows creating user profiles, setup preferences, setup external Web applications with custom parameters, etc. and back-end, through a RESTful-based interface aimed at enabling the integration within NoTube applications.

It runs under Apache Tomcat Web-server and leverages REST services to provide access data. Moreover all user profiles and data are stored into a SPARQL database, always accessible through a SPARQL persistency layer.

The reason behind the storage choice is that a highly flexible database is needed due to many different sources and applications data to store. Triple storage RDF data structure has been selected since it could contain potentially thousands of different data types. OpenLink Virtuoso is the storage solutions allowing all the NoTube data to be stored as RDF triple arranged in different graphs. The current structure contains a graph to manage all the NoTube users; each user has a dedicated graph where personal data and application custom settings are stored. The REST service API layer lies upon the data structure allowing the GET and SET of user’s data. Input and output parameters are JSON messages while Sesame API is used to connect to Virtuoso triple storage.

For prototyping purposes and integration the end-point has been publicly published at the following address: `http://demos.txt.it/Notube_Rest_Service/resources/`

Four main services groups are provided:

- Profile
- Authentication
- Application
- Management

The first prototype of the NoTube User Portal has been released during the second year of the project and heavily improved and extended for the third one, including:

- HTML + JQuery framework for the front-end
• Integrates the Beancounter (WP3) for user activity logging on social networks
• Supports NoTube Apps with user profile privacy preservation mechanism
• Supports both End-Users and Administrators
• Provides updated back-end RESTful services for integration

Below the portal homepage:

![NoTube User Portal - Homepage](image)

On the left the live RSS feed from the project Web site is included while on the right it’s possible to sign up very quickly by providing essential details. On the top right existing users can log in (OpenID is supported as well).
The above picture provides a snapshot of a typical page the user is presented with once logged in. In the center it's possible to browse the NoTube Apps repository, moving the mouse over a description appears in the bottom center of the page. On the right a box summarising the user profile details is displayed. Just below the list of possible actions is presented. In the example: « Application ShowCase ».

By clicking on the little gears icon, in the « User details » box, the user is presented with a form enabling to edit personal details, as presented in the next picture.
The «static profile» tab allows the user to edit fixed details, as described in FOAF. Moreover a user-image URL can be specified. Clicking on the «Dynamic Profile» tab, the front-end related to WP3’s Beancounter is presented:

Here the user can choose from a list of supported social networks and decide to grant access to a set of them in order for NoTube to monitor activity streams. This feature is very useful in order to collect precious information that will be part of the personal user profile, allowing inferring interests and computing better recommendations. Such task is part of WP3
R&D activities so please see WP3 for more details. It’s worth noticing, however, that popular social networks (like Facebook) are supported, implementing security mechanisms (like the one based on the OAUTH protocol) at the time of adding social networks to the NoTube profile.

For instance, by choosing «Facebook», Figure 6 shows the Facebook page the user is presented with, highlighting the NoTube back-end application, developed for the popular social network that in turn is asking to grant access to user profile personal details.

Going back to Figure 3, a similar approach has been implemented for NoTube Apps. The user can simply choose an App from the repository and add it to his/her profile by clicking on the «+» symbol at the bottom of the application’s icon or simply dragging the icon to the left column, where user’s chosen Apps are listed.
Once selected the desired application, the user is prompted about granting access to the user profile details. It’s possible to choose between static profile, dynamic profile or both (Figure 7). Applications invoking back-end services to retrieve user details will be prevented / allowed accordingly.

The following picture shows the main page populated with the chosen applications in the left column:

Figure 8 – NoTube User Portal – Added NoTube App
By moving the mouse over the small gears of each application the user is presented with a custom configuration panel, strictly related to the application logic, that will be saved as part of the user personal profile:

![Configuration panel](image)

Figure 9 – NoTube User Portal – Application custom settings

If we move to the Application Showcase section, a new page is presented with the list of the user’s Apps in the left column. Clicking on an App, the application is launched in the centre of the page. The only requirement is that the App provides a Web-based interface and entry-point.

The following picture shows a demo NoTube App we’ve developed in the scope of WP6, called TV Guide: it integrates application’s specific settings (i.e.: channel and schedule), stored within the current user profile and access through the portal’s back-end services, as well as platform services (EPG services, in the example).
Below is another demo NoTube App we’ve developed in the scope of WP6, integrating personalised recommendations about transcribed News Items and enrichment services:

It’s just a matter of choosing a News Item from the left column (User News) and drag it to the right (Enrichment Tool), to get the desired output. If we were logged in as Administrators, it could be possible to add new Apps to the repository. This could be done by clicking on the « + » icon labelled « New App », as presented in the picture below:
The administrator is presented with two options: add the application through a form or by uploading a properly formatted XML manifest (please see below for details about the currently available Apps).

The first choice presents the following pop-up:

![NoTube User Portal – Adding an App to the repository](image)

**Figure 12 - NoTube User Portal – Adding an App to the repository**

It's possible to specify name, description, image URL and application Web entry point (URL). Clicking on the « Dynamic » tab, it's then possible to visually create the application custom setting panel (the one presented to the standard end-user when clicking on the small gears next to each chosen application icon).
Typically an application configuration panel is built up by categories (tag1, tag2, tag3 in the example), each one presenting a list of options (attribute1, attribute2, attribute3, etc.). This approach gives great flexibility and enables third parties to easily add new NoTube Apps to the portal.

The Home Ambient of WP7.a final prototype is fully integrated with the last version of the NoTube User Portal.

2.3.1. NoTube Apps
Currently two applications have been designed and developed within the portal, mainly in order to demonstrate both the NoTube Apps repository and the integration with back-end services:
- EPG
- Enrichment

Details about these Apps are provided above, during the overview of the NoTube User Portal. In particular refer to Figure 10 and Figure 11.

The icon about "7A" is there just to point out that in general every use case developed in the scope of the project (UC 7.a, 7.b and 7.c) could easily be added to the portal, provided that it has a Web entry point.

In the same way new Apps could be added as well in the future, the only requirement is the availability of a Web interface with the related URI. Of course it's up to the application logic to integrate profile-related services invoking the portal's back-end as well as platform services in order to realise the desired component.

2.4. User Profile Management
The NoTube user profile management component, often informally referred with "Beancounter", is the basis for every NoTube-powered application who needs to include in its own business logic a mechanism to access rich user profiles.
The development of the "Beancounter" has been carried out within the WP3, supported by WP6 for what concerns the enforcement of security and privacy preserving policies, the overall integration with the three different project use cases and by WP4 for what concerns the semantic enrichment of user raw data.

The main goal of the "Beancounter" is to produce rich user profiles, in terms of interests and topics a user might be interested in, continuously monitoring the user activities on the social networks he is registered to.

The "Beancounter" main integration points are with:
- NoTube applications - via the back-end functionalities exposed through RESTful services, and with
- Social Networks - Through ad-hoc software connectors, working as plugins.

User profiles are made by collecting and aggregating user activities from the various social networks, storing them locally using triples in order to facilitate further semantic processing and perform on them statistical processing to infer interests and topics typically represented using Linked Open Data unique identifiers.

Basically, the user interests are inferred though linking user activities with other publicly available Linked Data Web identifiers or through extracting implicit knowledge using WP4 semantic enrichment services.

The following subsections introduce some new features that have been added to the user management module and the main motivations behind them within the scope of its third release.

2.4.1. Overview
The third prototype of the "Beancounter" comes up with a new set of features mainly related to the user data privacy control and to some statistical analysis which can be performed on the user data.

A mechanism to finely control which information contributes to the profile and which interests should be removed has been introduced, allowing the users to tightly control their profile.

Moreover, finer data analytics have been introduced to enrich the "Beancounter" user experience. Interests’ evolution over time and other statistics, such as interest clustering, have been added.

These new features requested some interventions on the original "Beancounter" architecture and code base. A slightly different way to index and store the user data has been introduced with some drawback and some advantages which are surely motivated by the new powerful analytics capabilities.

The original way of storing data, mainly achieved with graph-based representations stored on a triple store, has been sided by a "key-value" index to improve the system overall performances and to allow efficient statistical processing on a large set of profiles.

2.4.2. Data Protection
The improved storage model for user activities and interests enabled the possibility of a fine-grained privacy management for user profiles. These new features now allow the users to finely tune their profile letting them decide which interests should be public in their profiles and which shouldn't.
A brief description of the new features follows:

- **User Profile Visibility** - A user profile, in term of his RDF or JSON representation available from the "Beancounter" REST APIs or in term of a human-readable HTML page, could be public, protected or private. A public profile is a profile that could be freely accessed both from REST APIs and from the Web (hence potentially subjected to search engine indexing) without any kind of authorization or authentication from the requester. A protected profile could be seen as a public profile where a requester needs to be authenticated on the "Beancounter" as a registered application. This allows the "Beancounter" to keep track of who is accessing which data. A private profile could be accessed exclusively from the user who owns the data which cannot be used by any other external application.

- **Interests "blacklist"** - This feature allows a user to exclude one or more interest from the profile with three different options: public, protected and blacklisted. A public interest is an interest which is completely part of the user profile. A protected interest is an interest which is still part of the profile, hence could be seen by the user, but is not included in the REST APIs responses. Finally, a blacklisted interest is completely excluded from the user profile even during the construction of the profile in the "Beancounter" pipelines.

The main idea is to provide the users with a set of simple, but efficient, tools to finely control their profiles and, hence, their privacy.

**2.4.3. Finer Profile Analytics**

As long as the development and the subsequent adoption and integration of the "Beancounter" took place, the need of a set of finer tools to analyze the data emerged. Not only to give the users graphical tools to visualize their profiles but even to enrich the offer of the "Beancounter" APIs with new possibilities for third-party applications.

The idea is based on the premise that people are usually interested in information about themselves, and the initial inspiration came from the Dopplr annual report [16] which visually summarises an individual travel data. Moreover some interesting insights about analytics come from an experiment made on some TV watching habits [17].

Mainly, the new analytics features, implemented in the final release of the “Beancounter”, fall in the following three categories:

- **Overviews of interests** - these analytics are aimed to provide the user a clear and immediate understanding of what his profile is about in terms of relevant topics. Among classical rankings, such as the most prominent interest or top 10 interests, the "Beancounter" foresees new statistics aimed to show the evolution of the interest over time. For example, the current interest overview can be compared with the interest overview at a previous point in time. For example: one week ago, one month ago or 6 months ago. A completely new feature of the "Beancounter" has been introduced to find similar profiles, or other interests that, even if not found in the profile, might be somehow interesting to the user.

- **Overview of activities** - these kinds of analytics mainly regards the activities the "Beancounter" grabbed for a specific user. It regards features like: plotting the various activities along a timeline, showing recent activities in a period of time - e.g. What you’ve watched or listened to over the last 7 days, and options for the users to also fill in a specific period of time (i.e. showing activities for different time periods, some pre-determined, others user-defined). Moreover, the activities can be filtered by a specific
source (i.e. Twitter, Facebook, LastFM) plus some aggregated statistics such as relative frequencies of the different types of activities (e.g. like, listen, tweet, play, etc.) or contextual information such as when you tweeted, listen and played most (e.g. morning, afternoon, evening).

- Anonymous statistics - All the feature listed in the aforementioned categories have to be intended as "user-centric". They are about user data, and can be seen and consumed only from the original data owner, unless otherwise specified – see section 2.4.2 for details about data privacy. On the other hand the large amount of user interests can be valuable to perform some statistical and anonymous data aggregation to infer user behaviours and trends. For example, the "Beancounter" now foresees also the possibility to provide interest clusters such as the most co-occurring topics. This data are extremely useful for data mining tasks on user behaviours and interest without compromising the individual privacy of a user.

2.5. Metadata Services

2.5.1. Conversion

WP2 provides services for the conversion of input TV metadata to the internal TV metadata format used in NoTube. In particular, WP2 services allow the conversion from metadata in PrestoSpace format which is provided by use case 7.a and egtaMETA which is used in 7.b to TV-Anytime (TV-A).

TV-A is the metadata format internally used in the NoTube platform. Furthermore, WP2 provides use case 7.a specific metadata services for create, replace, update and delete operations (CRUD) on a News Item Container (NIC) in TV-A respectively RAI-NIC format.

The main challenge was to map all the input metadata elements to appropriate metadata elements in TV-A and to provide the means for CRUD operations on the TV-A metadata considering the target metadata formats used in the use cases.

As part of the 2nd Evaluation Phase in NoTube the underlying metadata mappings from PrestoSpace to TV-Anytime were evaluated regarding the consistency of the metadata in the conversion process and modified accordingly (see D2.4 for details). The CRUD services were updated and modified following a detailed test of a preliminary version of the services at RAI premises and are currently being integrated in the third prototype of WP7a.Use Cases Connection.

The metadata conversion services have been developed closely with the use cases. Use case 7.a (Personalised Semantic News) has provided very detailed requirements concerning the conversion of metadata and CRUD operations which have been reflected in the design and the implementation of the WP2 services. The requirements regarding the metadata conversion comprised a detailed description of all the metadata elements which need to be provided after the conversion process. Furthermore, a list of the CRUD operations that need to be provided through the WP2 services has been provided.

For use case 7.a the essential role for the metadata exchange has the News Item Container (NIC). The characteristics and the related requirements of the NIC have been analysed and noticed during the implementation of the transformation services. This work has been done in close collaboration with the work package 7.a members.

The TV-Anytime (TV-A) format has been selected as internal NoTube format for the provider side as well for the Home Ambient. Therefore the NIC concept was mapped into TV-A with respect to the required information. The alignment of the required data to describe a NIC and the TV-A transformation implementation has been done during the technical evaluation phase in WP2. During this work, examples of TV-A instances have been developed and discussed with the members of use case 7.a. The results were reflected to the adjustment of the implementation of the transformation services.
For Usecase 7b, the requirements were less complex, even though, concerning the metadata conversion, have been similarly reflected by the design and implementation. For use case 7b (Personalised TV guide with Adaptive Advertising), the work has been realized on the EBU/EGTA scheme (for the description of the advertisements). The characteristics and the related requirements of the EBU/EGTA have been analysed and noticed during the implementation of the transformation services. This work has been done in close collaboration with the work package 7.b members.

The TV-Anytime (TV-A) format has been selected as the internal NoTube format for the Provider Side as well for the Home Ambient. Therefore, the EBU/EGTA format was mapped into TV-Anytime with respect to the data required by use case 7.b. The TV-A transformation implementation has been done during the preliminary technical evaluation phase in WP2. During this work, examples of TV-A instances have been developed and discussed with the WP 7.b leader and EBU technical member. The results were reflected to the adjustment of the implementation of the transformation services.

In use case 7c it’s not foreseen to use any of the metadata conversion services. More details are already part of D7c.2.

The WP2 metadata conversion services need to be connected to both internal and external datasets.

For use case 7.a, the metadata conversion service needs to access the PrestoSpace metadata coming from RAI’s ANTS System which is provided on an FTP server. The converted metadata will be provided to the NIC repository which is under RAI's responsibility.

As mentioned before, TV-A was selected as internal metadata format. Therefore the NIC objects are stored as TV-A objects inside the NIC repository. But in order to be future proof, a more generic approach has been implemented instead of a simple one-to-one mapping from PrestoSpace to TV-A. To enable other broadcasters to connect to the NoTube platform, a uniform interface is needed. Therefore, the Broadcast Metadata Exchange Format (BMF) was chosen by WP2 as the interface between the NoTube platform and external broadcast sources. The transformation process maps first the PrestoSpace data into BMF and then the transformation BMF-to-TV-A is done. This approach enables easily to add other metadata formats (e.g. FESAD, a widely used format by the German Public Service Broadcasters) at a later time. These different transformations are implemented as separate services and due this fact the modular approach is supported. For the CRUD operations, the implemented service needs as input parameter TV-A datasets which are describing the NIC objects. Because of this parameter driven design of the CRUD service interfaces no direct access to the NIC repository is needed. The application which is using the CRUD service is responsible to have access to the NIC repository. The CRUD service is therefore independent of a specific repository technology. A detailed description of the CRUD service and the interfaces can be found in D2.3 of WP2.

For use case 7.b the metadata conversion service needs to access the egtaMETA metadata which is provided on an internal FTP Server. The service which allows converting egtaMETA metadata to TV-A has been published and made available through a Web Service. The web service has been deployed by Polymedia and Open University. A detailed description of the metadata conversion service and the interfaces can be found in D2.3 of WP2.

Finally, concerning the integration, the services have been developed in close collaboration with WP5, WP6 and the use case partners. The TV metadata transformation services are provided by WP2 via the Semantic Broker. This approach ensures re-usability between all the use cases and future developments. It also ensures the integration in the project-wide
workflow and enables the Broker to perform the desired orchestration involving metadata conversion when needed. Internally, WP2 services will use TV-Anytime as the common metadata format. All operations concerning the services can be called via Web Service operations. Input formats, provided via the Broker, will be converted into TV-Anytime (where necessary), processed and re-transformed into the requested output format (e.g. RAI-NIC format).

**2.5.2. Enrichment**

The motivation and needs behind enrichment services have been defined in deliverables D4.1 and D4.2. Lupedia is the core technology this NoTube's platform feature: it's a text enrichment service whose main function is recognising public names in texts, relying on dictionary data from an external knowledge base. The initial version of the service has been described in deliverable D4.4 with subsequent extensions in D4.5. Over the course of the project, the needs of the various work packages and partners have become clearer and as a result Lupedia has been continually extended.

The initial release of Lupedia was capable of finding DBPedia entities in English texts and providing the entities together with their most generic class and position in the input text. The classes were DBPedia's base classes Work, Place, Organisation, Person and Event and they proved to be too generic for most purposes. For example, films, books and songs were all identified as http://dbpedia.org/ontology/Work instead of the corresponding most specific types.

The final version addressed this problem by providing all classes from most generic to most specific, with the option to leave only the most specific one. In addition, users can choose the classes used for matching and thus get very domain-specific results (e.g. matching only films by specifying http://dbpedia.org/ontology/Film). In the setting of multilingual Europe, one of the most important improvements was adding support for eight additional languages: Arabic, Bulgarian, Dutch, French, German, Italian, Korean and Turkish, thereby covering the languages of all project partners. Searching can be performed in one or more language at the same time and all languages but Arabic and Korean have stop word filters. The initial set of basic filters and options controlling Lupedia's operation was extended with various new filters and options to match the needs of individual partners. As the number of options grew, it became unclear what the best (for typical usage) settings were. Therefore, WP4 evaluated the effect of the various filters and options on typical textual programme descriptions and were able to determine the best default settings for the service: skip short matches, skip matches composed of stop words, keep only first and longest match, keep only matches with the highest weight, keep only the most specific class, case sensitive. Specific use cases and scenarios can still choose individual options.

Lupedia is capable of using heuristics when the input does not match a given dictionary entry completely. This enables us to find matches like Pulp Fiction (film), typically encountered as Pulp Fiction, and The Pink Panther (sometimes encountered as Pink Panther). DBPedia provides a rich set of predicates (attributes) for each entity and some predicates are more salient than others, e.g. the proper name is preferred over a nickname. A good example would be The Matrix, which is the main name of the film http://dbpedia.org/page/The_Matrix and a nickname for the person http://dbpedia.org/page/Andre_Dirrell. WP4 introduced predicate weights to help deciding over preferred predicates, whereby the preferred ones will have a higher weight. Heuristics and predicate weights are combined into a single resultant weight that can be used to filter out undesired matches.

A comprehensive evaluation of Lupedia against two similar services, OpenCalais and AlchemyAPI, showed that Lupedia performed much better than the existing services on the test corpus data, which consisted of TV programme synopses.
The initial version of Lupedia was tested in the frame of the BBC’s use case scenario 7.c. The main objective of this use case is to follow users’ behaviour on various social networks and recommend content from the BBC programmes based on extracted user preferences. The main purpose of applying semantic enrichment services to this use case is to enrich the original program description. Lupedia was used to process the synopsis (as seen on the BBC website) of BBC programmes. The synopses were annotated in the background and the extracted entities were stored in a local semantic repository. They were made available to other partners at http://sparql-notube.ontotext.com/openrdf-workbench/repositories/notube-test/query.

In use case 7a, Lupedia is used for enrichment of news content in Italian language. The news data is produced by speech-to-text software and has no case information. This results in poor accuracy as the case difference is vital for proper disambiguation of named entities. Gradually, other partners started using Lupedia and expressed requests for extensions. All new extensions and options were a direct result of such requests. Examples of such extensions are the options single greedy match only and case insensitive. They are particularly useful for looking up individual movie titles or other similar entities unconnected to running text, i.e. a task different from enrichment of programme descriptions as described above for the BBC use case.

Concerning data sources connected to enrichment services, DBPedia is the main source. It’s a comprehensive multilingual resource and it serves as the central hub of the Linked Open Data (LOD) cloud. As such, it is well-linked to various other resources and was the logical choice for the central dictionary of Lupedia. The data is loaded from FactForge, Ontotext’s own LOD repository. The core technology used to build and search in the dictionary is the Large Knowledge Base Gazetteer (LKBG). More details on the technology and its implementation can be found in deliverable D4.4.

LinkedMDB is another data source that was added to Lupedia alongside DBPedia. Currently, it only contains English definitions but it is useful to the project as it “aims at publishing the first open semantic web database for movies, including a large number of interlinks to several datasets on the open data cloud and references to related webpages.”

The London Classification (LonClass) is a potential dictionary source maintained by the BBC. The main challenge with LonClass is its complexity and representation, as it allows for complex semantic expressions but is not an RDF-based resource. The initial work on LonClass showed that the effort required to integrate it in Lupedia would be beyond the scope of the project.

Lupedia is implemented as a set of RESTful services and it can produce output in four different formats:

- HTML (meant for humans)
- RDFa
- JSON
- XML

This has proven very flexible and it has met the requirements of all project partners.

2.5.3. Recommendation

Recommendation services have been researched and developed in a joint effort between WP3 and WP1.

Since the application scenarios scope concerns News Items (for WP7.a), advertisements (for WP7.b) and media programmes (for WP7.c), the general idea is to link those items to the user profile interests by means of the interlinked semantic data spread on the Web. In this way we can leverage existing knowledge in order to find the best recommendations for each user.
Their integration is based on a close connection with the user profile component, in particular the activity logging (Beancounter), as the main input on one side, and the metadata repositories used to perform the recommendation, on the other.

The typical scenario foresees that the NoTube user is authenticated (logged in) then, within the specific workflow of the considered application, the business logic invokes the recommender directly or through the broker, setting a specific goal.

As an example, let’s take the 7.a scenario. The user sits in front of the television, within the Home Ambient, the set-top box is already switched on and logged with the user’s account. The user chooses to playback the daily news. The 7.a Home Ambient back-end provides the front-end with the personalised newscast, prepared in advance, on top of the ingested news provided and enriched by the Service Provider and then filtered and sorted starting from the output of the news recommendation service that, in turn, crosses the current user profile (interests) with the news’ metadata. A similar integration could be seen through the showcase named “enrichment”, within the NoTube User Portal in its final version.

2.6. Content Services

NoTube content services include all the platform services aimed at processing audio and video files and streams. In particular the Consortium’s experts focused their activity on ingestion, audio normalisation (loudness analysis) and video smart cropping, as described below.

2.6.1. Audio

During the last year, in addition to the Loudness Analysis Web Service (see D4.3 for details), IRT implemented the loudness analyser in an umbrella service for loudness normalisation and metadata enrichment of multimedia content. The service’s objective is to automatically analyse the loudness of incoming audio-visual content, normalise the audio based on the analysis results (if required) and add dedicated loudness metadata to the metadata set associated to the audio-visual content (see D4.3 v3 for a more detailed description).

2.6.2. Video

Video processing services come from WP4 internal R&D activities and provide Web services for automatic Video Reframing and the automatic Ad Insertion in NoTube.

The automatic Video Reframing Web Service automatically repurposes the video content, i.e. adapts the image size to the screen size in a specific way, in order to provide a better viewing experience (e.g.: on mobile devices where the display is small). It takes in input a multimedia essence file (i.e. audio, video) and returns a multimedia essence file with the video that has been cropped.

The automatic Ad insertion Web Service aim is to insert advertising clips into a video sequence at the privileged moment and place of the video. It takes as inputs a movie file and an advertising file and returns the movie file with the Ad inserted into it.

These Web Services take into account the improvements realized on the two algorithms (automatic video reframing and automatic Ad insertion) as described in deliverable D4.3 v3

2.6.3. PVR and Ingestion

In the scope of WP6, to bootstrap the integration of contents, a Personal Video Recorder service for DVB-T broadcast has been designed and developed. This service is fully programmable, it can be driven through a RESTful interface and it is also integrated with the service providing the EPG. It allows the user as well as automated services to schedule DVB-T programmes recording. The PVR service is complemented by a Media Storage service that stores the recorded programmes for future playback, and indexes them leveraging on NoTube metadata services.

An instance of the Personal Video Recorder and Media Storage services is being used by the Personalised Semantic News Prototype (UC 7.a). The PVR is deployed in the Home
Ambient module. The application logic of the Home Ambient monitors available broadcasts through EPG services, retrieves metadata from the Broadcaster through WP2 services, and matches them against the user profile through WP3 recommendation services. Whenever a relevant or recommended programme is scheduled for broadcast, the application logic sets the PVR accordingly in order to record the programme. The recorded video is then managed by internal Media Storage services and made available for playback as part of a playlist when selected from the front end.

The PVR service uses services to retrieve detailed EPG entries for the scheduler. The Media Storage services accesses services on the side of the Service Provider to retrieve additional

The PVR service needs to be connected to a hardware DVB-T tuner that allows video recording. It can record in MPEG2 DVR-MS and DVR-TS and it uses the AVI format as container.

2.7. **Service Annotation and Brokering**

This section describes the work related to the improvement of service annotation and brokering. In more detail, it reflects the refinement of data schema, the re-engineering of SmartLink and the enhancement of service brokering.

2.7.1. **Refinement of Data Schema**

The data schema of non-functional properties (NfPs) of semantic Web services has been refined to facilitate collaborative, naturally diverse and less formally coherent annotation. In general, the proposed data schema captures four main aspects of the non-functional properties of Web services, i.e. social, technical, licensing and QoS.

Social attributes include human factors such as developer, contact person, organisation, and project. To ensure the widespread applicability and reusability of the NfP schema, we reuse the existing ontologies and vocabularies rather than constructing new ontologies from scratch. Therefore, FOAF\(^2\) and CommonTag\(^3\) vocabularies are adopted to respectively describe social factors and tags attached to services.

Technical NfPs refer to information about how to interact with the services and cover, for instance, the communication protocol (e.g. HTTP and SOAP), data (exchange) format (e.g. XML, RDF and JSON), status (e.g. testing, final, work-in-progress) and authentication model (e.g. HTTP Basic, API Key, OAUTH).

Licensing properties indicate the terms and conditions with respect to the usage of individual Web services. We currently define four concepts for the licensing properties, i.e. service license, data license, usage limits and fees. A service license authorizes and constrains invocation of the service, whereas a data license is for the reuse or repurpose of data generated or provided by the service. Usage limits cover the amount of times of service invocation within a certain time period, or the minimum interval between two times of invocation. Obviously, fees are applicable to non-free services only and refer to the price a consumer needs to pay for consuming a service.

In respect of the quality of Web services, we adopt the model from [13], where the QoS parameters are divided into two classes: objective parameters and subjective parameters. The former are quantitative measures like availability, reliability, throughput and response time, whereas the latter are qualitative measures like user ratings.

\(^2\) [http://www.foaf-project.org/](http://www.foaf-project.org/)

\(^3\) [http://commontag.org/](http://commontag.org/)
2.7.2. SmartLink Re-Engineering

SmartLink\(^4\) ("SeMantic Annotation enviRonmenT for Linked services") has been re-engineered to enable semantically describing, browsing and filtering services in an interactive way. As stated in D5.2, the first version of SmartLink provides only a simple Web form for the authoring of semantic service annotations. Now, the entire user interface of SmartLink 2.0 has been re-designed. As a result, SmartLink is running as a rich Internet application, which is implemented using Google Web Toolkit (GWT). In addition, the architecture of SmartLink has also been re-designed to facilitate the access of both users and machines.

In summary, the key features of SmartLink 2.0 are as follows.

- Browsing services stored in the repository
- Filtering services by non-functional properties such as status, category and project
- Querying for suitable services by using the SPARQL language for RDF graphs
- An integrated environment for editing and authoring of semantic service annotations from scratch, even without any documents about the services
- Recommending suitable model references to users with the support of Watson – an established online ontologies repository
- Publishing the non-functional properties of services as Linked Data on the Web
- Interlinking with iServe to provide means for retrieving more information about the functionalities and behaviours of the services
- Exposing a SPARQL endpoint on the Web

2.7.3. Service Brokering

In general, tasks of service brokering include service discovery, execution and mediation, which is implemented based on IRS-III\(^1\). Although IRS-III directly covers the descriptions of service execution, choreography and orchestration, but it still has the following limitations:

- Using OCML rather than RDF/OWL to semantically describe services;
- Adopting WSMO rather than MSM (Minimal Service Model) as the conceptual model of services;
- Lack of semantic service authoring tools with good user experiences;
- Not following the principles of Linked Data.

Therefore, a novel framework of service brokering is proposed, which is composed of SmartLink, iServe and OmniVoke\(^5\). It can serve as a complement to IRS-III. SmartLink offers not only an environment for the authoring of semantic service annotations, but also a repository of services. Now, a library of the services has been established, which currently contains 28 services developed by all the WPs of NoTube project. SmartLink is a publicly available Linked Data endpoint. It has been registered as a CKAN package\(^5\), and included in the Linked Data cloud\(^6\). SmartLink and iServe provides a set of service discovery mechanisms, which are based on both the functional and non-functional properties.

OmniVoke aims to automating the invocation of generic Web APIs and services. It provides a unique entry point for the invocation of most services that can be found on the Web. Thus, it abstracts away the heterogeneities of different services and consequently eliminates the need for developing a custom tailored client per service. OmniVoke relies on non-intrusive semantic service annotations conforming to MSM, in order to capture both their semantics as well as the information necessary to carry out their invocation. It is based on RESTful

\(^4\) http://smartlink.open.ac.uk/
\(^5\) http://ckan.net/package/smartlink
\(^6\) http://richard.cyganiak.de/2007/10/lod/
principles to simplify its use and to adequately exploit the Web infrastructure for scalability. The service engine includes a RESTful interface enabling the invocations as well as the monitoring or post-mortem analysis of service execution by publishing associated artifacts generated or used during the interaction with remote services, such as messages exchanged, etc.

 Appropriately supporting the use and management of heterogeneous services requires sharing the semantics of services through formal machine-processable descriptions as well as using a common syntax for representing these descriptions and the data exchanged or adequate transformation mechanisms. We shall therefore also use RDF as lingua-franca for communicating with Omnivoke. Doing so carries out additional requirements like the need to provide mechanisms for transforming messages between RDF and the data format used by the Web APIs internally if necessary.

 In more detail, Omnivoke can offer the following functionalities:

- Validate invocation request
- De-capsulate invocation request
- Map RDF input data to the expected data format used internally by the service implementation
- Compose the invocation request to the actual Web API
- Invoke the actual Web API
- De-capsulate the response message
- Map non-RDF data, e.g. XML, JSON in response message body to RDF

Omnivoke is proposed as complement to IRS-III. It aims at implementing a unified service invocation engine for heterogeneous services, especially having better support to services consuming Linked Data. It is worth noting that the adoption of Omnivoke is an internal change within the semantic service broker. It has no influence upon the existing services used by the use cases of NoTube project. More information can be found in D5.3.
3. NoTube Adoption and Evaluation

3.1. Introduction
For the third release of this document we decided to focus on the platform and provide the evaluation plan with results targeting technological partners as well as application scenarios leaders.
The summary of the three use cases integration mapping has been already presented in D6.3 proving to be a successful approach hence, since in the final stage of the project it hasn’t changed, for the final round of prototypes the updated description including individual integration details is demanded to WP7.a/b/c as part of the core activities towards the release of the third and final demonstrators.

3.2. Evaluation
The evaluation of the three final integrated prototypes has been performed according to the individual use cases functional requirements and thus planned and performed respectively in WP7.a, WPP7.b and WP7.c.

From the WP6 perspective the evaluation has been designed, instead of at application level, at the integration one. In particular we performed evaluation for:
- Interface with legacy CMS
- Security and privacy preservation

3.2.1. Interface with Legacy CMS
The main goal is to understand how easy is to connect legacy CMS to the NoTube platform. This is an indicator of the work that shall be performed at the side of a TV broadcaster in order to connect its content assets to the NoTube platform.

We consider two potential issues in this respect:
1. Legacy CMS are usually proprietary, closed software that the broadcaster is not likely to modify without a proper motivation.
2. At the technical level, the main obstacle is represented by proprietary contents (data and metadata) formats to be managed by the platform.

The main actors involved are:
- The Broadcasters (WP7)
- Metadata Conversion Services (WP2)
- Advanced Audio/Video content Services (WP4)

The idea behind the evaluation has been to leverage the NoTube applications development experience through the collection of feedback about the two main issues we pointed out at the beginning of this section, by means of technical interviews: broadcasters on one side (UC 7.a, 7.b and 7.c leaders) and technicians on the other (WP1, WP2, WP3, WP4 and WP5 developers).

With reference to the non-functional attributes described earlier on in D6.1, the acquired data had been useful to evaluate: interoperability, scalability, extensibility and adaptability of the platform.

3.2.1.1. Results: Legacy CMS Integration (Broadcasters Perspective)
With reference to the collected evaluation results (see Annex I for details), below is a list of pros and cons related to the survey targeting broadcasters.
Pros

✓ The current environment workflow will not be altered by the introduction of NoTube
✓ The main introduced improvements are perceived to be: enrichment, recommendation, user profiling and EPG management
✓ Results provided by metadata enrichment services translate in medium improvements
✓ Results provided by A/V processing services translate in medium/high improvements (where applicable).

Cons

✗ The overall workflow of the integrated system results slower than before
✗ Improvements provided by current content recommendation services could be more efficient

3.2.1.2. Results: Legacy CMS Integration (Developers Perspective)

With reference to the collected evaluation results (see Annex I for details), below is a list of pros and cons related to the survey targeting developers.

Pros

✓ Broadcaster usually adopt standards for metadata and audio/video formats
✓ Good reusability of already implemented conversion services
✓ Services could be deployed onsite improving availability
✓ Usually no software licenses are required

Cons

✗ The overhead impacting on the development of transformation services is not low
✗ The integration is not always transparent for broadcasters however the introduced benefits should be better advertised
✗ It’s not always easy from a service developer perspective to collect clear requirements from broadcasters

3.2.2. Security and Privacy Preservation

The main aim is to ensure the privacy protection of the user by measuring potential weak points in the platform as well as the technical mechanisms adopted to prevent security flaws.

The main actors are:

- The User Profile Management module
- NoTube services and applications

The evaluation focused on collecting technical feedback about:

- Storage modalities for the user’s profile
- Storage modalities for the user’s activities
- Connection to external source (i.e.: Social Networks)
- Back-end interface of the User Profile Management module
- Techniques adopted to preserve security and privacy
  - Access to personal user details
  - Data exchange

The modality of the evaluation has been based on simple low-level software “attacks”, basically trying to retrieve user profile details without providing credentials or trying to bypass the OAUTH mechanism.
### 3.2.3. Results: Security and Privacy Preservation

With reference to the collected evaluation results (see Annex I for details), below is a list of pros and cons related to the survey.

**Pros**
- The choice of data storage technologies have been influenced by the need of preserving privacy
- Social activities are collected avoiding direct references to the user, using the most secure way supported by the considered social network
- It’s hard even for a malicious user breaking into the system to link the user identity with social activities

**Cons**
- Currently no encryption is implemented so it’s easy for a malicious user breaking into the system to link the user identity with the personal details (age, date of birth, sex, etc.)
- The data access to Social Network leverages on the most secure supported standards (i.e. OAuth) however the data exchange is performed according to the exposed APIs, that foresee to use the HTTP protocol (not encrypted)

### 3.3. Final Considerations

With respect to the collected feedback, below is the list of potential weaknesses of the current platform with related actions aimed at mitigating them.

<table>
<thead>
<tr>
<th>Weakness</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The integration is not always transparent for broadcasters</td>
<td>Developed services should be demonstrated in the context of the considered scenario’s workflow</td>
</tr>
<tr>
<td>Not easy from a service developer perspective to collect clear requirements from broadcasters</td>
<td>Strengthen the bottom-up approach focusing more on the broadcaster’s requirements instead of just individual research objectives</td>
</tr>
<tr>
<td>Added value introduced by some categories of services is not always remarkable as expected</td>
<td>Improve the efficiency of the algorithms and focus more on UC specific requirements</td>
</tr>
<tr>
<td>Personal social activities are exchanged in plain HTTP</td>
<td>Monitor Social Network’s APIs updates in order to adopt the most secure protocol available for data exchange</td>
</tr>
<tr>
<td>Hackers breaking into the system could easily link user identities with personal details</td>
<td>Adopt encryption algorithms or techniques for decoupling the mentioned entities</td>
</tr>
</tbody>
</table>

Table 1 – Evaluation: weaknesses/mitigation actions summary
4. Market and Technology Evaluation

The purpose of this chapter is to provide an overview of the market offer in terms of main high-level players involved in the “TV of the future” scenario. In particular: devices (front-end), delivery models (back-end), adopted standards (where possible) with the final goal of presenting a technology evaluation and comparison with NoTube.

4.1. Devices

4.1.1. Second Screen Paradigm

Mobile devices seem more and more destined to take over as the remote controls of the future. A lot of apps are being released on the different platform to help users quickly search, find and consume multimedia contents. Recent trend indicates not just a frustration with the current state of navigation and search on legacy programming guides, but increasing use of so-called second screen devices while watching TV. The traditional grid guides for displaying programming line-ups and available video operated by traditional remote controls are typically capable of just up-down-left-right browsing and navigation while users are seeking new ways to search and discover contents. Moreover today’s generation of smart phones and tablets are powerful enough to support complex searches being at the same time perfect input devices for the task and being already used and present in the living room, anyway. Users are increasingly accessing the Web, texting with friends or chatting while watching TV, so extending the interaction with the TV to those devices makes perfectly sense.

The above considerations are already supported by the market: not only technology companies and hardware manufacturers but also Pay TV distributors like Comcast, Time Warner Cable, AT&T, Dish Network, Verizon, etc. that have announced or released applications for the most popular mobile devices such as Apple iOS-based and Android-based ones [1].
4.1.2. Commercial Hardware Solutions

4.1.2.1. Sony Internet TV

Figure 15 – Sony Internet TV (Google TV) hardware snapshot

Sony has been the first hardware manufacturer providing a TV model that is powered by Google TV. From a hardware perspective it is basically a standard LED TV with a 1.2GHz Intel processor. It’s not noticeably deeper or heavier than a standard 32-inch LCD using CCFL backlighting, but relatively chunky compare to an edge-lit LED TV. The remote is light and well-balanced, and features mostly familiar controls. In addition, it includes an optical trackpad at the upper right [5].

4.1.2.2. Logitech Revue

Figure 16 – Logitech Revue hardware snapshot

The Logitech Revue is just the hardware aimed at running Google TV, similarly to set-top boxes, plus remote controls; the display is not included. It comes with a keyboard remote control, which is roughly the size of a regular computer keyboard, but adds a touchpad and
D-pad used for searching through media and browsing the Web via Google's own Chrome browser.

4.1.2.3. **Apple TV**

![Figure 17 – Apple TV hardware snapshot](image)

Apple TV package comprises the proprietary digital media receiver, which is quite small and light, plus the remote control. Wiring options for the device are minimal: Ethernet port, micro USB jack, an HDMI port, an optical audio hook-up, and a spot for the power cable. Inside, the exact specs are unknown, but the Apple TV is powered by the Apple A4 CPU, the same chip that powers the iPhone 4, iPad, and new iPod touch. The Apple TV comes with a minimal remote manufactured out of aluminum. The slim accessory is short on buttons (a menu key, play / pause key, and four way rocker with center button).

What's more concerning is the fact that getting around the menus and especially entering text is a chore with this remote, though this is also due in part to the way Apple has laid out text. Having to click your way to a password, movie title, or email address is pretty time consuming. Luckily for the users already owning an iPad, iPhone, or iPod touch, the company just issued an update for its Remote app that allows controlling the Apple TV via a touch surface and virtual buttons [6].
4.1.2.4. **Boxee**

The most interesting part of the Boxee Box experience isn’t the box but the remote. It features a two-faced QWERTY remote. The front side holds a four-way D-pad with select button, play / pause buttons, and a menu button, while the rear has a small QWERTY keyboard for easy searches and quick typing. Popular smartphones are not officially supported as alternative control devices, anyway [7].

4.1.2.5. **Lava**

Lava TV, from a user perspective, is a standard HD TV that has been included in our analysis as the first example of next generation television powered by Google Android. It doesn’t provide any advanced remote control or second screen device but it’s a full-featured Android device that is capable of connecting to Internet, playback streaming contents and, more in general, leverage on any additional functionality provided by Android Apps.
4.1.2.6. Microsoft Zune Video Rental

Microsoft Zune Video Rental service is provided as part of the media center functionalities of the popular Microsoft's console, namely the XBOX 360. For this reason the supported controllers are the one available for the console, including the standard joypad as well as the optional remote control.

At the time of reporting no integration is foreseen with Windows Phones, however it's somewhat conceivable to expect it as a natural next step in both platforms' future evolution.

4.1.2.7. Yahoo! Connected TV

Similarly to Google, Yahoo! announced its TV platform supported by a set of hardware manufacturers. Among others: Toshiba, Sony (Figure 21), Vizio and LG. Yahoo's platform hardware requirements are supported by such televisions, however no specific remote devices or integration with second screens/smartphones is foreseen by Yahoo!. These
features, if present, are provided by individual manufacturers as part of their own proprietary solutions.

4.1.2.8. Samsung Smart TV

![Samsung Smart TV hardware snapshot]

The Samsung Smart TV empowers a number of TV devices produced by the company, like the Series 8 one. Hardware specifications are in line with similar products offered by other vendors (e.g.: Sony, running Google TV). The most interesting thing is the remote control which is basically a QWERTY keyboard that comes in handy for browsing, chatting or sharing comments through social TV applications.

4.1.2.9. Netflix

![Netflix hardware snapshot]

Netflix can be accessed on gaming consoles such as: Nintendo Wii, Sony PS3 and Microsoft Xbox 360, as well as Windows and Mac laptops, regular television and internet-connected television (including set-top boxes), and all the most popular hand-held devices such as the iOS and Android based ones.
4.1.2.10. Hulu (Plus)

Hulu Plus can be run on TV. Currently it works on selected Internet-enabled Samsung TVs and Blu-ray players. It is also available for consoles such as the Sony PS3, Microsoft XBOX 360, and some Sony entertainment devices in the coming months. Right now it is possible to download Hulu Plus through Samsung Apps and watch Hulu content in 720p HD. Hulu Plus is also one of the latest additions to the Roku XDS streaming video box. On the mobile side, running Hulu Plus on iPhone or iPad is simple: it’s required just to download the Hulu Plus app available in the Apple App Store. While the app is free to download, users still need to subscribe to Hulu Plus to get full access. Otherwise only a selection of episodes is available for free.

4.2. Delivery Models

4.2.1. Introduction

TV experience augmented with user interaction is definitely not an innovative idea since the first platforms saw the light early in 2000. They were mainly experiments based on the remote control as the central input device while SMS were used for communications. Usability was very poor and there wasn’t any social graphs to manage connection among users thus interacting with strangers was pretty common and, at the end of the day, not very interesting.

Nowadays this concept has evolved and looking at the industry we now have mainstream products supported by electronics and software giants like AppleTV, Google TV, Microsoft XBOX, Netflix, Samsung Smart TV, Sony, etc. on one side and aggressive, smaller start-ups like IntoNow, Miso, GetGlue, etc. on the other. Philosophies appear to be somewhat different, anyway: while market giants work is focused on integrating popular social networks like Facebook, Twitter, Flickr, etc. in addition to adding a basic content suggestion mechanism on top of the community preferences, on the other side small companies focus on building the social graph as the main starting point for providing a brand new content consumption experience.
4.2.2. Content-Centric Model

4.2.2.1. Google TV

Google TV\(^7\) is the homonymous TV-based ecosystem from Google. Providing typical media center functionalities (audio/video playback supporting a wide range of formats, YouTube streaming, pictures slide show, etc.) it leverages in addition the power of Google to search multimedia contents as well as the Web by embedding a full-fledged Chrome browser (including the Adobe Flash support). The platform is extensible thanks to the support of Apps, moreover popular smartphone (Android-based or iOS-based) are supported as remote controls / second screen [3].

At the time of reporting a number of hardware makers chose or are planning to empower certain models of their devices with Google TV. Among the others we can mention [4]:

- Sony Internet TV
- Sony Internet TV Blu-ray Player
- Logitech Revue set-top box

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\(^7\) http://www.google.com/tv/
4.2.2.2. Apple TV

![Apple TV](image)

**Figure 26 - Apple TV**

Apple TV* is a standalone digital media receiver, running Apple's proprietary operating system and software. It is a small form factor network appliance designed to play IPTV digital content originating from the iTunes Store, Netflix⁹, YouTube¹⁰, Flickr¹¹, MobileMe¹², MLB.tv¹³, NBA League Pass¹⁴ or any Mac OS X or Windows computer running iTunes onto an enhanced-definition or high-definition widescreen television.

In contrast with Google's solution, hardware and software are strictly bound. The business model is focused on the Apple Store for the content acquisition and delivery. Brand new TV shows are available at $0.99 a rental, and HD movies for $4.99 a go (or $3.99 for older titles). And that includes new releases the same day DVDs hit shelves (or Netflix distribution centers). Speaking of Netflix, the new Apple TV also features the rental service's "Watch Instantly" as a wholly integrated component of its offerings, alongside a new function the company calls AirPlay which will allow to "push" video and audio content from iPad, iPhone, or iPod touch with the tap of a button. On top of that, streamlines sharing from user’s home computers or laptops is provided as well [6].

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* http://www.apple.com/appletv/
⁹ https://www.netflix.com/
¹⁰ http://www.youtube.com/
¹¹ http://www.flickr.com/
¹² http://www.apple.com/mobileme/
¹³ http://www.mlb.tv/
¹⁴ http://www.nba.com/global/leaguepassemial.html
4.2.2.3. **Boxee**

Boxee\(^\text{15}\) is all about delivering content from multiple internet sources to the user in a seamless and unified way. The main page allows the selection of featured apps and videos (including Vevo music video app). The Friends tab pulls in all the video friends from various services have shared: if Boxee is hooked into Facebook, for example, all the videos friends post will show up automatically. Right now the Box supports Facebook, Twitter and Google Buzz.

Then it’s possible to choose the Watch Later option, which is a queue of things user chosen to watch later. Shows and Movies tabs offer galleries of available content, and finally Apps (Boxee Box comes preloaded with a variety of different apps) and Files [7].

\[^{15}\text{http://www.boxee.tv/}\]
Rovi Connected Platform enables Android-based devices connecting to an array of PCs, set-top boxes or NAS devices, which in turn would be connected to a monitor or HDTV of some sort. The idea is to help manufacturers and distributors speeding up time to market and differentiate their offerings by enabling them to build networked products that store, discover, and play back personal and Internet-based content. Standards supported by the software enables connectivity with millions of DLNA-, UPnP-, DTCP-IP-, and OCAP/tru2way compliant devices, allowing consumers to easily discover, manage and enjoy their digital content on their own terms. Music, photo and video files stored on Android devices powered by Rovi Connected Platform will be capable of sharing media over the consumer’s home network for streamed playback on connected entertainment products. Connected Platform on Android will also enable consumers to access and manage their connected devices around their home right from their personal Android device, and stream their personal, premium and recorded content stored on their PC or NAS devices directly to the Android mobile device in the palm of their hand [8]. Such solution is quite different from the other we’ve presented here since it mainly provides an infrastructure for the integration of multimedia devices aimed at consuming contents. It doesn’t rely on specific hardware or provide a specific front-end for users. Actual stakeholders have to be found in Original Equipment Manufacturers (OEM).

4.2.2.5. Lava

The Scandinavia is the world's first Android TV, with pre-installed and downloadable Apps. The pre-installed Apps include a complete and open web-browser, Facebook, YouTube, Email, Google Maps and more. At the App-store, the user can download and install a constant flow of new Apps and services. The People of Lava Scandinavia TV is different

http://www.rovicorp.com/
http://www.peopleoflava.com/
from Google’s Google-TV since it’s based on Android. In other words what it offers in terms of contents accessibility is exactly what Android is capable of.

4.2.2.6. Microsoft Zune Video Rental

Microsoft XBOX 360, in addition to playing games, can also play back content from Windows computers on a TV embedding the Windows Media Center powered by an ad-hoc video rental service Microsoft Zune Video Rental. Zune allows to buy (download) or directly consume streaming music and movies, including high-definition and popular TV series. The business model foresees the user to buy virtual credits called “Microsoft Points” that can be spent for content purchase or rental. Prices depend on the content provider. On the other side, thanks to the integration with Windows-based computers, the user is enabled to connect to the home network and access personal content. Mobile devices integration is limited to Windows Phones\(^{18}\).

\(^{18}\) http://www.microsoft.com/windowsphone/default.aspx
4.2.2.7. **Yahoo! Connected TV**

![Yahoo! Connected TV](image)

**Figure 30 – Yahoo! Connected TV**

Yahoo!\(^{19}\) offers a much more modest integration of the Web with television than Google TV. Instead of full-screen apps, it mostly provides widgets for popular services like Pandora, Twitter, TV Guide, and news and weather services, although it also offers internet TV through services like YouTube and Amazon video on demand. The main draw may be Yahoo!’s own services, including Flickr, News, Weather, Finance and popular social games like Y! Fantasy Football.

“We don’t think people want the whole Web browser experience crammed in a TV,” Yahoo!’s Russ Schafer told the AFP. “It is a best-of-the-Web, not all-of-the-Web.”

Because Yahoo! TV takes a less radical approach than Google or Apple TV in delivering web content through the television set, it’s faced less pushback from networks and other content makers. This makes for less frustration, but also fewer features and less long-term upside [9].

\(^{19}\) [http://connectedtv.yahoo.com/](http://connectedtv.yahoo.com/)
4.2.2.8. Samsung Smart TV

Smart TV\textsuperscript{20} has adapted the popularity of app stores for smartphones and brought them to the living room. It comes loaded with apps like the one related to major video streaming services (Netflix, Hulu Plus, and YouTube) along with news and information from sources like ESPN, AccuWeather, and Yahoo!. New applications can of course be browsed and downloaded, including popular social networks’ Apps like Facebook and Twitter. Games are present as well.

Viewing content, whether it’s user own or streamed from the internet, is possible. The built-in DLNA (digital living network alliance) compatibility can wirelessly access content like videos, music and pictures on similarly compatible devices like smartphones, network external hard drives and desktop and laptop computers. Recording content directly from the TV is also possible when connecting a USB memory or hard drive.

Surfing the Web is also possible and like a regular browser, the Smart TV one runs Adobe Flash.

Social TV is there too even though without second screen or mobile devices support: the QWERTY keyboard remote allows viewers to type out a comment to post to Twitter, Facebook or Google Talk.

Down one side of the screen is the text area of the social network currently plugged into while the TV program is still running underneath [10].

\textsuperscript{20} http://www.samsung.com/uk/smarttv/
4.2.2.9. **Netflix**

Netflix\(^{21}\) is one of the main leaders among online DVD rental services. Unlike many of its competitors, Netflix allows the “watch instantly” feature which streams television shows and movies directly to all the user’s electronic devices, including mobile ones. Although only one DVD is issued at a time, user has no limit on how many DVDs can be received in a month. And there are no late fees. Movies are provided together with metadata including the rating (e.g. TV-14), cast director, length, subtitle languages and format of the television or movie is pertinent when choosing which show to watch. All of the cast and director names are linked to additional sites where both the actors’ and directors’ additional work can be found and watched\(^{11}\).

4.2.2.10. **Hulu (Plus)**

Hulu\(^{22}\) (Plus) is probably the major Netflix competitor sharing many similarities with it. Streaming TV service Hulu (free) launched Hulu Plus, a $7.99 per month subscription

\(^{21}\) www.netflix.com/
\(^{22}\) www.hulu.com/
service that offers a deeper catalogue of shows and compatibility with more devices than the free, basic Hulu service. Hulu Plus removes most of the episode and content limits faced with the regular Hulu service, as it lets watch a full season or series. As part of the package, the user can stream content to iPhone 4 ($199.99-$699.00 list), iPad, Sony PlayStation 3 ($299.99 list), Microsoft XBOX 360 ($299.99 list), and some Internet enabled TVs, in up to 720p.

As the name suggests, the draw of Hulu Plus is that it gives more content in more places. It doesn't replace the non-subscription Hulu service, which can still be used for free. It also doesn't replace cable service. It doesn't offer news or sports, provides little cable network content, and has virtually no premium cable content. Moreover it's worth noticing that Hulu Plus doesn't support Hulu Desktop (which lets you watch Hulu on Mac or PC, using a remote). On the plus side, it streams content in 720p HD, while the highest quality offered for the free version of Hulu is 480p [12].

4.2.3. Social-Centric Model

Below is a brief overview of the emerging Social TV Apps [2].

4.2.3.1. IntoNow

Yahoo’s IntoNow[^1] is new on the social TV scene, introducing an innovative, patented sound-recognition technology (called SoundPrint) that hears and recognizes what the user is watching, with an impressive detail right down to the single episode. The user is enabled by pushing a button to let IntoNow recognize the TV show and then is provide with the possibility to share it on Facebook or Twitter. The central database is claimed to identify live TV or anything that has run on TV in the last 5 years. Such application runs on TV, computer or mobile device.

Beside this interesting feature IntoNow provides information about TV shows like episode synopsis, cast info, etc. leveraging the social connections by notifying the user about when friends are watching the same show providing instant access to IMDb[^24], iTunes[^25] and Netflix[^26].

[^1]: http://www.intonow.com/ci
[^24]: http://www.imdb.com/
[^26]: https://signup.netflix.com/global
4.2.3.2. TunerFish

![TunerFish App](image)

Tunerfish\(^{27}\) lets users check-in to what they’re watching (TV or Web) and share it with friends. Similarly to IntoNow it allows also to discover new content based upon what friends are watching. The business model foresees users to earn fun badges when watching certain shows. This social application is available on Android-based and iOS-based mobile devices.

4.2.3.3. Miso

![Miso App](image)

Miso\(^{28}\) offers yet a similar option for users looking to have fun while checking into their favorite TV shows: they can unlock achievement badges as they watch more programmes. The check-in paradigm is still applied putting the focus on specific episodes while some similar services allow people to check into shows in general and not episodes. In addition to that Miso allows also updating metadata for specific shows, which makes them unique. The application is available on iOS-based and Android-based mobile devices.

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\(^{27}\) http://www.tunerfish.com/

\(^{28}\) http://gomiso.com/
4.2.3.4. Yap.TV

Yap.TV\(^{29}\) is a sort of social TV Guide. It allows the user to see what other fans are saying about the considered favourite shows, on Twitter. It permits to see what friends are watching, invite them to a group and chat about favourite shows. Moreover it provides the TV schedule related to the user’s local area by surfing a picture-based TV show guide. Voting on fan polls is supported.

The focus of this application isn’t about badges and achievements like Tunerfish and Miso, but it is all about starting conversation around favourite shows. Supported mobile devices are the iOS-based one (iPhone, iPad).

\(^{29}\) http://www.yap.tv/
4.2.3.5. GetGlue

GetGlue\(^30\) is a social network for entertainment, thus it's somewhat different from the previous apps: in addition to letting users check-in to TV shows or movies it also lets you check-in to whatever music you're listening to, book you're reading, video game you're playing, celebrity you're chatting about, topic you're thinking about or even wine you're drinking. It goes beyond the scope of social TV but probably it's worth mentioning it as a possible future extension of this kind of apps in particular because, at the end of the day, it collects « user activities » that are very important for recommendation engines since they contribute to better define personal user preferences and interests.

Content-centric:
- Apple, Microsoft, Google, Samsung, Sony, Netflix, Hulu

User-centric:
- IntoNow, TunerFish, Miso, Yap.TV, Philo, GetGlue

4.3. Standards

The aim of this section is to include and briefly describe potentially interesting standards and formats related to the broadcast world, at this point in time, that go beyond the project end. They've been collected from Consortium’s experts and included in this document to complete the picture about market and technology evaluation. Concerning metadata please refer to WP2 for a detailed description.

Ambient Intelligence technologies are summarised as well with particular focus on NoTube goals.

4.3.1. Hybrid Broadcast Broadband

Hybrid Broadcast Broadband TV (HbbTV)\(^31\) is a pan-European initiative aiming at complementing the broadcast delivery to the end-user via an additional broadband

\(^{30}\) [http://getglue.com/](http://getglue.com/)

\(^{31}\) HbbTV Consortium, [http://www.hbbtv.org](http://www.hbbtv.org)
connection (typically via DSL) to TV sets ("Connected TVs") and set-top boxes (STBs). The HbbTV specification was developed to manage the increasing amount of available content targeted at today’s end consumer. It is based on elements of existing standards and web technologies including those developed by OIPF[^32], CEA[^33], DVB[^34] and W3C[^35]. HbbTV was standardised by ETSI in June 2010 [18].

![HbbTV Logo](image)

**Figure 39 - HbbTV Logo**

According to the HbbTV Consortium which now counts more than 50 international members, HbbTV products and services will “provide the consumer with a seamless entertainment experience with the combined richness of broadcast and broadband. This entertainment experience will be delivered with the simplicity of one remote control, on one screen and with the ease of use of television that we are used to. Through the adoption of HbbTV, consumers will be able to access new services from entertainment providers such as broadcasters, online providers and also CE manufactures including catch-up TV, video on demand (VoD), interactive advertising, personalisation, voting, games and social networking as well as programme-related services such as digital text and EPGs.”

Today, devices capable are available from all major manufacturers ranging from a few hundred to several thousand Euros. All DVB transmission modes are used, even for DVB-IP first devices are under development. After Germany which pioneered the introduction of HbbTV into the market since IFA 2010, France and Spain launched HbbTV in 2011. Several more European countries show also great interest and prepare first applications for test cases.

HbbTV and NoTube share similar objectives. The use case scenarios which are in focus of NoTube could technically also be realised with HbbTV. However, in contrary to a lot of available HbbTV applications today, which are clearly broadcast-centric and programme-related, NoTube aims at providing general solutions across all electronic media services. HbbTV applications require negotiations with all service providers involved. Nevertheless, the technologies developed in NoTube might result in broadcast-centric or programme-related applications suitable for HbbTV. Besides, more and more broadcast-independent HbbTV applications are available, too.

### 4.3.2 Interfaces with AmI

The NoTube project explored Ambient Intelligence systems and technologies for the integration of the user that is moving inside the Home Ambient. The core features of a generic Ambient Intelligence system are:

- **Embedded**: many different devices are integrated into the environment
- **Personalized**: they can be tailored to the user needs
- **Adaptive**: they can change in response to the user needs
- **Context aware**: these devices can recognize the ambient context

[^33]: Consumer Electronics Association, [http://www.ce.org/](http://www.ce.org/)
[^35]: World Wide Web Consortium, [http://www.w3.org/](http://www.w3.org/)
A typical context for Ambient Intelligence environments is the Home Ambient defined in the NoTube project. A variety of technologies can be used to enable Ambient Intelligence interfacing with the user. Among others the Consortium evaluated:

4.3.2.1. **QR Codes**  
A QR code (Quick Response code) is a two-dimensional barcode; the system has become popular due to its fast readability and large storage capacity. The code consists of black modules arranged in a square pattern on a white background. The information encoded can be any kind of data. For example it can be used in the Home Ambient in order to uniquely identify users and devices and perform the pairing between the main consumption device and the second screen device. Such mechanism has been implemented in the use case 7.a.

4.3.2.2. **RFID**  
Radio-frequency identification (RFID) is a technology that uses radio waves to transfer data from an electronic tag attached to an object through a reader for the purpose of identifying and tracking the object. Some RFID tags can be read from several meters away and beyond the line of sight of the reader. The tag information is stored electronically. The RFID tag includes a small RF transmitter and receiver. An RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information. Many RFID tags do not use a battery. Instead, the tag uses the radio energy transmitted by the reader as its energy source.

4.3.2.3. **Human Implant**  
A human microchip implant is an integrated circuit device or RFID transponder implanted in the body of a human being. A sub dermal implant typically contains a unique ID number that can be linked to information contained in an external database, such as personal identification, medical history, medications, allergies, and contact information.

4.3.2.4. **Sensors (and Sensor Networks)**  
A sensor is a device which receives and responds to a signal and it is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. A sensor networks can be used to monitor the movement of the user inside the Home Ambient.

4.3.2.5. **Affective Computing**  
The Affective computing study the way for enable the machine to interpret the emotional state of humans and adapt its behaviour to them, giving an appropriate response for those emotions. Is the study and development of systems and devices that can recognize, interpret, process, and simulate human affection. It is an interdisciplinary field spanning computer sciences, psychology, and cognitive science.

4.3.2.6. **Biometrics**  
Biometrics can be used as a form of identity access management and access control. Biometrics consists of methods for uniquely recognizing humans based upon one or more physical or behavioural characteristics. In particular it could be used to identify individuals inside the Home Ambient. Biometric characteristics can be: physiological, that are related to the body of the user (fingerprint, face recognition, DNA and retina) or behavioural, related to the behaviour of a person (typing rhythm, gait and voice).
4.3.2.7. XMPP
Speaking in terms of communication protocol standards a very interesting work is the Extensible Messaging and Presence Protocol (XMPP) that is an open-standard communication protocol for message-oriented middleware. XMPP-based software is deployed widely across the Internet according to the XMPP Standards Foundation. XMPP is a set of open technologies for instant messaging, presence, multi-party chat, voice and video calls, collaboration, lightweight middleware, content syndication, and generalized routing of XML data. XMPP can be used inside the Home Ambient for the exchange of data between devices. Sub-prototyping in use case 7.c made use of this technology during the project lifetime.

4.3.2.8. AmI in NoTube
Due to the vastness of the subject in the NoTube project only some aspect of integration between Home Ambient and AmI have been developed in the three prototypes. For instance, UC 7.c uses XMPP for data exchange between devices while UC 7.a implemented the QR Code for authentication and user access. Please see WP7 for more details about the individual implementation of the chosen technologies.

To give an idea, UC 7.a Home Ambient third prototype has been extended with a second-screen device, namely an Android-based smartphone. User identification and pairing with the main consumption display is exposed through QR code. The user can access 7.a functionalities by ambient intelligence authentication (Figure 40).

![Figure 40 – AmI in Notube: integrated login using the QRCode (UC 7.a)](image)

When the user logs in the system through his/her mobile device just by pointing it towards the main screen showing the QR code, he/she will be presented with the personalized news show that has been automatically created following the related user profile (as well as all the other functionalities provided by the 7.a demonstrator).

4.4. Comparison with NoTube
The following table provides a quick summary of the listed solutions in terms of:

- Hardware platform - Standard computer, TV/Internet-TV, Set-Top Box/Digital Media Receiver, gaming consoles, proprietary devices
- Controller device – Standard/Custom remote control, second-screen support including mobile devices and smartphones, any additional controller
- App Support – Whether or not the considered solution offers the support of Apps, enabling the platform extension in terms of software functionalities.
- Personal Profile Support – Refers to the ability of the platform to manage personal profiles not just in terms of user identity but involving personal details, preferences or application-specific attributes.
- Personalised Content Recommendation – Refers to the platform’s capability to provide content recommendations on top of user’s profile or behaviour, out of the box.
- Content Enrichment – Refers to the platform’s capability to provide metadata enrichment out of the box.
- Social Network Support – Refers to the platform’s capability to provide or contextual or standalone social network support.

The aim is to highlight the technology trends in terms of software and hardware features in respect to the NoTube platform.
<table>
<thead>
<tr>
<th>Solution's Name</th>
<th>Platform</th>
<th>Controller Device</th>
<th>App Support</th>
<th>Personal Profile Support</th>
<th>Personalised Content Recommendation</th>
<th>Content Enrichment</th>
<th>Social Networks Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google TV</td>
<td>TV (Sony Internet TV), STB (Logitech Revue), both running Google TV</td>
<td>Second Screen/Mobile Support (Android) and/or manufacturer's proprietary remote control</td>
<td>Yes (Google TV specific apps)</td>
<td>Not by platform</td>
<td>Yes, on top of manufacturer's customisations</td>
<td>Not by platform, depending on individual Apps</td>
<td>Not integrated by the platform but instead by services (i.e. YouTube) or specific Apps</td>
</tr>
<tr>
<td>Apple TV</td>
<td>Apple TV digital media receiver, running an iOS custom version</td>
<td>Second Screen/Mobile Support (iOS) and/or Apple Remote</td>
<td>Yes (Apple App Store)</td>
<td>Yes, iTunes account</td>
<td>Yes, basing on iTunes</td>
<td>Partial (static) as provided by iTunes, then it's up to individual Apps</td>
<td>Ping, as part of Apple iTunes platform or specific Apps</td>
</tr>
<tr>
<td>Boxee</td>
<td>Boxee Box, running proprietary OS</td>
<td>Proprietary remote control with QWERTY keyboard</td>
<td>Yes</td>
<td>No</td>
<td>No, the only recommendations come from the community statistics</td>
<td>No</td>
<td>Yes, supporting Facebook, Twitter and Google Buzz integration</td>
</tr>
<tr>
<td>Lava</td>
<td>Lava TV, running Google Android</td>
<td>Proprietary remote control</td>
<td>Yes (Android Market place)</td>
<td>Not by platform</td>
<td>Not by platform, depending on individual Apps</td>
<td>Not by platform, depending on individual Apps</td>
<td>Not integrated by the platform, depending on individual Apps</td>
</tr>
<tr>
<td>Zune Video Rental</td>
<td>Microsoft XBOX 360</td>
<td>XBOX Joypad, Microsoft Remote Control</td>
<td>No</td>
<td>Yes, Microsoft Live account</td>
<td>No</td>
<td>No</td>
<td>Yes, as part of the whole platform (nor specific to the media center)</td>
</tr>
<tr>
<td>Service</td>
<td>TV (Manufacturer)</td>
<td>TV manufacturer's remote control</td>
<td>Yes (widgets)</td>
<td>Not by platform</td>
<td>Not by platform, depending on individual widgets</td>
<td>Not by platform, depending on individual widgets</td>
<td>Yes, by ad-hoc widgets</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------</td>
<td>----------------------------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Yahoo! Connected TV</td>
<td>TV (Toshiba, Sony, Vizio, LG, etc.)</td>
<td>Proprietary remote control (QWERTY keyboard for certain models)</td>
<td>Yes, proprietary</td>
<td>Not by platform</td>
<td>Not by platform, depending on individual Apps</td>
<td>Not by platform, depending on individual Apps</td>
<td>Yes, via &quot;Samsung Social TV&quot;</td>
</tr>
<tr>
<td>Samsung Smart TV</td>
<td>Samsung TV</td>
<td>Platform dependant hardware</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, via Facebook</td>
</tr>
<tr>
<td>Netflix</td>
<td>Standard PCs, Macs, gaming consoles, STB, Internet-connected TVs, Android and iOS handheld devices</td>
<td>Platform dependant hardware</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, via Facebook</td>
</tr>
<tr>
<td>Hulu (Plus)</td>
<td>Standard PCs, Macs, gaming consoles, STB, Internet-connected TVs, Android and iOS handheld devices</td>
<td>Platform dependant hardware</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes, via Facebook</td>
</tr>
</tbody>
</table>

Table 2 – Software and Hardware trends of the market solutions
Provided that the global contact point between NoTube and the listed solutions is the aim of unifying Broadcast and Broadband worlds, we’ve chosen the above categories for the summary since they adhere to the pillars of our project. In particular we focussed our attention on software features like personalised contents, recommendation and enrichment as well as social networks.

From the hardware requirements side it’s not so straightforward to derive a common trend: it appears that some manufactures (i.e.: Sony, Samsung, LG, etc.) are pushing towards the integration of TV and Internet within the same physical package, sometimes in partnership with the so-called open platforms like Google’s one (Google TV or Android) and some are instead preferring to provide the user with more flexibility, by packaging their product in small Set-Top Boxes or Digital Media Receivers (like Apple, Boxee). In addition to these two main trends, big manufacturers leading the gaming market like Microsoft, Sony and Nintendo are pushing towards the integration of TV or, more in general, multimedia services, in popular gaming consoles. A cross solution that touches all these different approaches is represented by companies like Netflix and Hulu that started their activity as simple e-services for movie rental and then extended their capabilities by adding streaming contents besides physical rental as well as by integrating social TV capabilities. Here NoTube appears to be well aligned to all these possibilities: thanks to the flexibility of the Home Ambient architecture the three use cases implement demonstrators running on a variety of devices: from standard computers to set-top boxes or Internet-connected TVs. Gaming consoles are not supported but it’s not realistic to integrate NoTube in such devices: consoles market is owned by two or three big companies around the world that build up closed a very limited set of solutions, providing their own hardware and software and then protecting their own interests.

Directly related to this topic is the discussion about how the platform is controlled by the end user. Here the solutions offered by the market are mainly towards traditional or customised remote controllers with fancy keyboards or special keys. Some manufacturer, however, is trying to integrate more and more mobile devices like popular smartphones (Android or iOS based) in order to augment the whole experience with the “second screen” paradigm. The latter path is exactly what NoTube is trying to follow from the beginning and WP7.a represents a clear example in doing so: nowadays smartphones and tablets are commonly adoted as companion devices when watching TV shows or movies, mainly in order to chat with friends or share live comments on social networks. So, why not making the whole experience more integrated? Smartphones could be paired with the main display device, acquiring the context, acting as remote controllers and providing also personalised or elaborated contents via a set of services that are exactly the ones mentioned earlier on (enrichment, recommendation, etc.). Of course such experience could be enriched or limited depending on the platform capabilities in terms of provided services.

Usually, to mitigate this lack of features and to follow the popular, successful trend of mobile devices, almost all manufacturers are adding support to Apps or widgets that users could choose from the related marketplace basing on personal preferences. This trend does not apply to video streaming services like Netflix and Hulu but instead empowers almost all the most popular platforms like Google TV, Yahoo! Connected TV, Samsung Smart TV, etc. NoTube provides this feature through the NoTube User Portal, implementing a privacy protection mechanism for which each chosen App prompts the user to explicitly grant access to the personal profile or a part of it.

Going on in our analysis, it’s surprising to see that personal profile support is weak across the majority of the analysed solutions. In particular it seems that user identities are supported by almost everyone (in other words the possibility to login/logout with a personal account) but very few players save personal details to customise the final experience. In this respect NoTube goes beyond the simple static user profile paradigm by integrating user
activity logging from subscribed social network streams in order to better infer user tastes and interest basing on his/her comments and activities in the different communities.

Personal recommendation, feature that is usually strictly related to the personal profile, is often provided on top of the whole community experience and feedback and not on a personal basis such as in NoTube. Metadata enrichment, on the other side, is somewhat absent at all while in NoTube is one of the core services. However, looking at the analysed market solutions, it's important to notice that, unlike in NoTube, recommendation and enrichment (when present), are often not part of the considered platform but instead provided by Apps as part their individual, standalone behaviour.

The same consideration applies to social networks integration for the content-centric products: it seems that more or less everyone nowadays allows to access Facebook, Twitter, etc., however there’s no connection with the user profile and there’s no integration with the context (e.g.: the TV show the user is watching) that, in turn, is how the thing works in NoTube. And this how it works for the analysed social-centric applications.

In conclusion, at the end of this brief overview of the market technologies, it seems that NoTube integrated architecture, after 3 years from the beginning of the project, proves to successfully support features that are consolidated in commercial products but, at the same time, provides enough flexibility to move a step forward in the direction of the very recent trends like personalised contents, contextual social network integration, semantic content recommendation and enrichment. In this respect NoTube appears to be both content-centric and social-centric, covering the best of the two worlds and providing room for continuous improvement.
5. Conclusions

This document represents a companion to the third and final release of the NoTube integrated services platform developed in WP6 with references to the application scenario prototypes developed in the scope of WP7. Its purpose is to provide an overview of the integrated services platform including the broad lines of the integration approach.

This deliverable provides a high level view of the developed and exploited services for the main categories envisaged in NoTube from the beginning of the project. The internal evaluation plan in terms of actors, goals, target groups and methodology has been presented as well focusing on field-specific issues like legacy systems and data/privacy protection. Results have been included and elaborated accordingly to drive the last phase of the platform development.

The NoTube services platform is the result of a design and implementation work that accommodates requirements originating from several different stakeholders (e.g. service developers, use case designers, broadcasters, end users) and integrates heterogeneous technologies into a unified reference framework. This process required an effort from both a technical design and coordination perspective.

From a technical perspective the main research challenges faced have been the integration of heterogeneous software modules involving different technologies, data repositories and, in turn, potentially different data formats. This also includes the procedures for interfacing legacy Content Management Systems with NoTube semantic services. From the coordination perspective, we closely monitored activities both in the R&D work packages (WP1-5) and the application scenarios (WP7a/b/c). This iterative communication activity facilitated the individual prototypes implementation as well as the development of a set of platform services in line with both the project goals and the specific scenarios requirements. Tight cooperation with activities in WP5 was also instrumental in creating a service base that supports brokerage, and, in turn, a use cases design that is decoupled from low level services thanks to the Service Broker.

The NoTube User Portal, in its final prototype stage, has been detailed extending the past concept of end-user with the roles of administrator and generic end user. NoTube Apps repository has been introduced together with two sample applications (EPG and Enrichment), giving the possibility for the future to easily add new ones with the only requirement for the new App to provide a Web-based entry point. The internal application logic can leverage the updated back-end services for profile-related tasks as well as platform services by direct invocation or through the Semantic Service Broker. The user profile privacy has been further improved by introducing the possibility for the user to explicitly grant/deny access to profile details or just a part of them.

An additional input we’ve tried to provide in the third year is related not only to the final achievements within NoTube but also to the potential future improvements after the contractual end of the project. This process has been bootstrapped through a market and technology evaluation activity focusing on hardware devices, delivery models, standards and, more in general, market trends that have influenced our work, complemented by exploitation plans elaborated in WP9. The technical comparison with NoTube in its final stage appears comforting, proving the success of many architectural and technological choices during the three years we’ve spent and promising in terms of platform’s potential.
6. References

[18] Hybrid Broadcast Broadband TV, ETSI TS 102 796 (V1.1.1), European Telecommunications Standards Institute (ETSI), June 2010
7. Annex I – Evaluation Results

7.1. Legacy CMS Integration (Broadcasters Perspective)

Question 1
Does the existing environment present internal databases that need to be integrated with NoTube?
- Yes: 13%
- No: 67%

Question 2
Does the existing environment present legacy CMS or components that need to be integrated with NoTube?
- Yes: 13%
- No: 67%

Question 3
Assuming to integrate NoTube (or a subset of the NoTube’s services) in the existing workflow, please rate the impact of its introduction in terms of workflow alteration.
- No Impact: 1%
- Low Impact: 3%
- Medium Impact: 10%
- High Impact: 0%

Question 4
Does NoTube replace or improve any feature of the existing environment?
- Yes: 33%
- No: 67%

If yes, please provide a brief description of the major improvements. View Survey: enrichment, EPG Management, User Profiling, Recommendation.

Question 5
Assuming to integrate NoTube (or a subset of the NoTube’s services) in the existing environment, please rate the impact of its introduction in the existing workflow in terms of perceived performance.
- Slower: 5%
- Equal: 100%
- Faster: 0%
Question 6
Is the existing system depending on integrated NoTube services or will it be able to run as before?
- Dependent: 33%
- Independent: 67%

Question 7
Please rate the improvements introduced by NoTube in terms of metadata enrichment.
- Doesn't apply: 0%
- No improvements: 0%
- Low improvements: 67%
- Medium improvements: 33%
- High improvements: 0%

Question 8
Please rate the improvements introduced by NoTube in terms of content recommendation.
- Doesn't apply: 0%
- No improvements: 33%
- Low improvements: 33%
- Medium improvements: 33%
- High improvements: 0%

Question 9
Please rate the improvements introduced by NoTube in terms of audio/video processing.
- Doesn't apply: 33%
- No improvements: 0%
- Low improvements: 0%
- Medium improvements: 33%
- High improvements: 33%

Question 10
Does NoTube introduce potential threats like copyright loss, proprietary data leaks, etc. Please rate this sentence.
- Doesn't apply: 0%
- No: 33%
- Yes minor threats: 0%
- Yes severe threats: 33%
- Yes many threats: 33%

Table:
<table>
<thead>
<tr>
<th>ID</th>
<th>If yes, please add some more details.</th>
<th>View</th>
<th>Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>D350681</td>
<td>The sharing of any audio/video material gives some threats anyway. The NoTube platform promotes this type of sharing and so also the copyright issues.</td>
<td>View</td>
<td></td>
</tr>
<tr>
<td>S453561</td>
<td>some grabbers may obtain protected (EPG) data or data protected by other authors (IMDB etc)</td>
<td>View</td>
<td></td>
</tr>
</tbody>
</table>
7.2. Legacy CMS Integration (Developers Perspective)

Question 1*
Are broadcasters using standard metadata formats? Please rate each project use case.

<table>
<thead>
<tr>
<th>UC 7.a</th>
<th>Only proprietary formats</th>
<th>Some standards used</th>
<th>Fully compliant to standards</th>
<th>Responses</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>2</td>
<td>33%</td>
</tr>
<tr>
<td>UC 7.b</td>
<td>0%</td>
<td>10%</td>
<td>60%</td>
<td>2</td>
<td>33%</td>
</tr>
<tr>
<td>UC 7.c</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>2</td>
<td>33%</td>
</tr>
</tbody>
</table>

Question 2*
Are broadcasters using standard A/V formats? Please rate the project use cases about it.

Only proprietary formats 0%  
Some standards used 50%  
Fully compliant to standards 50%

Question 3*
Considering the integration with the different use cases, please rate the effort impact of mapping the existing data and metadata formats to NoTube.

Minimal overhead 0%  
Proper analysis required 50%  
Higher than expected 50%

Question 4*
Considering the experiences with the project use cases, please rate the reusability of the metadata conversion services implemented.

Doesn’t apply 0%  
Ad-hoc services hard to reuse 0%  
Some services could be reused 50%  
Fully reusable services 50%

Question 5*
Considering the experiences with the project use cases, please rate the reusability of the audiovisual processing services implemented.

Doesn’t apply 0%  
Ad-hoc services 0%  
Some services could be reused 100%  
Fully reusable services 0%
**Question 6**

Does the integration of audiovisual processing services require additional services (i.e. transcoding, normalizing, etc.)?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

100% 9%

---

**Question 7**

What’s your perception about broadcasters’ willingness to integrate services directly versus using a middleware? Please rate each project use case.

<table>
<thead>
<tr>
<th>Keen to adopt a middleware</th>
<th>Keen to integrate services directly</th>
<th>Doesn’t matter</th>
<th>Responses</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC 7.a</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>2</td>
</tr>
<tr>
<td>UC 7.b</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>2</td>
</tr>
<tr>
<td>UC 7.c</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**Question 8**

Please rate the easiness of collecting clear requirements for services design and development, with respect to real-life scenarios.

- Straightforward: 3 0%
- Not always clear: 3 0%
- Difficult: 1 50%
- Very difficult: 1 50%

---

**Question 9**

Will you be happy to install your services onsite (within the broadcaster’s environment) or would you prefer to host and maintain your services in house?

- Onsite: 1 60%
- In-house: 0 0%
- Doesn’t matter: 1 50%

---

**Question 10**

Do your services leverage on proprietary technologies introducing license-related constraints, royalties, etc. or are you developing free open-source software?

<table>
<thead>
<tr>
<th>ID</th>
<th>You can add more details here.</th>
<th>View Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>5420182</td>
<td>Some services are open, others use commercial licenses.</td>
<td>View</td>
</tr>
</tbody>
</table>
7.3. Security and Privacy Preservation

**Question 1**
Considering the adopted technologies for local data storage, how much are they driven by the security preservation requirement?

- No impact: 0%
- Low impact: 0%
- Medium impact: 100%
- High impact: 0%

**Question 2**
Are you using any kind of data encryption to store personal data?

- Yes: 9%
- No: 100%

**Question 3**
How easy is for an hacker breaking into the local user data to link the user identity with the user personal details?

- Straightforward: 0%
- Easy: 0%
- Hard requiring skills: 0%
- Almost impossible for a human: 0%
- Almost impossible with the current technology: 0%

**Question 4**
How are the social user activities collected?

- Anonymously: 0%
- Making direct reference to the user: 0%
- Making indirect reference to the user: 100%

**Question 5**
Please rate the security of the social user activities storage.

- Low: 0%
- Medium: 100%
- High: 0%
Question 6*
How much time are the collected user activities kept into the system?

<table>
<thead>
<tr>
<th>Days</th>
<th>Months</th>
<th>Years</th>
<th>Forever</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Question 7*
How easy is it for a hacker to break into the user data to link the user identity with the user social activities?

<table>
<thead>
<tr>
<th>Straightforward</th>
<th>Easy</th>
<th>Hard requires skills</th>
<th>Almost impossible for a human</th>
<th>Almost impossible with the current technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Question 8*
Are personal user activities collected from social networks accessed in a secure way (i.e.: OAuth)?

<table>
<thead>
<tr>
<th>ID</th>
<th>Please add more details here.</th>
<th>View Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>6132864</td>
<td>Activities are accessed in the most secure way foreseen by the specific social network</td>
<td>View</td>
</tr>
</tbody>
</table>

Question 9*
Are personal user activities collected from social networks exchanged in a secure way (i.e.: HTTPS)?

<table>
<thead>
<tr>
<th>ID</th>
<th>Please add more details here.</th>
<th>View Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>6132864</td>
<td>TEST HTTP api as exposed by the social network</td>
<td>View</td>
</tr>
</tbody>
</table>

Question 10*
Is any kind of personal data coming from the NoTube local network stored in external data sources?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Question 11*

In the assumption of a malicious access, please rate how easy it is to link external user activities with locally stored user identities.

- Straightforward: 0%  
- Easy: 2%  
- Hard requires skills: 0%  
- Almost impossible for a human: 0%  
- Almost impossible with current technology: 0%