Deliverable D2.2 Specification of lightweight metadata models for multimedia annotation

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Work Package 2: Linking hypervideo to Web content

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Abstract (for dissemination)	This deliverable presents a state-of-art and requirements analysis report for the LinkedTV metadata model as part of the WP2 of the LinkedTV project. More precisely, we first provide a comprehensive overview of numerous multimedia metadata formats and standards that have been proposed by various communities: broadcast industry, multimedia analysis industry, news and photo industry, web community, etc. Then, we derive a number of requirements for a LinkedTV metadata model. Next, we present what will be the LinkedTV metadata ontology, a set of built-in classes and properties added to a number of well-used vocabularies for representing the different metadata dimensions used in LinkedTV, namely: legacy metadata covering both broadcast information in the wide sense and content metadata and multimedia analysis results at a very fine grained level. We finally provide a set of useful SPARQL queries that have been evaluated in order to show the usefulness and expressivity of our proposed ontology.

History

Table 1: History of the document

Date	Version	Name	Comment
2012/06/01	v0.1	Vacura, UEP	Initial Version, survey of existing ontologies
2012/07/03	v0.2	Redondo García, EURECOM	Description of the selected ontologies for describing multimedia metadata in LinkedTV
2012/08/23	v0.3	Redondo García, EURECOM	Examples for the two scenarios (RBB and Sound and Vision)
2012/08/27	v0.4	Redondo García, EURERCOM	Conversion in RDF of both the legacy metadata and the results of automatic analysis
2012/08/28	v0.5	Troncy, EURECOM	Formatting and clarification
2012/09/07	v0.6	Troncy, EURECOM	Address QA comments
2012/10/02	v0.7	Troncy, EURECOM	Address more QA comments
2012/10/11	v0.8	Troncy, EURECOM	Add long appendix made of SPARQL queries and results, finalized deliverable
2012/10/16	v0.9	Troncy, EURECOM	Address remaining QA comments
2012/10/18	v1.0	Troncy, EURECOM	Finalization after second QA assessment

0 Table of Content

1 Introduction

Multimedia systems typically contain digital documents of mixed media types, which are indexed on the basis of strongly divergent metadata standards. This severely hampers the inter-operation of such systems. Therefore, machine understanding of metadata comming from different applications is a basic requirement for the inter-operation of distributed multimedia systems. In the context of LinkedTV, we have to deal with metadata standards that come from both the broadcast industry and the web community. Furthermore, the content will be processed by automatic multimedia analysis tools which have their own formats for exchanging their results. One of the main goal of LinkedTV is to enrich seed video content with additional content, personalized to a particular user, that come from diverse sources including broadcast archives, web media, news and photo stock agencies or social networks.

We aim at studying this broad diversity in order to present in this deliverable a state-of-art and requirements analysis report for the LinkedTV metadata model. More precisely, we first provide a comprehensive overview of numerous multimedia metadata formats and standards that have been proposed by various communities: broadcast industry, multimedia analysis industry, news and photo industry, web community, etc. (Section 2).

We derive then a number of requirements for a LinkedTV metadata model (Section 3). In particular, we adopted semantic web technologies and its languages as a basis for representing the semantics of the metadata model (Figure 1). When developing the LinkedTV metadata model, we always had in mind to design a lightweight model that would re-use as much as possible existing vocabularies. This has lead to the development of the first version of the LinkedTV metadata ontology, a set of built-in classes and properties added to a number of well-used vocabularies for representing the different metadata dimensions used in LinkedTV, namely: legacy metadata covering both broadcast information in the wide sense and content metadata and multimedia analysis results at a very fine grained level (Section 4). We conclude this deliverable by outlining future work regarding an online metadata converter following the model presented in this deliverable (Section 5). We finally provide a set of useful SPARQL queries that have been evaluated in order to show the usefulness and expressivity of our proposed ontology (Section 6).

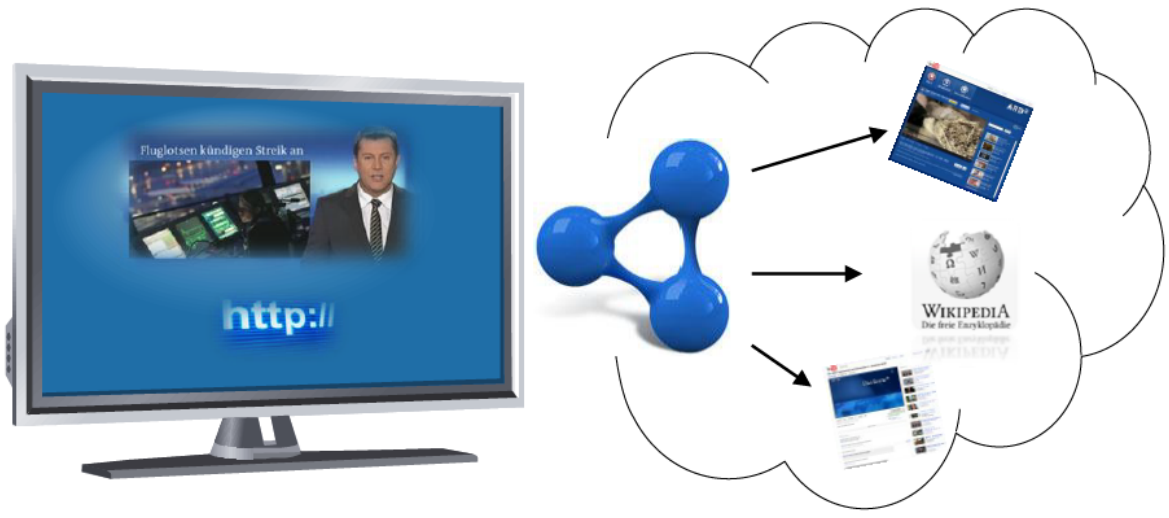


Figure 1: LinkedTV vision

2 State of the art in lightweight multimedia metadata models

Multimedia object is a term that encompasses a wide variety of media items (both analog and digital), with different modalities and in a broad range of applications. Multimedia metadata needs to capture this diversity in order to describe the multimedia object itself and its context. A large number of multimedia metadata standards exist, coming from different application areas, focusing on different processes, supporting different types of metadata and providing description on different levels of granularity and abstraction.

In [vNH04] the authors discuss requirements for semantic content description and review the capabilities of standards coming from the W3C and MPEG communities. In the second part of their article [NvH05a], they focus on the formal semantic definition of these standards which determines the expressiveness for semantic content description and enables mapping between descriptions. The report in [EZG+06] surveys multimedia ontologies and related standards and defines requirements for a multimedia ontology of which many are also relevant for multimedia metadata standards. A comprehensive overview on multimedia metadata standards and formats has been prepared by the W3C Multimedia Semantics XG [HBB+07]. A recent review in [PVS08] focuses on the standards from MPEG but also discusses interoperability issues between standards in the context of general multimedia metadata application scenarios.

This section provides a comprehensive overview of the most commonly used multimedia metadata standards. In LinkedTV, we deal with so called seed video content or broadcast content. Therefore, we start by describing several metadata formats developed in the broadcast industry in the Section . Work Package 1 is in charge of performing numerous multimedia analysis processes on this seed video content. The low-level features computed are then interpreted into higher level semantic metadata information that can be used to describe the program content. We review the standards developed by the multimedia analysis community in the Section . The goal of the work package 2 is also to enrich seed video content with additional multimedia content hosted and shared on the web. We review the current formats used to describe the web multimedia content in the Section . The news and photo industry has a long tradition of developing metadata standards for photos and videos. We review those formats in the Section . Since two years, the W3C has created a working group to standardize an ontology that will bridge the gap between the numerous standards used on the web to develop multimedia content. We describe in details the resulting Ontology for Media Resources, a W3C recommendation, that will be heavily used in LinkedTV in the Section . Events are also commonly used to describe multimedia resources: event models can be used to describe the fact of broadcasting a program on a channel at a particular moment in time, or they can be used to describe the content itself at a very fine grained level. We review the event models proposed by the semantic web community and beyond in the Section . Being automatically or manually made, multimedia metadata consist of annotations that link a concept or an entity with a multimedia content or a part of it (called media fragments). This annotation relationship can sometimes be reifed or specialized. In any case, we need a powerful yet general model for representing this annotation relationship. We present the ongoing effort of the web community under a W3C community group to propose a generic annotation model with several extensions in the Section . Finally, we conclude this survey by describing several commonly used vocabularies such as FOAF or the Provenance Ontology in the Section .

2.1 Metadata models from the broadcasting industry

The broadcast industry has developed several metadata formats for representing TV programs, their broadcast information or targeted audience and their content in order to generate Electronic Program Guides. In this section, we review those different standards. First, we describe the XML-based formats such as DVB, BMF developed by the German broadcaster ARD and TV Anytime. Second, we present more recent models that are largely inspired by the Semantic Web technologies such as EBU (and its application in EU Screen and Europeana) or the BBC Programmes ontology.

2.1.1 DVB metadata model

> *The Digital Video Broadcasting Project (DVB[1]) is an industry-led consortium of around 250 broadcasters, manufacturers, network operators, software developers, regulatory bodies and*

[1] http://www.dvb.org/metadata/index.xml

others in over 35 countries committed to designing open technical standards for the global delivery of digital television and data services.

The DVB metadata model contains the following classification schemes, represented using the MPEG-7 standard:

- Audio Codec: `http://www.dvb.org/metadata/cs/AudioCodecCS.xml`
- Video Codec: `http://www.dvb.org/metadata/cs/VideoCodecCS.xml`
- Parental Guidance, a complex classification scheme: `http://www.dvb.org/metadata/cs/ParentalGuidance.xml`
- Broadband Content Guide Type, composed of only 3 classes: `http://www.dvb.org/metadata/cs/BCGTypeCS.xml`

The DVB metadata model is also composed of various XML Schemas:

- DVB Classification Scheme schema: `http://www.dvb.org/metadata/schema/dvbCSschema.xsd`
- Content Item Information which uses mostly MPEG7 and TV Anytime content types: `http://www.dvb.org/metadata/schema/ContentItemInformation.xsd`
- File Content Item Information with duration and geolocation information: `http://www.dvb.org/metadata/schema/FileContentItemDescription.xsd`

DVB is using the MPEG standard (Moving Picture Expert Group) to compress, en-code and transmit audio / video and data streams. Several variable bit rate data streams are multiplexed together to a fixed data stream. This makes it possible to transfer video and audio channels simultaneously over the same frequency channel, together with various services. These data services provide additional programme information to enable a complete EPG (Electronic Program Guide) for present and following schedule programme events. A DVB programme event consists of a broadcast at a certain scheduled date. Digital television and services are broadcasted in various platforms and technologies with specified transmission and encoding standards. Each platform is specified by a standard by the European Telecommunications Standards Institute (ETSI)[2].

The DVB transport stream includes metadata called Service Information (DVB-SI). This metadata delivers information about transport stream as well as a description for service / network provider and programme data to generate an EPG and further programme information. The Service Information information tables which are of interest for LinkedTV are the EIT (Event Information Table) and the SDT (Service Description Table).

The EIT contains additional sub tables with information about the present and following events by each service. This includes:

- Start time (Start time of the event)
- Duration (Duration of the event)
- Short event descriptor (Name and a short description of the current event)
- Extended event descriptor (Detailed long text description of the event)
- Content descriptor (Classification of the event)

The SDT delivers particular information about the service of the current transport stream such as the Service name and the Service identification.

The content descriptor from the EIT table defines a classification schema for a pro-gramme event. It provides various genre categories using a two-level hierarchy. First it specifies a first (top) level genre which is categorized more specifically in the second level. Top level contains about 12 genres (with several sub genres): Undefined, Movie/Drama, News/Current affairs, Show/Game show, Sports, Children's/Youth programs, Music/Ballet/Dance, Arts/Culture (without music), Social/Political issues/Economics, Education/Science/Factual topic, Leisure hobbies, Special characteristics. Each top level genre contains several sub genres describing the content of the current broadcast more specifically. The classification information is encoded in the EIT table using 4-bit fields assigned to each level within DVB transport stream.

[2]European Telecommunications Standards Institute, `http://www.etsi.org`

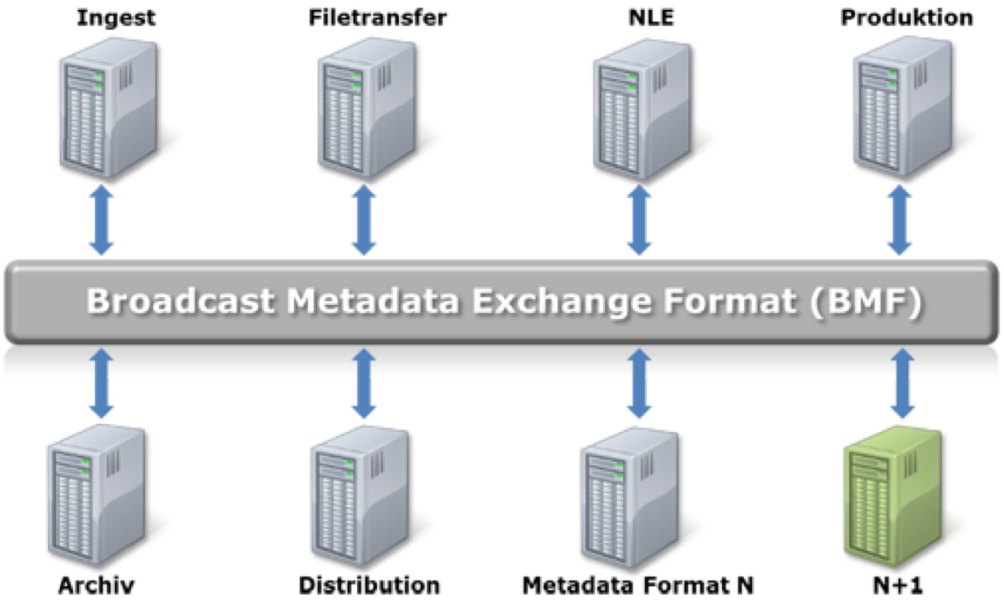


Figure 2: Broadcast Metadata Exchange Format (BMF) 2.0, courtesy of `http://www.irt.de/en/activities/production/bmf.html`

2.1.2 ARD BMF

IRT (Institut für Rundfunktechnik / Broadcast Technology Institute) is the primary research institute co-operating with public-broadcasting organisations in Germany, Austria and Switzerland. The Institute focuses on solutions which enhance the quality of radio, television and new media for the benefit of users and is committed to preserving broadcasting in Germany and abroad. IRT associates are the following public broadcasters: ARD, ZDF, DRadio, ORF and SRG/SSR.

The Broadcast Metadata Exchange Format Version 2.0 (BMF 2.0) has been developed by IRT in close cooperation with German public broadcasters with focus on the harmonization of metadata and the standardized exchange thereof. The standard particularly reflects the requirements of public broadcasters (figure 2). BMF contains metadata vocabulary for TV, radio and online content and defines a standardized format for computer-based metadata exchange. It facilitates the reuse of metadata implementations and increases the interoperability between both computer-based systems and different use case scenarios. BMF enables to describe TV, radio and online content as well as production, planning, distribution and archiving of the content. Metadata in BMF are represented in XML documents while the structure for the XML metadata is formalized in an XML Schema. The latest version of the format is the version BMF 2.0 Beta[3].

2.1.3 TV Anytime

The TV-Anytime Forum is a global association of organizations founded in 1999 in USA focusing on developing specifications for audio-visual high volume digital storage in consumer platforms (local AV data storage). These specifications for interoperable and integrated systems should serve content creators/providers, service providers, manufacturers and consumers. The forum created a working group[4] for developing a metadata specification, so-called TV-Anytime[5] and composed of (Figure 3):

- Attractors/descriptors used e.g. in Electronic Program Guides (EPG), or in web pages to describe content (information that the consumer – human or intelligent agent – can use to navigate and select content available from a variety of internal and external sources).
- User preferences, representing user consumption habits, and defining other information (e.g. demographics models) for targeting a specific audience.

[3] `http://bmf.irt.de/en`
[4] `http://www.tv-anytime.org/workinggroups/wg-md.html`
[5] `http://www.tv-anytime.org`

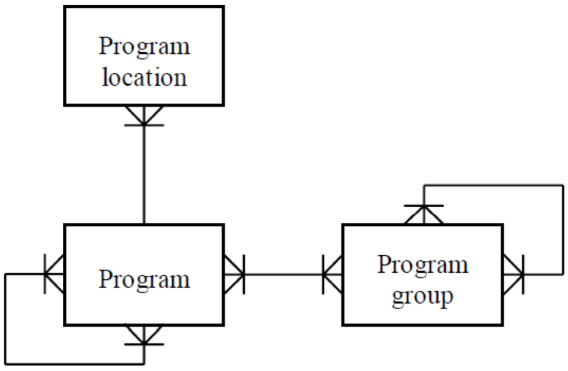


Figure 3: TV-Anytime Content Description Model

– Describing segmented content. Segmentation Metadata is used to edit content for partial recording and non-linear viewing. In this case, metadata is used to navigate within a piece of segmented content.

– Metadata fragmentation, indexing, encoding and encapsulation (transport-agnostic).

The TV-Anytime metadata specification focuses in Phase 1 on uni-directional delivery of content but bi-directional access to metadata is also supported. The next Phase 2 is currently in stage of requirements preparation and preparation of Call for Contribution. TV Anytime employs the MPEG-7 Description Definition Language (DDL) based on XML to be able to describe metadata structure and also the XML encoding of metadata. TV-Anytime also uses several MPEG-7 datatypes and MPEG-7 Classification Schemes.

The TV-Anytime Content Description model is depicted on Figure 3[6] and its documentation provides the following definitions:

– Entity definitions:

  ◦ *Program* - the programme represents an editorially coherent piece of content.

  ◦ *Program group* - the programme group simply represents a grouping of programmes. A number of different types of group have been identified, such as series, show, aggregate (magazine) programme, and programme concept. Programme groups can also contain other programme groups.

  ◦ *Program location* - A programme location contains information about one instance (or publication event) of a programme. Multiple programme locations from the same service provider can be grouped to form a schedule.

– Relationship definitions:

  ◦ *Program to Program location (zero to many)*: a given programme can appear at any number of programme locations (e.g. schedule events) and a given programme location instantiates one programme.

  ◦ *Program to Program Group (many to many)*: a given programme can be a member of any number of programme groups and a given programme group can contain any number of programmes.

  ◦ *Program Group to Program Group (many to many)*: a given arbitrary programme group can contain any number of programme groups and a given programme group can be a member of many programme groups.

  ◦ *Program to Program (many to many)*: a programme can be part of one or more aggregated programmes and aggregated programmes contain one or more than one programme.

As an example, we reproduce the XML schemas of some simple and complex types structure, as shown in Figures 4, 5, and 6.

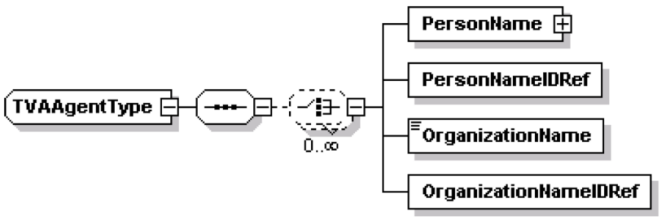


Figure 4: TV-Anytime Agent Type

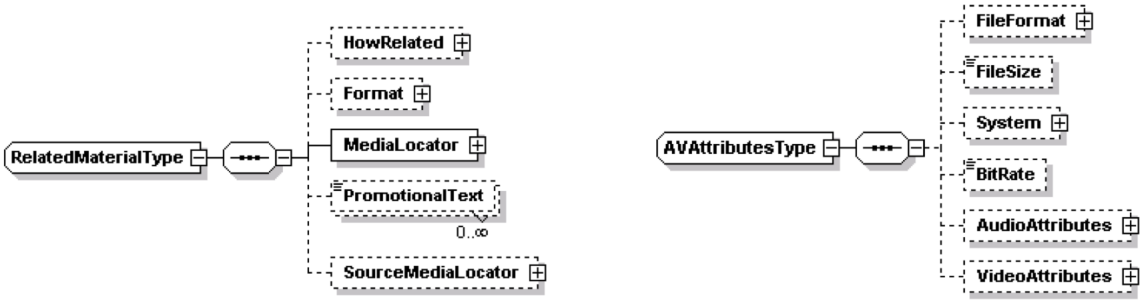


Figure 5: TV-Anytime Related Material and AV Attributes Type

NoTube[7] is a European research project that aims to show how Semantic Web technologies can be used to connect TV content and Web content using Linked Open Data. NoTube uses TV-Anytime as the persistent internal metadata format. The project participants argue that it was the only standardised format widely used in CE devices such as STBs, PVRs at that time. TV metadata interoperability[8] has also been well studied by the project. In particular, various converters have been implemented to align the PrestoSpace metadata model with TV Anytime via a proposed ontology of the BMF format described above.

2.1.4 EBU metadata model

The EBU (European Broadcasting Union) is the collective organization of Europe's 75 national broadcasters claiming to be the largest association of national broadcasters in the world. EBU's technology arm is called EBU Technical. EBU represents an influential network in the media world[9]. The EBU projects on metadata are part of the Media Information Management (MIM) Strategic Programme. MIM benefits from the expertise of the EBU Expert Community on Metadata (EC-M), participation to which is open to all metadata experts, or users and implementers keen to learn and contribute[10].

MIM currently manages four projects:

– MM: Metadata Models

– AM: Acquisition Metadata

– SCAIE: automatic extraction / generation of metadata

– MDN: Metadata Developer Network

[6] Image taken from `ftp://tva:tva@ftp.bbc.co.uk/pub/Specifications/COR3_SP003v13.zip`, document SP003v13 PartA.doc

[7] `http://notube.tv/`

[8] `http://notube.tv/tv-metadata-interoperability/`

[9] `http://tech.ebu.ch/aboutus`

[10] `http://tech.ebu.ch/metadata`

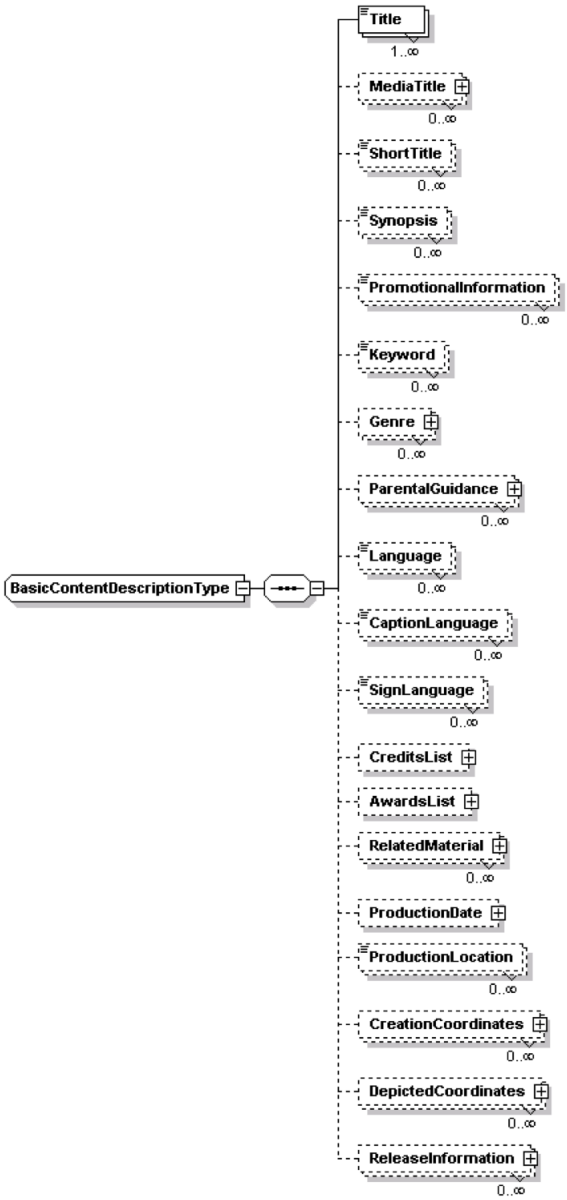


Figure 6: TV-Anytime Basic Content Description Type

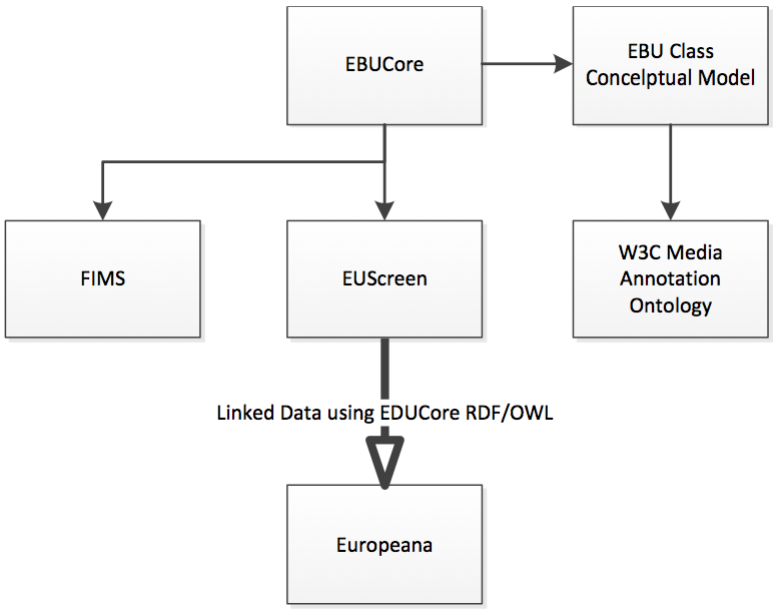


Figure 7: EBUCore and its relationships to other metadata models

EBUCore. The EBUCore (EBU Tech 3293) is the main result of this effort to date and the flagship of EBU's metadata specifications. It can be combined with the Class Conceptual Data Model of simple business objects to provide the appropriate framework for descriptive and technical metadata for use in Service Oriented Architectures. It can also be used in audiovisual ontologies for semantic web and Linked Data environment. EBUCore has high adoption rate around the world. It is also referenced by the UK DPP (Digital Production Partnership). All EBU metadata specifications[11] are coherent with the EBU Class Conceptual Data Model (CCDM).

EBUCore is the foundation of technical metadata in FIMS 1.0 (Framework for Interoperable Media Service)[12]. FIMS is currently under development. It embodies the idea of sites like Google, Twitter, YouTube and many other web sites offer service interfaces to remotely initiate an action, export data, import a file, query for something, etc. FIMS specifies how media services should operate and cooperate in a professional, multi-vendor, IT environment – not just through a web site interface[13].

EBUCore is also the metadata schema of reference in the project EUScreen which delivers linked data to Europeana using EBUCore's RDF/OWL representation. EBUCore has been also published as AES60 by the Audio Engineering Society (AES)[14]. The W3C Media Annotation Ontology is based on EBU's Class Conceptual Data Model and is fully compatible with EBUCore which mapping has been defined and published as part of the W3C specification (Figure 7).

EU Screen. EU Screen[15] consists of 28 partners and 9 associate partners in fields of audiovisual archives, research and software technology from 20 European countries. The EUscreen project focuses on promotion of exploration of Europe's rich and diverse cultural history by the use of television content. It aims to create access to over 30,000 items of programme content and information. It also plans to develop interactive functionalities and interlinking with Europeana.

The content selection policy for EUscreen is divided into three strands.

- Historical Topics.
- Comparative Virtual Exhibitions.
- Content Provider Virtual Exhibitions.

[11] http://tech.ebu.ch/MetadataSpecifications
[12] http://wiki.amwa.tv/ebu/index.php/Main_Page
[13] http://community.avid.com/blogs/avid/archive/2011/09/28/building-media-workflows.aspx?cmpid=AV-SM-IME-2
[14] http://www.aes.org/
[15] http://www.euscreen.eu/

The **EUscreen metadata schema** is based on **EBUcore** schema that are backward compatible with the **Video Active** schema and fully mappable to the Europeana[16] Data Model (EDM 5.2)[17]. It includes 39 elements of which 18 are mandatory. Programme classification in EUscreen consists of seven main headings:

- *News*: Including news bulletins, news magazine programme, politics programmes, current affairs, newsreels, discussion programmes about events in the news, feature programmes about events in the news, elections, party conferences, political speeches, political broadcasts, live (outside broadcasts) of state occasions.
- *Drama/Fiction*: Including series drama, serial drama, single drama (teleplays), cop/police/detective/crime dramas, soap opera, telenovela, family sagas, docudrama/drama-documentary, animated drama, tele fantasy and science fiction.
- *Entertainment and performing arts*: Including comedy, stand-up comedy, situation comedy, sketch shows, political comedy, satire, cartoons (for adults and/or children) quiz and game shows, celebrity talk shows, variety shows, cabaret, dancing shows, talent competitions, music programmes and concerts (popular and classical), ballet, pantomime and mime.
- *Factual Programming*: Including documentary (observational/fly-on-the-wall), reality television, docu-soap, historical programmes, science programmes, natural history programmes, biographical documentaries, government information films, documentaries about the arts, travel programmes, lifestyle programmes about shopping, cookery, fashion, homes, gardens and hobbies.
- *Advertisements*: Including all commercial advertisements for consumer products and services.
- *Interstitials and trailers*: Including trailers for future programmes and events, and channel idents and logos, continuity announcements.
- *Sport*: Including regional, national and international sporting events.

Other EBU Specifications. The metadata projects and EC-M experts also contribute to the definitions of metadata solutions for the EBU-AMWA FIMS project via the MIM FIMS project (user group). Over the last few years the European Broadcasting Union (EBU) and its members have developed several metadata specifications to facilitate the search and exchange of content:

- EBU Tech 3293 - EBUCore: `http://tech.ebu.ch/docs/tech/tech3293v1_3.pdf`
- EBU Tech 3295 - P-META: `http://tech.ebu.ch/docs/tech/tech3295v2_2.pdf`
- EBU Tech 3331 - Exchange: `http://tech.ebu.ch/docs/tech/tech3331v1_1.pdf`
- EBU Tech 3332 - Music: `http://tech.ebu.ch/docs/tech/tech3332v1_1.pdf`
- EBU Tech 3336 - Classification Schemes: `http://tech.ebu.ch/docs/tech/tech3336v1_1.pdf`
- EBU Tech 3340 - egtaMETA: `http://tech.ebu.ch/docs/tech/tech3340.pdf`
- EBU Tech 3349 - Acquisition Metadata: `http://tech.ebu.ch/docs/tech/tech3349.pdf`
- EBU Tech xxxxx - CCDM: `http://tech.ebu.ch/Jahia/site/tech/classmodel`
- EBU Eurovision - News Exchange: `http://tech.ebu.ch/webdav/site/tech/shared/metadata/NMS_NewsML-G2_eng.pdf`

Tech 3295 (P-META) consists of descriptive elements and datatypes based on XML. It is designed to be able to describe structure of AV content (programme groups, shots, audio channels, etc.). It contains also rights information. Some of the Tech 3295 constructs are also reused in EBUCore. P-META can be used together with standards such as MPEG-7 as specified by the European project PrestoSpace[18] or PrestoPrime.

[16]The Europeana Foundation aims at enhancing collaboration between museums, archives, audiovisual collections. It is developing a cross-domain portal providing access to Europe's cultural and scientific heritage. It also facilitates required formal agreement across museums, archives, audiovisual archives and libraries. `http://pro.europeana.eu`

[17]`http://blog.euscreen.eu/wp-content/uploads/2010/11/D1.3.1-Annual-public-report-FINAL.pdf`

[18]`http://www.crit.rai.it/attivita/PrestoSpaceFormats/PrestoSpaceFormats.html`

Tech 3331 (Exchange) builds on the P-META tools to specify metadata formats targeted to information exchange between broadcasters and production systems.

Tech 3340 (egtaMETA) is published in collaboration with egta[19], the association of radio and television sales houses. This specification focuses on the exchange of advertising files. egtaMETA consists of semantically defined attributes describing advertising clips (title of the advertising spot, what is the period during which it shall be used, credits inc. keys persons and companies involved in the creation, post-production and release of the advertising spot), and technical information (file format, its audio, video and data components). It uses a standardised XML schema.

EBU Eurovision News Exchange details the NewsML-G2 mapping into which data can be transmitted. EBU has on this basis developed its own EBU RDF representation of NewsML-G2[20].

2.1.5 BBC Programmes

The British Broadcasting Corporation (BBC) is the largest broadcaster in the world. One of the main resource used to describe programmes is the Programmes ontology[21]. This ontology provides the concepts of brands, series (seasons), episodes, broadcast events, broadcast services, etc. and is represented in OWL/RDF. The design of this ontology document is based on the Music Ontology[22] and the FOAF Vocabulary[23]. The programmes model is depicted on Figure 8[24] and in based on the PIPS database schema used previously at the BBC. It describes content in terms of: Brands, Series, Episodes and Programs.

Publishing is then described in terms of Versions of episodes and Broadcasts. Versions are temporarily annotated. Publishing of content is related to medium, that is described in terms of: Broadcaster, Service-outlet and Channel. This conceptual scheme describes how brands, series, episodes, particular versions of episodes and broadcasts interact with each other. The BBC Programmes ontology also re-uses other ontologies such as FOAF to express a relationship between a programme to one of its actors (a person who plays the role of a character).

The exhaustive list of classes available in the ontology is:

AudioDescribedVersion — Brand — Broadcast — Broadcaster — Category — Channel — Clip — DAB — DVB — Episode — FM — FirstBroadcast — Format — Genre — IPStream — LW — LocalRadio — MusicSegment — NationalRadio — OriginalVersion — Outlet — Person — Place — Programme — ProgrammeItem — Radio — RegionalRadio — RepeatBroadcast — Season — Segment — Series — Service — ShortenedVersion — SignedVersion — SpeechSegment — Subject — Subtitle — TV — Version — Web

The exhaustive list of properties available in the ontology is:

actor — anchor — aspect_ratio — author — broadcast_of — broadcast_on — broadcaster — category — channel — clip — commentator — credit — director — duration — episode — executive_producer — format — frequency — genre — location — long_synopsis — masterbrand — medium_synopsis — microsite — news_reader — outlet — parent_series — parent_service — participant — performer — person — place — position — producer — schedule_date — season_broadcast — series — service — short_synopsis — sound_format — subject — subtitle_language — synopsis — tag — text — time — track — version

2.2 Metadata models from the multimedia analysis community

MPEG-7, formally named *Multimedia Content Description Interface* [MPE01b], is an ISO/IEC standard developed by the Moving Picture Experts Group (MPEG) for the structural and semantic description of multimedia content. MPEG-7 standardizes *tools* or ways to define multimedia *Descriptors* (Ds), *Description Schemes* (DSs) and the relationships between them. The descriptors correspond either to the data features themselves, generally low-level features such as visual (e.g. texture, camera motion) and audio (e.g. spectrum, harmonicity), or semantic objects (e.g. places, actors, events, objects). Ideally, most low-level descriptors would be extracted automatically, whereas human annotation would be required

[19] http://www.egta.com/
[20] http://www.ebu.ch/metadata/ontologies/NML2/ebu_NewsML_2_simplified_v06.owl
[21] http://purl.org/ontology/po/
[22] http://www.musicontology.com/
[23] http://xmlns.com/foaf/spec/
[24] Image taken from http://www.bbc.co.uk/ontologies/programmes/2009-09-07.shtml

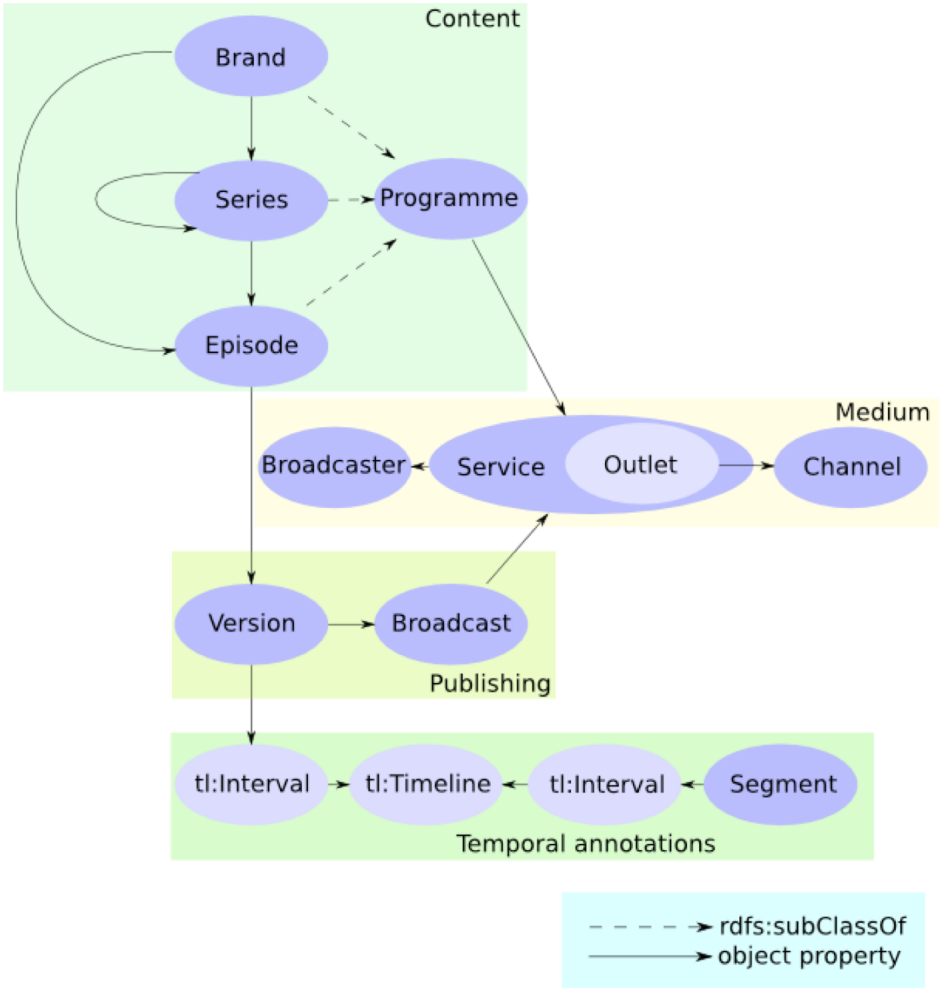


Figure 8: BBC Programme ontology model

for producing high-level descriptors. The description schemes are used for grouping the descriptors into more abstract description entities. These tools as well as their relationships are represented using the *Description Definition Language* (DDL), the core part of MPEG-7. After a requirement specification phase, the W3C XML Schema recommendation[25] has been adopted as the most appropriate syntax for the MPEG-7 DDL.

The flexibility of MPEG-7 is therefore based on allowing descriptions to be associated with arbitrary multimedia segments, at any level of granularity, using different levels of abstraction. The downside of the breadth targeted by MPEG-7 is its complexity and its ambiguity. Hence, MPEG-7 XML Schemas define 1182 elements, 417 attributes and 377 complex types which make the standard difficult to manage. Moreover, the use of XML Schema implies that a great part of the semantics remains implicit. For example, very different syntactic variations may be used in multimedia descriptions with the same intended semantics, while remaining valid MPEG-7 descriptions. Given that the standard does not provide a formal semantics for these descriptions, this syntax variability causes serious interoperability issues for multimedia processing and exchange [NvH05b, ONH04, TC04]. The profiles introduced by MPEG-7 and their possible formalization [TBH+06] concern, by definition, only a subset of the whole standard.

For alleviating the lack of formal semantics in MPEG-7, four multimedia ontologies represented in OWL and covering the whole standard have been proposed [ATS+07a, GC05, Hun01, TPC04]. The Table 2 summarizes the main characteristic of these four ontologies.

	Hunter	**DS-MIRF**	**Rhizomik**	**COMM**
Foundations	ABC	none	none	DOLCE
Complexity	OWL-Full[a]	OWL-DL[b]	OWL-DL[c]	OWL-DL[d]
Coverage	MDS+Visual	MDS+CS	All	MDS+Visual
Reference	[Hun01]	[TPC04]	[GC05]	[ATS+07a]
Applications	Digital Libraries, e-Research	Digital Libraries, e-Learning	Digital Rights Management, e-Business	Multimedia Analysis and Annotations

Table 2: Summary of the different MPEG-7 based Multimedia Ontologies.

[a] http://metadata.net/mpeg7/
[b] http://www.music.tuc.gr/ontologies/MPEG703.zip
[c] http://rhizomik.net/ontologies/mpeg7ontos
[d] http://multimedia.semanticweb.org/COMM/

2.2.1 Hunter's MPEG-7 ontology

In 2001, Hunter proposed an initial manual translation of MPEG-7 into RDFS (and then into DAML+OIL) and provided a rationale for its use within the Semantic Web [Hun01]. This multimedia ontology was translated into OWL, extended and harmonized using the ABC upper ontology [LH01] for applications in the digital libraries [Hun02, Hun03] and eResearch fields [HL05].

The current version is an OWL Full ontology containing classes defining the media types (Audio, AudioVisual, Image, Multimedia, Video) and the decompositions from the MPEG-7 Multimedia Description Schemes (MDS) part [MPE01b]. The descriptors for recording information about the production and creation, usage, structure and the media features are also defined. The ontology can be viewed in Protégé[26] and has been validated using the WonderWeb OWL Validator[27].

This ontology has usually been applied to describe the decomposition of images and their visual descriptors for use in larger semantic frameworks. Harmonizing through an upper ontology, such as ABC, enables queries for abstract concepts such as subclasses of *events* or *agents* to return media objects or segments of media objects. While the ontology has most often been applied in conjunction with the ABC upper model, it is independent of that ontology and can also be harmonized with other upper ontologies such as SUMO [PNL02] or DOLCE [GGM+02].

[25] http://www.w3.org/XML/Schema
[26] http://protege.stanford.edu/
[27] http://www.mygrid.org.uk/OWL/Validator

2.2.2 DS-MIRF ontology

In 2004, Tsinaraki *et al.* have proposed the DS-MIRF ontology that fully captures in OWL DL the semantics of the MPEG-7 MDS and the Classification Schemes. The ontology can be visualized with GraphOnto or Protege and has been validated and classified with the WonderWeb OWL Validator. The ontology has been integrated with OWL domain ontologies for soccer and Formula 1 [TPC07] in order to demonstrate how domain knowledge can be systematically integrated in the general-purpose constructs of MPEG-7. This ontological infrastructure has been utilized in several applications, including audiovisual digital libraries and e-learning.

The DS-MIRF ontology has been conceptualized manually, according to the methodology outlined in [TPC04]. The XML Schema simple datatypes defined in MPEG-7 are stored in a separate XML Schema to be imported in the DS-MIRF ontology. The naming of the XML elements are generally kept in the `rdf:ID`s of the corresponding OWL entities, except when two different XML Schema constructs have the same names. The mapping between the original names of the MPEG-7 descriptors and the `rdf:ID`s of the corresponding OWL entities is represented in an OWL DL mapping ontology. Therefore, this ontology will represent, for example, that the `Name` element of the MPEG-7 type `TermUseType` is represented by the `TermName` object property, while the `Name` element of the MPEG-7 type `PlaceType` is represented by the `Name` object property in the DS-MIRF ontology. The mapping ontology also captures the semantics of the XML Schemas that cannot be mapped to OWL constructs such as the sequence element order or the default values of the attributes. Hence, it is possible to return to an original MPEG-7 description from the RDF metadata using this mapping ontology. This process has been partially implemented in GraphOnto [PTC06], for the OWL entities that represent the `SemanticBaseType` and its descendants.

The generalization of this approach has led to the development of a transformation model for capturing the semantics of any XML Schema in an OWL DL ontology [TC07]. The original XML Schema is converted into a main OWL DL ontology while a OWL DL mapping ontology keeps trace of the constructs mapped in order to allow circular conversions.

2.2.3 Rhizomik ontology

In 2005, Garcia and Celma have presented the Rhizomik approach that consists in mapping XML Schema constructs to OWL constructs following a generic XML Schema to OWL together with an XML to RDF conversion [GC05]. Applied to the MPEG-7 schemas, the resulting ontology covers the whole standard as well as the Classification Schemes and TV Anytime[28]. It can be visualized with Protege or Swoop[29] and has been validated and classified using the Wonderweb OWL Validator and Pellet.

The Rhizomik ontology was originally expressed in OWL Full, since 23 properties must be modeled using an `rdf:Property` because they have both a data type and object type range, i.e. the corresponding elements are both defined as containers of complex types and simple types. An OWL DL version of the ontology has been produced, solving this problem by creating two different properties (`owl:DatatypeProperty` and `owl:ObjectProperty`) for each of them. This change is also incorporated into the XML2RDF step in order to map the affected input XML elements to the appropriate OWL property (object or datatype) depending on the kind of content of the input XML element.

The main contribution of this approach is that it benefits from the great amount of metadata that has been already produced by the XML community. Moreover, it is implemented in the ReDeFer project[30], which allows to automatically map input XML Schemas to OWL ontologies and, XML data based on them to RDF metadata following the resulting ontologies. This approach has been used with other large XML Schemas in the Digital Rights Management domain, such as MPEG-21 and ODRL [GGD07], or in the E-Business domain [GG07].

2.2.4 COMM ontology

In 2007, Arndt *et al.* have proposed COMM, the *Core Ontology of MultiMedia* for annotation. Based on early work [Tro03, IT04], COMM has been designed manually by re-engineering completely MPEG-7 according to the intended semantics of the written standard. The foundational ontology DOLCE serves as the basis of COMM. More precisely, the Description and Situation (D&S) and Ontology of Information Objects (OIO) patterns are extended into various multimedia patterns that formalize the MPEG-7

[28] `http://www.tv-anytime.org`
[29] `http://code.google.com/p/swoop`
[30] http://rhizomik.net/redefer

concepts. The use of a upper-level ontology provides a domain independent vocabulary that explicitly includes formal definitions of foundational categories, such as processes or physical objects, and eases the linkage of domain-specific ontologies because of the definition of top level concepts.

COMM covers the most important part of MPEG-7 that is commonly used for describing the structure and the content of multimedia documents.

- *Decomposition*. COMM provides the equivalence of MPEG-7 decomposition to segments. MPEG-7 provides set of descriptors for spatial, temporal, spatiotemporal and media source decompositions of multimedia content into segments. A segment in MPEG-7 can refer to a region of an image, a piece of text, a temporal scene of a video or even to a moving object tracked during a period of time.
- *Annotation*. COMM provides equivalent of MPEG-7 descriptors used to annotate a segment. These descriptors can be low-level visual features, audio features or more abstract concepts. They allow the annotation of the content of multimedia documents or the media asset itself.

COMM consists of the following main components:

- *Multimedia Data* represents the multimedia content (sub-concept of DigitalData) This concept is further specialized for concrete multimedia content types (e.g. ImageData corresponds to the pixel matrix of an image).
- *Decomposition Pattern* is used to represent decomposition of multimedia content to segments.
- *Content Annotation Pattern* is used to represent attachment of metadata (i.e. annotations) to segmented multimedia content.
- *Media Annotation Pattern* is used to represent attachment of metadata (i.e. annotations) to media.
- *Semantic Annotation Pattern* is used to represent attachment semantic descriptions from independent domain ontologies to multimedia content.
- *Digital Data Pattern* is used to represent information entities of arbitrary size, which are used for communication between machines.
- *Algorithm Pattern* is used to represent execution of algorithms or the application of computer assisted methods which are used to produce or manipulate digital data.

Current investigations show that parts of MPEG-7 which have not yet been considered (e.g. navigation & access) can be formalized analogously to the other descriptors through the definition of other multimedia patterns. COMM is an OWL DL ontology that can be viewed using Protege. Its consistency has been validated using Fact++-v1.1.5. Other reasoners failed to classify it due to the enormous amount of DL axioms that are present in DOLCE. The presented OWL DL version of the core module is just an approximation of the intended semantics of COMM since the use of OWL 1.1 (e.g. qualified cardinality restrictions for number restrictions of MPEG-7 low-level descriptors) and even more expressive logic formalisms are required for capturing its complete semantics[31].

2.2.5 Comparison Summary

Integration with domain semantics. The link between a multimedia ontology and any domain ontologies is crucial. Hunter's MPEG-7 and COMM ontologies both use an upper ontology approach to relate with other ontologies (ABC and DOLCE). Hunter's ontology uses either semantic relations from MPEG-7, such as `depicts`, or defines external properties that use an MPEG-7 class, such as `mpeg7:Multimedia`, as the domain or range. In COMM, the link with existing vocabularies is made within a specific pattern: the *Semantic Annotation Pattern*, reifing the DOLCE Ontology of Information Object (OIO) pattern. Consequently, any domain specific ontology goes under the `dolce:Particular` or `owl:Thing` class.

The DS-MIRF ontology integrates domain knowledge by sub-classing one of the MPEG-7 `SemanticBaseType`: places, events, agents, etc. Furthermore, it fully captures the semantics of the various MPEG-7 relationships represented as instances of the `RelationType`. According to the standard, the value of the these properties must come from some particular classification schemes: `RelationBaseCS`, `TemporalRelationCS`, `SpatialRelationCS`, `GraphRelationCS` and `SemanticRelationCS`. A typed relationship ontology extending DS-MIRF has been defined for capturing all these relationships.

[31] The reification schema of DOLCE D&S is even not completely expressible in OWL 1.1

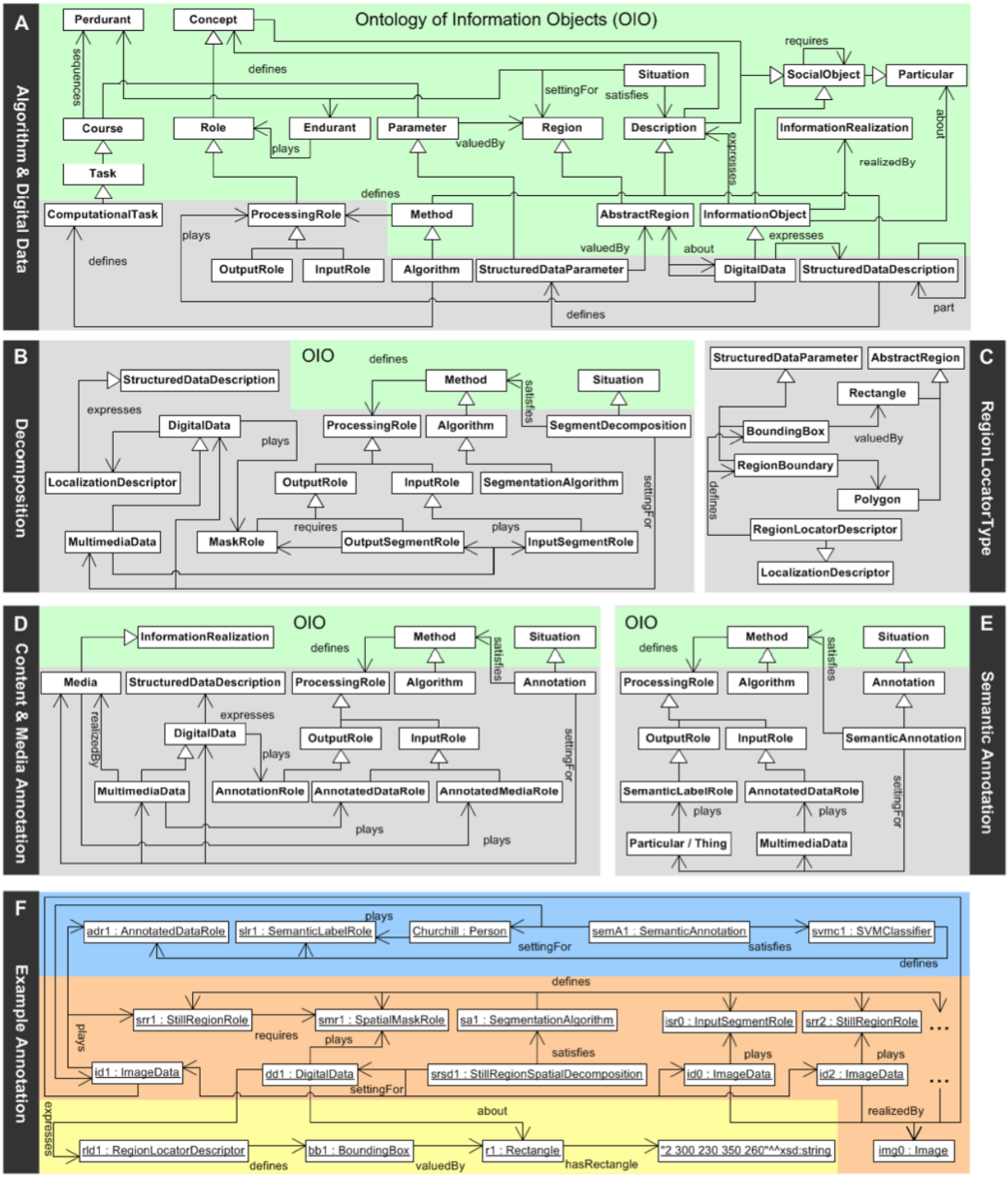


Figure 9: COMM: Core Ontology for Multimedia

Coverage of a multimedia ontology. The four multimedia ontologies discussed here cover partially or totally MPEG-7 (see Table 2). They also extend sometimes the standard. For example, Hunter's MPEG-7 ontology has been extended for the description of scientific mixed-media data. Common terms used in signal processing and image analysis for describing detailed low-level features such as eccentricity, major axis length, lightest color, etc. are lacking in the MPEG-7 visual descriptors. These extra visual feature descriptors have been introduced as sub-properties of the visual descriptor and color properties, using the namespace `mpeg7x` to keep these extensions independent of the core MPEG-7 descriptors [HLH05].

The modeling approach of COMM confirms that the ontology offers even more possibilities for multimedia annotation than MPEG-7 since it is interoperable with existing web ontologies. The explicit representation of algorithms in the multimedia patterns describes the multimedia analysis steps (e.g. manual annotation, output of an analysis algorithm), something that is not possible in MPEG-7. The need for providing this kind of annotation is demonstrated in the use cases of the W3C Multimedia Semantics Incubator Group[32].

Modeling decisions and scalability. An important modeling decision for each of the four ontologies is how much they are tied to the MPEG-7 XML Schema. These decisions impact upon the ability of the ontology to support descriptions generated automatically and directly from MPEG-7 XML output and on the complexity of the resulting RDF. Therefore the modeling choices also affect the scalability of the systems using these ontologies and their ability to handle large media data sets and cope with reasoning over very large quantities of triples.

Both the DS-MIRF and the Rhizomik ontologies are based on a systematic one-to-one mapping from the MPEG-7 descriptors to equivalent OWL entities. For the DS-MIRF ontology, the mapping has been carried out manually while for the Rhizomik ontology, it has been automated using an XSL transformation and it is complemented with an XML to RDF mapping. This has been a key motivator for the Rhizomik ontology and the ReDeFer tool where the objective is to provide an intermediate step before going to a more complete multimedia ontology, such as COMM.

The advantage of the one-to-one mapping is that the transformation of the RDF descriptions back to MPEG-7 descriptions may be automated later on. In addition, this approach enables the exploitation of legacy data and allows existing tools that output MPEG-7 descriptions to be integrated into a semantic framework. The main drawback of this approach is that it does not guarantee that the intended semantics of MPEG-7 is fully captured and formalized. On the contrary, the syntactic interoperability and conceptual ambiguity problems such as the various ways of expressing a semantic annotation remain.

The COMM ontology avoids doing a one-to-one mapping for solving these ambiguities that come from the XML Schemas, while an MPEG-7-to-COMM converter is still available for re-using legacy metadata. A direct translation from an MPEG-7 XML description using Hunter's ontology is possible. However, in practice, the multimedia semantics captured by the ontology have instead been used to link with domain semantics. Therefore rather than translating MPEG-7 XML descriptions into RDF, this ontology has been used to define semantic statements about a media object and to relate these statements to the domain semantics.

2.3 Metadata models from the web community

2.3.1 hMedia

hMedia[33] is a format aiming to be simple and open for publishing metadata about Images, Video and Audio. It can be embedded in XML and HTML, XHTML, Atom or RSS formats. It is closely related to hCard[34] and uses its facilities for describing information about people, companies, organizations. The basic properties defined in this format are:

- fn: The name of a media.
- contributor: Using text or hCard.
- photo: Using the HTML IMG element (optional).
- player: Using any appropriate html element such as OBJECT (optional).

[32] `http://www.w3.org/2005/Incubator/mmsem/XGR-interoperability/`
[33] `http://microformats.org/wiki/hmedia`
[34] `http://microformats.org/wiki/hcard`

– enclosure: A URL using the rel-design-pattern.

2.3.2 schema.org

Schema.org provides a collection of schemas freely available for marking up data. It offers a number of schemas usable for metadata annotation of multimedia data.

– schemas used for describing the encoding metadata of audiovisual data (MediaObject): AudioObject, ImageObject, VideoObject.

– schemas designed for metadata description specific to: Book, Movie, TVSeries, Recipe, CreativeWork, Painting, Photograph, Sculpture etc.

The example below used the Movie schema:

```
<div itemscope itemtype="http://schema.org/Movie">
  <h1 itemprop="name">Pirates of the Carribean: On Stranger Tides (2011)</h1>
  <span itemprop="description">Jack Sparrow and Barbossa embark on a quest to
  find the elusive fountain of youth, only to discover that Blackbeard and
   his daughter are after it too.</span>
  Director:
  <div itemprop="director" itemscope itemtype="http://schema.org/Person">
    <span itemprop="name">Rob Marshall</span>
  </div>
  Writers:
  <div itemprop="author" itemscope itemtype="http://schema.org/Person">
    <span itemprop="name">Ted Elliott</span>
  </div>
  <div itemprop="author" itemscope itemtype="http://schema.org/Person">
    <span itemprop="name">Terry Rossio</span>
  </div>
</div>
```

2.3.3 MediaRSS

MediaRSS[35] is a RSS module developed to supplement the ¡enclosure¿ capabilities of RSS 2.0. Currently RSS enclosures are used to integrate audio files and images to RSS. Media RSS is an extension that allows handling other media types and enables media creator to provide additional metadata with the media.

MediaRSS defines its namespace to be `http://search.yahoo.com/mrss/`. The primary elements of MediaRSS are:

– <**media:group**> sub-element of <item>. Enables grouping of <media:content>.

– <**media:content** is a sub-element of either <item>or <media:group>. It defines the following properties:

  ◦ url - specifies the direct URL to the media object.

  ◦ fileSize - specifies the number of bytes of the media object.

  ◦ type - the standard MIME type.

  ◦ medium - specifies the type of media object (image — audio — video — document — executable).

  ◦ isDefault - specifies if this is the default media object that should be used for the ¡media:group¿.

  ◦ expression - specifies if the media object is a sample or the full version of the object, and if it is a continuous stream (sample — full — nonstop).

  ◦ bitrate - specifies the kb/sec rate of media.

  ◦ framerate - specifies frames/sec rate of the media object.

  ◦ samplingrate - specifies samples/sec (kHz) rate of media object.

  ◦ channels - specifies number of audio channels in the media object.

  ◦ duration - specifies playing time of the media object plays.

  ◦ height - specifies the height of the media object.

[35] `http://www.rssboard.org/media-rss`

- width - specifies the width of the media object.
- lang - specifies the primary language of the media object. Language codes are derived from RFC 3066, similarly to the xml:lang attribute detailed in the XML 1.0 Specification (Third Edition).

Optional elements of MediaRSS are:

- media:rating
- media:title
- media:description
- media:keywords
- media:thumbnails
- media:category
- media:hash
- media:player
- media:credit
- media:copyright
- media:text
- media:restriction
- media:community
- media:comments
- media:embed
- media:responses
- media:backLinks
- media:status
- media:price
- media:license
- media:subtitle
- media:peerLink
- media:rights
- media:scenes

2.3.4 YouTube metadata

YouTube[36] is an online video streaming service provided by Google. It provides documentation (YouTube Data API) for programmers who are writing client applications that interact with YouTube media content. It lists the different types of feeds that a user can retrieve and provides diagrams that explain how to navigate between them. It also defines the parameters used in YouTube Data API requests as well as the XML tags returned in an API response. The YouTube API supports the following XML schemas for tags Youtube Data API requests:

- Atom elements: `https://developers.google.com/youtube/2.0/reference?hl=de-CH#Atom_elements_reference`.

[36] `https://developers.google.com/youtube/2.0/reference?hl=de-CH#YouTube_elements_reference`

- OpenSearch elements: https://developers.google.com/youtube/2.0/reference?hl=de-CH#OpenSearch_elements_reference.
- Media RSS elements: https://developers.google.com/youtube/2.0/reference?hl=de-CH#Media_RSS_elements_reference.
- GData elements: https://developers.google.com/youtube/2.0/reference?hl=de-CH#GData_elements_reference.
- GeoRSS elements: https://developers.google.com/youtube/2.0/reference?hl=de-CH#GeoRSS_elements_reference.
- GML elements: https://developers.google.com/youtube/2.0/reference?hl=de-CH#GML_elements_reference.
- Atom Publishing Protocol elements: https://developers.google.com/youtube/2.0/reference.
- Browser-based upload API response elements.
- Batch processing elements.

2.4 Metadata models from the news and photo industry

2.4.1 IPTC

The IPTC (International Press Telecomunications Council) is a consortium of more than 60 news agencies, news publishers and news industry vendors from all continents except South America and Oceania. It develops and maintains technical standards for improved news exchange that are used by the most of major news organizations in the world.

2.4.2 G2 standards and their predecessors

IPTC provides news standards. The latest specifications are part of the so-called G2 family of standards that are based on XML but created with the Semantic Web technologies idea[37]. The family of formats consists of:

- NewsML-G2 - standard to exchange news of any kind and media-type (XML).
- EventsML-G2 - standard for conveying event information in a news industry environment (XML).
- SportsML-G2 - standard for sharing sports data (XML).

Older News Exchange Formats are:

- NewsML 1 - IPTC's first standard to exchange multimedia news and packages of them (XML).
- NITF - format to define the content and structure of news articles (XML).
- IIM - first multimedia format of the IPTC (binary data).
- IPTC7901 - first news exchange format of the IPTC which is still widely used for simple text-only transmissions.

2.4.3 IPTC Photo Metadata Standard

The IPTC Photo metadata standards are described in the CEPIC-IPTC Image Metadata Handbook[38]. IPTC provides also a free Adobe CS Metadata toolkit. IPTC issued the *Embedded Metadata Manifesto (2011)* document proposing guiding principles for embedding metadata in image formats[39].

[37] http://www.iptc.org/site/News_Exchange_Formats/
[38] http://www.iptc.org/site/Photo_Metadata/
[39] http://www.iptc.org/site/Photo_Metadata/Embedded_Metadata_Manifesto_(2011)

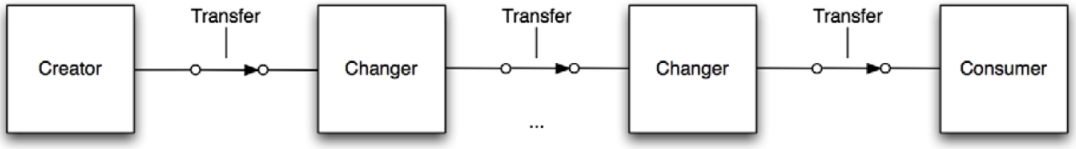


Figure 10: MWG Guidelines Actor state diagram

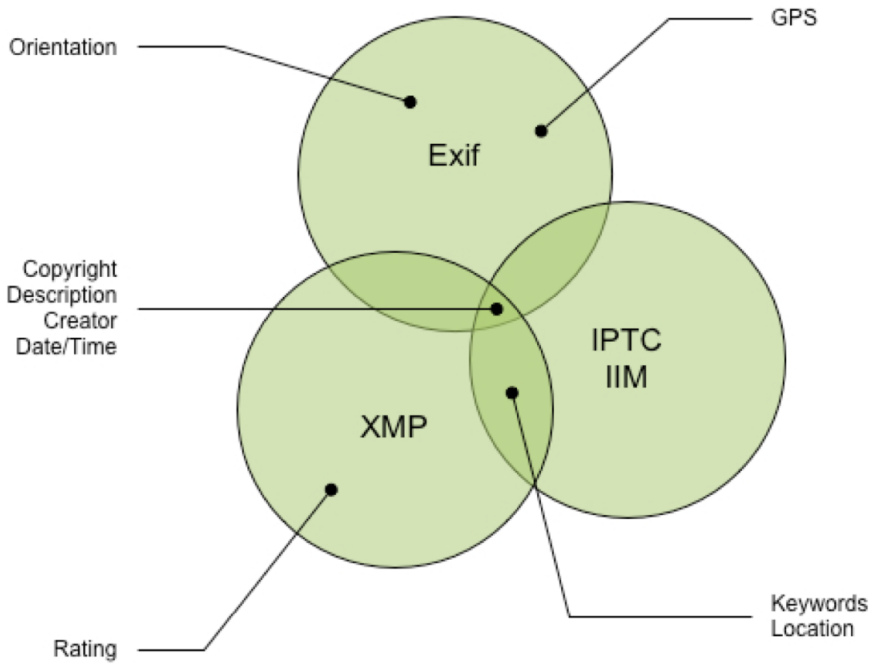


Figure 11: MWG image metadata relation results

2.4.4 rNews

IPTC works recently on the rNews[40] format to embed metadata in online news. rNews is considered by IPTC to be at production level, i.e. the version 1.0 was approved in October 2011. rNews uses RDFa to embed semantic markup into HTML documents.

2.4.5 Metadata Working Group's Guidelines for Handling Image Metadata

The Metadata Working Group[41] (MWG) is a consortium of companies in the digital media industry, focused on preservation and seamless interoperability of digital image metadata and interoperability and availability to all applications, devices, and services. Technical specifications published by MWG describe ways to effectively store metadata into digital media files. These specifications are freely available to software developers, manufacturers and service providers, ensuring that their use of metadata is consistent. It also allows consumers to better describe, organize and find their media. MWG specifications often rely on existing standards and the current document is the Guidelines For Handling Image Metadata version 2.0[42].

MWG guidelines introduce the notion of different actors that play specific roles in metadata processing. There are essentially three types of actors: Creator, Changer and Consumer. The Guidelines For Handling Image Metadata specification also analyzes existing image metadata formats and their respective relation. They end up with result depicted on Figure 10.

[40] http://dev.iptc.org/rNews
[41] http://www.metadataworkinggroup.com/specs
[42] http://www.metadataworkinggroup.com/pdf/mwg_guidance.pdf

2.5 W3C Ontology for Media Resources

The Ontology for Media Resources[43] is a core vocabulary of descriptive properties for media resources. Its main aim is to bridge the different descriptions of media resources and provide a coherent set of media metadata properties along with their mappings to existing metadata standards and formats. The Ontology for Media Resources provides also implementation compatible with Semantic Web paradigm in RDF/OWL form. It is a W3C recommendation since February 2012, produced the Media Annotations Working Group[44].

The Ontology for Media Resources provides mapping tables for metadata from many other standards such as CableLabs 1.1, DIG35, Dublin Core, EBUcore, EXIF 2.2, ID3, IPTC, LOM 2.1, Media RSS, MPEG-7, OGG, QuickTime, DMS-1, TTML, TV-Anytime, TXFeed, XMP, YouTube, 3GP, Flash (FLV, F4V), MP4, WebM. The following subsections provide an overview of the core properties, their descriptions and their relevance for the LinkedTV project.

2.5.1 Identification properties

LinkedTV will use URI identifiers to uniquely identify media resources. Properties such as title, language and locator will also be used. Language and locator properties are necessary for providing input to software that performs advanced analysis of media data.

Table 3: Ontology for Media Resources - Identification properties

Name	Description
identifier	A URI identifying a media resource, which can be either an abstract concept (e.g., Hamlet) or a specific object (e.g., an MPEG-4 encoding of the English version of "Hamlet"). When only legacy identifiers are available, a URI must be minted, for example using the tag: scheme RFC 4151.
title	A tuple that specifies the title or name given to the resource. The type can be used to optionally define the category of the title.
language	The language used in the resource. We recommend to use a controlled vocabulary such as BCP 47. An BCP 47 language identifier can also identify sign languages e.g. using ISO 639-3 subtags like bfi (British sign language).
locator	The logical address at which the resource can be accessed (e.g. a URL, or a DVB URI).

`http://www.ietf.org/rfc/rfc4151.txt`
`http://www.rfc-editor.org/rfc/bcp/bcp47.txt`

2.5.2 Creation properties

The Ontology for Media Resources contains properties for describing the creator of the media resource. LinkedTV will use those properties together with more advanced provenance information when needed.

2.5.3 Technical Properties

The Ontology for Media Resources contains properties for describing the technical information of the media resource.

2.5.4 Content description properties

The Ontology for Media Resources contains simple (free text) properties for describing the content itself of a media resource. For general properties, such as the description, this is appropriate for LinkedTV but we will use the more general Open Annotation model for linking annotations to media fragments.

[43] `http://www.w3.org/TR/mediaont-10/`
[44] `http://www.w3.org/2008/WebVideo/Annotations/`

Table 4: Ontology for Media Resources - Creation properties

Name	Description
contributor	A tuple identifying the agent, using either a URI (recommended best practice) or plain text. The role can be used to optionally define the nature of the contribution (e.g., actor, cameraman, director, singer, author, artist, or other role types). An example of such a tuple is: `imdb:nm0000318`, director.
creator	A tuple identifying the author of the resource, using either a URI (recommended best practice) or plain text. The role can be used to optionally define the category of author (e.g., playwright or author). The role is defined as plain text. An example of such a tuple is: `dbpedia:Shakespeare`, playwright.
date	A tuple defining the date and time that the resource was created. The type can be used to optionally define the category of creation date (e.g., release date, date recorded, or date edited).
location	A tuple identifying a name or a set of geographic coordinates, in a given system, that describe where the resource has been created, developed, recorded, or otherwise authored. The name can be defined using either a URI (recommended best practice) or plain text. The geographic coordinates include longitude, latitude and an optional altitude information, in a given geo- coordinate system (such as the World Geodetic System) that MAY also be specified. At least a name or (longitude, latitude) must be provided. A registry of coordinate reference systems such as EPSG Geodetic Parameter Dataset can be used to identify coordinate systems by URIs.

`http://www.w3.org/2003/01/geo/`
`http://www.epsg-registry.org/`

2.5.5 Relational properties

Relational properties are intended to convey a semantic relationship between a source content and other resources that sometimes are derivative. For example, one can express a semantic relationship between a movie and its trailer. This set of properties will be useful for typing the relationship between a seed video content and the suggested hyperlinked resources.

2.5.6 Rights properties

The Ontology for Media Resources contains simple properties to describe the rights to attach to a media resource.

2.5.7 Distribution properties

The Ontology for Media Resources contains properties to describe the publisher and the target audience of a media resource. This is however much simpler that what a standard such as TV Anytime can express.

2.5.8 Fragment properties

The Ontology for Media Resources contains finally properties to describe media fragments identified by media fragments URI.

2.6 Event metadata models

2.6.1 Event Ontology

The Event Ontology[45] is developed by Y.Raimond and S. Abdallah in the Centre for Digital Music in Queen Mary, University of London. The central concept of this ontology is the notion of event understood as the way by which cognitive agents classify arbitrary time/space regions. The Event ontology is inspired by the work of J. F. Allen and G. Fergusson who claim: *"events are primarily linguistic or*

[45] `http://motools.sourceforge.net/event/event.html`

Table 5: Ontology for Media Resources - Technical properties

Name	Description
frameSize	A tuple defining the frame size of the resource (e.g., width and height of 720 and 480 units, respectively). The units can be optionally specified; if the units are not specified, then the values MUST be interpreted as pixels.
compression	The compression type used. For container files (e.g., QuickTime, AVI), the compression is not defined by the format, as a container file can have several tracks that each use different encodings. In such a case, several compression instances should be used. Thus, querying the compression property of the track media fragments will return different values for each track fragment. Either or both of two values may be supplied: a URI, and a free-form string which can be used for user display or when the naming convention is lost or unknown. The URI consists of a absolute-URI (RFC 3986, section 4.3) and fragment (RFC 3986, section 3.5), that is, e.g. in the form absolute-URI#name. The absolute-URI identifies the naming convention used for the second parameter, which is a string name from that convention. A URL is preferred for the URI, and if it is used, it (a) might contain a date in the form mmyyyy, indicating that the owner of the domain in the URL agreed to its use as a label around that date and (b) should be dereferencable, yielding an informative resource about the naming convention. Note that this use of URIs with fragments also closely matches RDF. Note that for some container files, the format parameter can also carry an extended MIME type to document this; see RFC 4281, for one such instance. See examples.
format	The MIME type of the resource (e.g., wrapper or bucket media types, container types), ideally including as much information as possible about the resource such as media type parameters, for example, using the “codecs” parameter - RFC 4281.
samplingRate	The audio sampling rate. The units are defined to be samples/second.
frameRate	The video frame rate. The units are defined to be frames/second.
averageBitRate	The average bit rate. The units are defined to be kbps.
numTracks	A tuple defining the number of tracks of a resource, optionally followed by the type of track (e.g., video, audio, or subtitle).

`http://www.ietf.org/rfc/rfc3986.txt`
`http://www.ietf.org/rfc/rfc4281.txt`
`http://www.w3.org/2003/01/geo/`

Table 6: Ontology for Media Resources - Content description properties

Name	Description
description	Free-form text describing the content of the resource.
keyword	A concept, descriptive phrase or keyword that specifies the topic of the resource, using either a URI (recommended best practice) or plain text. In addition, the concept, descriptive phrase, or keyword contained in this element SHOULD be taken from an ontology or a controlled vocabulary.
genre	The category of the content of the resource, using either a URI (recommended best practice) or plain text. In addition, the genre contained in this element SHOULD be taken from an ontology or controlled vocabulary, such as the EBU vocabulary .
rating	The rating value (e.g., customer rating, review, audience appreciation), specified by a tuple defining the rating value, an optional rating person or organization defined as either a URI (recommended best practice) or as plain text, and an optional voting range. The voting range can optionally be used to define the minimum and maximum values that the rating can have.

`http://www.ebu.ch/metadata/cs/web/ebu_ContentGenreCS_Mapping_p.xml.html`

Table 7: Ontology for Media Resources - Relational properties

Name	Description
relation	A tuple that identifies a resource that the current resource is related with (using either a URI -recommended best practice- or plain text), and optionally, specifies the nature of the relationship. An example is a listing of content that has a (possibly named) relationship to another content, such as the trailer of a movie, or the summary of a media resource.
collection	The name of the collection (using either a URI or plain text) from which the resource originates or to which it belongs. We recommend to use a URI, as a best practice.

Table 8: Ontology for Media Resources - Rights properties

Name	Description
copyright	A tuple containing the copyright statement associated with the resource and optionally, the identifier of the copyright holder. Issues related to Digital Rights Management are out of scope for this specification, apart from the metadata supported by the copyright and policy attributes.
policy	A tuple containing a policy statement either human readable as a string or machine resolvable as a URI, and the type of the policy to provide more information as to the nature of the policy. See examples. Issues related to Digital Rights Management are out of scope for this specification, apart from the metadata supported by the copyright and policy attributes.

Table 9: Ontology for Media Resources - Distribution properties

Name	Description
publisher	The publisher of a resource, defined as either a URI or plain text. We recommend, as a best practice, to define the publisher as a URI.
targetAudience	A tuple identifying the audience being addressed (demographic class, parental guidance group, or geographical region) and an optional classification system (e.g., a parental guidance issuing agency).

Table 10: Ontology for Media Resources - Fragment properties

Name	Description
fragment	A tuple containing a fragment identifier and optionally, its role. A fragment is a portion of the resource, as defined by the MediaFragment Working Group.
namedFragment	A tuple containing a named fragment identifier and its label.

cognitive in nature. That is, the world does not really contain events. Rather, events are the way by which agents classify certain useful and relevant patterns of change." [AF94].

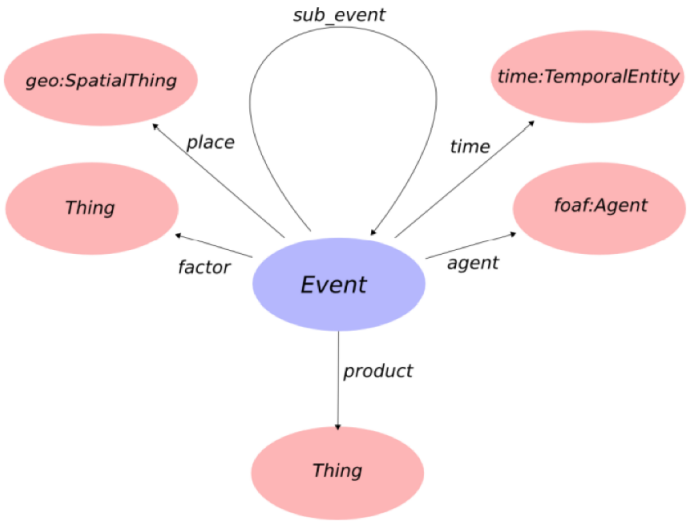


Figure 12: Event Ontology

The Event ontology defines the classes: Event, Factor, Product, and the properties Agent, agent_in, factor, factor_of, has Agent, hasFactor, hasLiteralFactor, hasProduct, hasSubEvent, isAgentIn, isFactorOf, literal_factor, place, producedIn, produced_in, product, sub_event, time.

2.6.2 LODE Ontology

LODE[46] is a minimal model that encapsulates the most useful properties for describing events, enabling an interoperable modeling of the "factual" aspects of events, where these can be characterized in terms of the *four Ws*: *What* happened, *Where* did it happen, *When* did it happen, and *Who* was involved. "Factual" relations within and among events are intended to represent intersubjective "consensus reality" and thus are not necessarily associated with a particular perspective or interpretation. The LODE model thus allows to express characteristics about which a stable consensus has been reached, whether these are considered to be empirically given or rhetorically produced will depend on one's epistemological stance.

The LODE ontology contains numerous axioms that establish mappings with other event vocabularies such as Event, Dolce Ultra Light (DUL), Cyc, ABC, CIDOC-CRM, SEM. It consists of a single class `lode:Event` and a number of properties:

- *atPlace* - a named or relatively specified place that is where an event happened.
- *atTime* - an abstract instant or interval of time that is when an event happened.
- *circa* - an interval of time that can be precisely described using calendar dates and clock times.
- *illustrate* - an event illustrated by some thing (typically a media object)
- *inSpace* - an abstract region of space (e.g. a geospatial point or region) that is where an event happened.
- *involved* - a (physical, social, or mental) object involved in an event.
- *involvedAgent* - an agent involved in an event.

[46] `http://linkedevents.org/ontology/`

2.7 Annotation models

The Open Annotation specification is being developed by the W3C Open Annotation Community Group[47]. The document aims at developing an open common specification for annotating digital resources and is therefore well appropriate for LinkedTV. The current document is actually a reconciliation of two recent proposals: the Annotation Ontology[48] and the Open Annotation Model[49].

The Open Annotation Community Group has published two drafts:

- Core Open Annotation Specification[50].
- Open Annotation Extension Specification[51].

In the following, we describe how the features of the Open Annotation specification will be used in LinkedTV. The general structure of an annotation in this proposal is depicted in Figure 13. In this model,

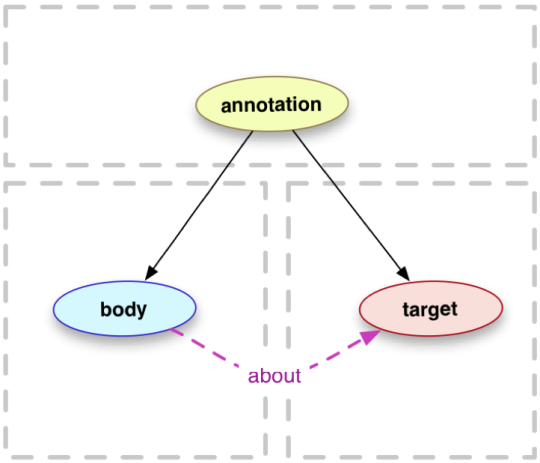


Figure 13: Open Annotation core mode

an annotation consists of set of connected resources, including a body and target, which has to be interpreted as the body is somehow about the target. The core model of Open Annotation consists of one class and two relations:

- *oa:Annotation*: The class for Annotations.
- *oa:hasBody*: The relationship between an Annotation and the Body of the Annotation
- *oa:hasTarget*: The relationship between an Annotation and the Target of the Annotation.

The Open Annotation model includes also tracking provenance information. The provenance model of Open Annotation consists of:

- *oa:annotator* - Relation - Identification of agent (human or software) responsible for annotation.
- *oa:annotated* - Property - Time of creation of annotation.
- *oa:generator* - Relation - Agent (software) responsible of generating serialization of annotation.
- *oa:generated* - Property - Time at which the software agent generated the serialization.
- *oa:modelVersion* - Relationship - The version of model of annotation.

However, as we will see later, provenance information can be better handled by the W3C Provenance Ontology.

[47] http://www.w3.org/community/openannotation/
[48] http://code.google.com/p/annotation-ontology/
[49] http://www.openannotation.org/spec/beta/
[50] http://www.openannotation.org/spec/core/
[51] http://www.openannotation.org/spec/extension/

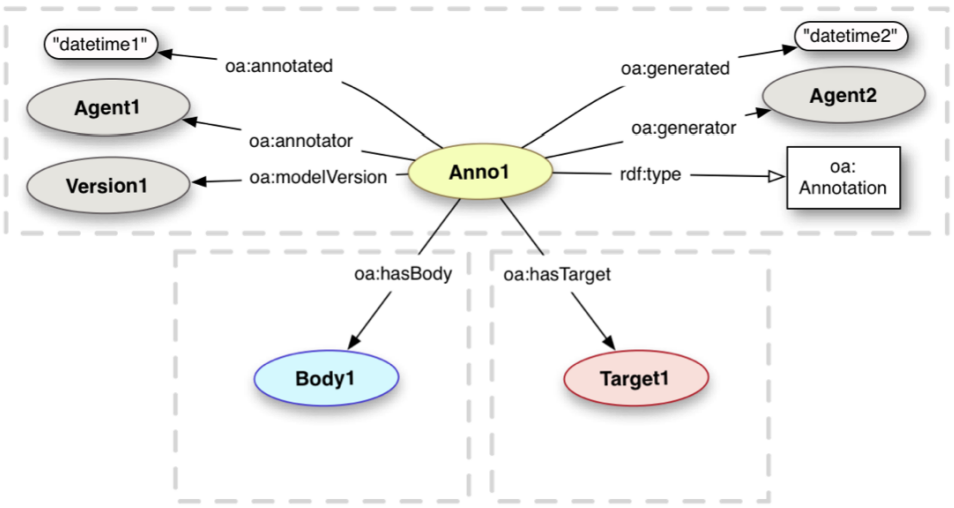


Figure 14: Open Annotation provenance model

2.7.1 Open Annotation Extension

The Open Annotation Extension[52] defines a number of subclasses of `oa:Annotation` that enable to refine the type of annotation:

- oax:Bookmark
- oax:Change
- oax:Classification
- oax:Comment
- oax:Description
- oax:Highlight
- oax:Link
- oax:Moderation
- oax:Question
- oax:Reference
- oax:Reply
- oax:Tag

The Open Annotation Extension defines also the types of resources used as body or target of an annotation based on the *Dublin Core Types* vocabulary:

- dctypes:Dataset
- dctypes:Image
- dctypes:MovingImage
- dctypes:Sound
- dctypes:Text

Finally, the Open Annotation Extension provides tools for the specification of agents defined in Open Annotation Core based on FOAF and *Dublin Core Types*.

[52] `http://www.openannotation.org/spec/extension/`

- foaf:Person - used for human agents
- dctypes:Software - used for software agent
- foaf:name
- foaf:mbox
- foaf:openid

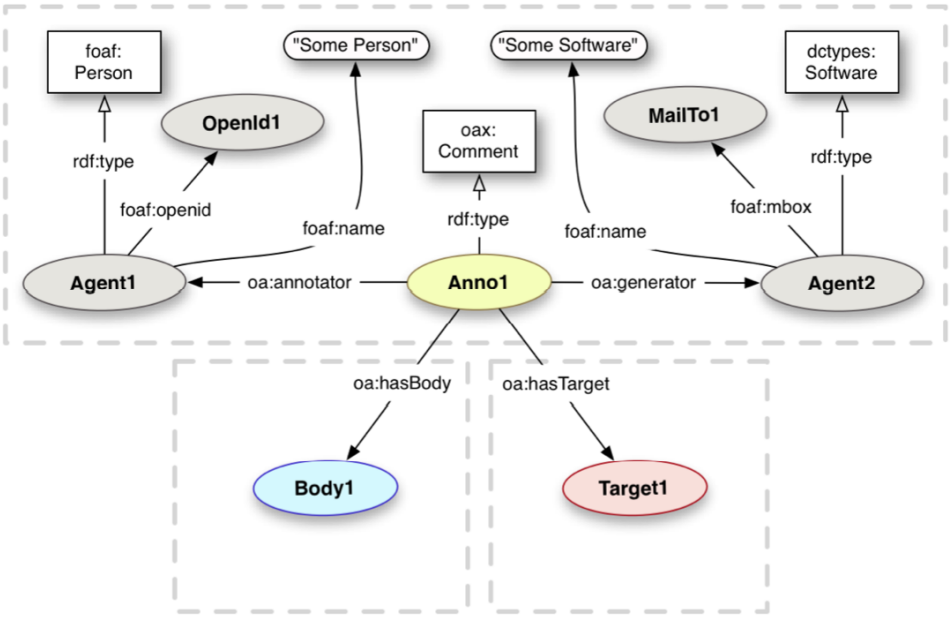


Figure 15: Open Annotation Extension provenance model with agents

2.7.2 Open Annotation semantic tags

The Open Annotation model allows users to associate tags to annotated entities. These tags then can be used in the process of indexing, sorting, visualization and discovery of information. The tags conform to the Semantic Web principles and are identified by URI. The Open Annotation model includes a single relationship for associating tags to entities: *oax:hasSemanticTag* which describes the relation between an Annotation and the Tagging Resource.

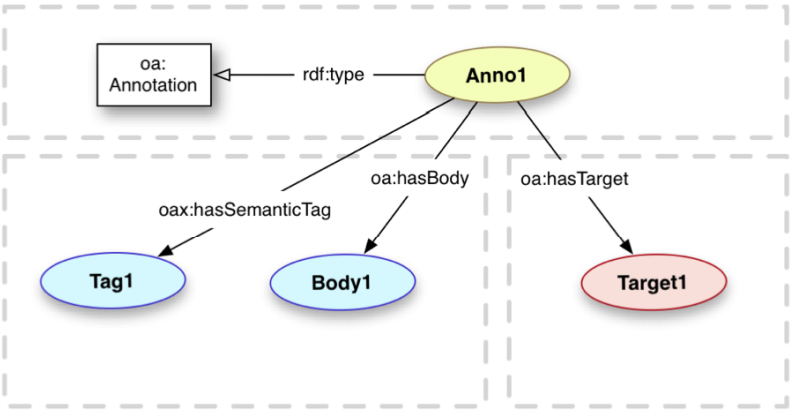


Figure 16: Open Annotation Extension semantic taging

2.8 Other common used vocabularies

Finally, we conclude this overview of metadata models by surveying some of the most common used vocabularies in the Semantic Web.

2.8.1 FOAF ontology

The Friend of a Friend (FOAF) project started with the aim of creating a Web of machine-readable pages describing people, the links between them and the things they do, work on, create and like, with an emphasis on the on-line presence of people[53]. The FOAF project is well known in the Linked Data community and since 2004, more than 1.5 million FOAF documents have been generated.

There is a number of sites that use the FOAF vocabulary as a standard for data exchange: blogging sites[54] or content management systems such as Drupal 7 which uses FOAF as one of the vocabularies for its RDF-based core[55].

FOAF defines the 13 classes (Agent, Document, Group, Image, LabelProperty, OnlineAccount, OnlineChatAccount, OnlineEcommerceAccount, OnlineGamingAccount, Organization, Person, PersonalProfileDocument, Project) and 62 properties (account, accountName, accountServiceHomepage, age, aimChatID, based_near, birthday, currentProject, depiction, depicts, dnaChecksum, familyName, family_name, firstName, focus, fundedBy, geekcode, gender, givenName, givenname, holdsAccount, homepage, icqChatID, img, interest, isPrimaryTopicOf, jabberID, knows, lastName, logo, made, maker, mbox, mbox_sha1sum, member, membershipClass, msnChatID, myersBriggs, name, nick, openid, page, pastProject, phone, plan, primaryTopic, publications, schoolHomepage, sha1, skypeID, status, surname, theme, thumbnail, tipjar, title, topic, topic_interest, weblog, workInfoHomepage, workplaceHomepage, yahooChatID). There are also several FOAF add-ons extending this vocabulary with a focus on various specific needs[56].

2.8.2 PROV-O ontology

PROV-O[57] is an ontology that provides a set of classes, properties, and restrictions allowing users to represent and interchange provenance information. It also aims at providing a common ground for exchange of provenance information generated in heterogeneous systems. PROV-O is being developed by the W3C Provenance Working Group. PROV is actually a family of specifications consisting of:

- PROV-DM: data model for provenance
- PROV-CONSTRAINTS: constraints applying to the PROV data model
- PROV-N: a notation for humans
- PROV-O: the PROV ontology based on OWL-RL
- PROV-AQ: the mechanisms for querying provenance data
- PROV-PRIMER: a primer for the PROV data model
- PROV-SEM: a formal semantics for the PROV data model
- PROV-XML: an XML schema for the PROV data model

The core of the PROV-O model consists of the concepts of agent, entity and activity:

- *prov:Entity* - the thing one wants to provide provenance for. (physical, digital, conceptual, etc.)
- *prov:Activity* - occurs over a period of time and acts upon or with entities (e.g. consuming, processing, transforming, modifying, relocating, using, generating, etc.)
- *prov:Agent* - an agent has a responsibility for an activity.

PROV-O enables the extension of its core model with more detailed description of agents, concepts concerning activity and entities.

[53] http://www.foaf-project.org
[54] http://www.livejournal.com/
[55] http://drupal.org/node/574624
[56] http://wiki.foaf-project.org/w/FoafExtensions
[57] http://www.w3.org/TR/prov-o/

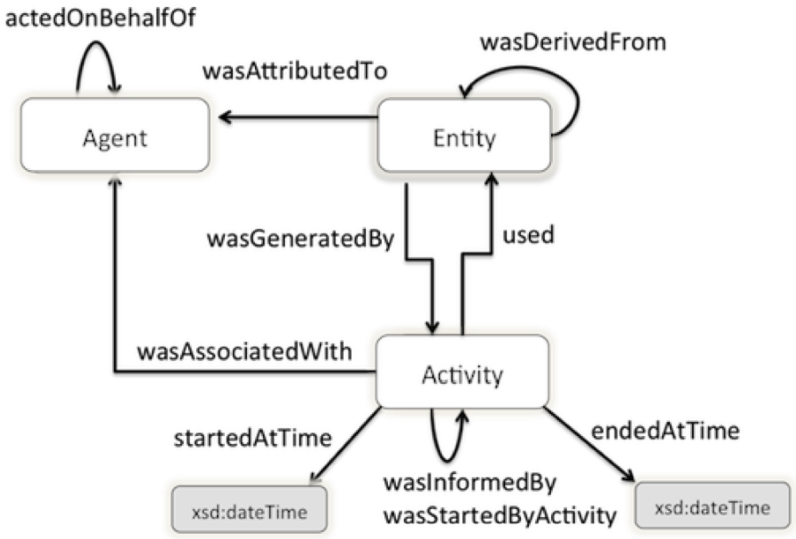


Figure 17: PROV-O ontology core model

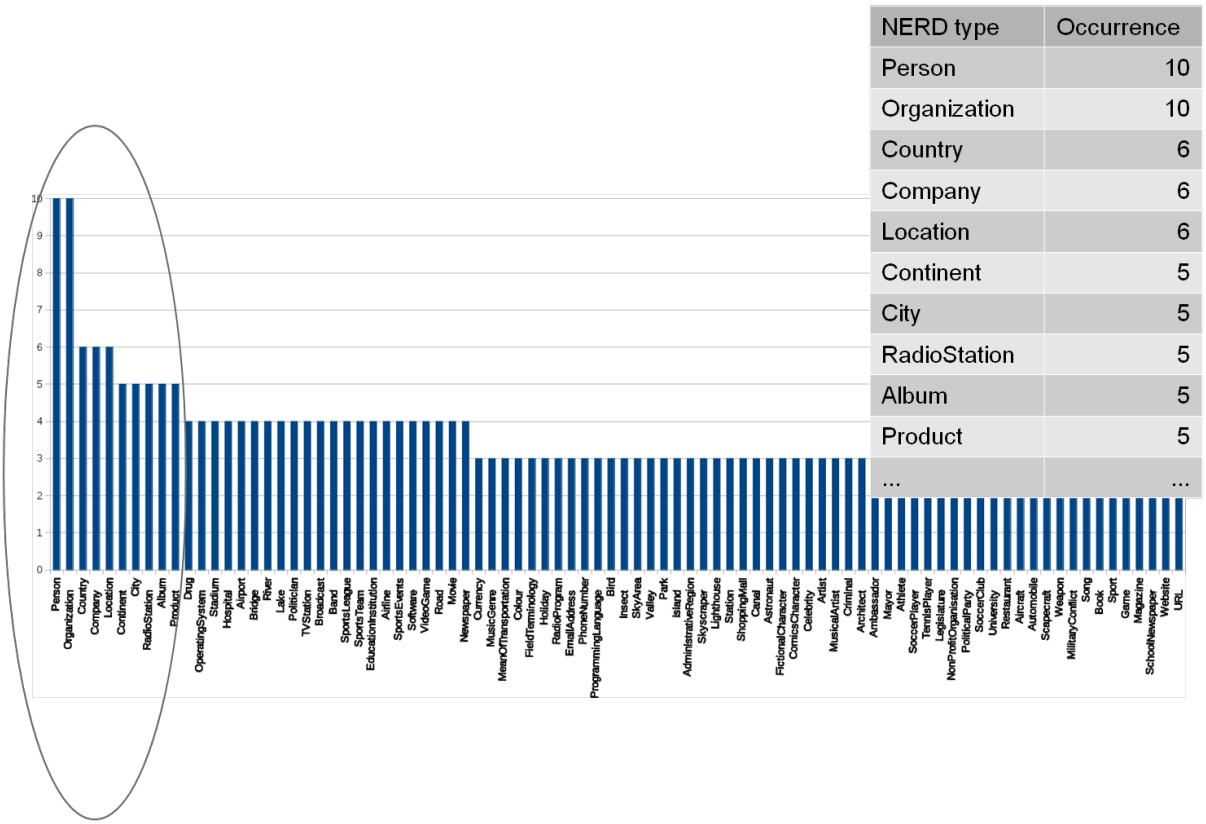
2.8.3 NERD ontology

The NERD ontology[58] is a set of mappings established manually between different taxonomies of named entity types recognized by numerous web APIs that perform Named Entity extraction. Concepts included in the NERD ontology are collected from different schema types: ontology (for DBpedia Spotlight, Lupedia, and Zemanta), lightweight taxonomy (for AlchemyAPI, Evri, and Yahoo!) or simple flat type lists (for Extractiv, OpenCalais, Saplo, and Wikimeta). The selection of these concepts has been done considering the greatest common denominator among the taxonomies. The concepts that do not appear in the NERD namespace are sub-classes of parents that end-up in the NERD ontology (Figure 18).

To summarize, a concept is included in the NERD ontology as soon as there are at least two extractors that use it. The NERD ontology becomes a reference ontology for comparing the classification task of NE extractors. We show an example mapping among those extractors below: the `City` type is considered as being equivalent to `alchemy:City`, `dbpedia-owl:City`, `extractiv:CITY`, `opencalais:City`, `evri:City` while being more specific than `wikimeta:LOC` and `zemanta:location`.

```
nerd:City a rdfs:Class ;
  rdfs:subClassOf wikimeta:LOC ;
  rdfs:subClassOf zemanta:location ;
  owl:equivalentClass alchemy:City ;
  owl:equivalentClass dbpedia-owl:City ;
  owl:equivalentClass evri:City ;
  owl:equivalentClass extractiv:CITY ;
  owl:equivalentClass opencalais:City .
```

[58] http://nerd.eurecom.fr/ontology



NERD type	Occurrence
Person	10
Organization	10
Country	6
Company	6
Location	6
Continent	5
City	5
RadioStation	5
Album	5
Product	5
...	...

Figure 18: NERD ontology: the long tail of common denominator between NER extractors taxonomies

3 Requirements for lightweight metadata models in LinkedTV

After having reviewed the numerous multimedia metadata standards, we derive some general requirements (Section 3.1), some functional requirements (Section 3.2) and some other requirements dealing with IPR management (Section 3.3) that the LinkedTV metadata model should comply with. When developing the LinkedTV metadata model, we always had in mind to design a lightweight model that would re-use as much as possible existing vocabularies.

3.1 General requirements

First, we describe general requirements applicable to the LinkedTV metadata model.

- **Extensibility.** Information systems, especially audio-visual and multimedia ones, evolve over time and keep being extended, connected, linked, combined or integrated. The lightweight metamodel infrastructure needs to support such system evolution and enable implementation of new extensions to information systems that would solve new functional requirements should they arise. A lightweight metamodel infrastructure should be extensible enough to provide tools and development support for now unforeseen needs.
- **Modularity.** Some systems may require only parts of a metamodel. Making the underlying metamodeling infrastructure modular allows each information system to select only modules it requires without unnecessary increase of complexity.
- **Reusability.** The proposed metadata modeling infrastructure will be used by several information systems built for different tasks and different users. Sometimes they may even work in different domains. Life of involved systems may span long periods so the reusability of developed metadata model is an important requirement.

- **Formal precision.** Metadata modeling infrastructure aims at establishing common foundation for interoperability of many different information systems developed by authors with different backgrounds and working in different domains. The modeling infrastructure should be formally described to enable a common understanding and usage of the important concepts.
- **Machine accessible semantics.** With the advent of Semantic Web technologies, the requirement of machine accessible semantics has gained popular and important. Interpretation of metadata can no longer be available only to human but it should be directly accessible by information systems.
- **Standardization.** The LinkedTV metadata model should rely on standards or commonly used vocabularies. Standardized solutions allow interoperability with external system and future extensibility and reusability. Requirement for standardization is therefore logically connected with requirements to reusability and extensibility.
- **Seamlessness.** The adopted solution should allow seamless internal and external integration. The metadata modeling infrastructure must be internally designed to provide seamless and coherent interconnection of its structural components.
- **Unobtrusiveness.** The metadata modeling infrastructure should not be undesirably noticeable or blatant. It should not be sticking out in an unwelcome way. There should be no obstacles or difficulties preventing a user for effectively using the LinkedTV model.
- **Multilingual support.** The adopted solution should not be specific to a single language but should be applicable to the description of multilingual content. The models itself should be documented in multiple languages.
- **Well documented.** The classes and properties of the LinkedTV model should be well documented. The ontology should be published following the best practices of the semantic web community.

3.2 Functional requirements

3.2.1 Semantic Web and Linked Data conformity

The Semantic Web is an extension of the current Web in which information is given well-defined semantics [BLHL01]. The well-defined semantics is based on common knowledge representation formalisms defined and promoted by the World Wide Web Consortium. The Semantics Web initiative is based on three fundamental formal languages specifically designed for data: XML (Extensible Markup Language), a syntax for serializing information, RDF (Resource Description Framework), a simple data model that consists in representing knowledge in the forms of triples and OWL (Web Ontology Language), a description logic based language for defining schema knowledge.

The other important characteristics are the usage of URI for identifying any resources or entities and the usage of Unicode for encoding text. The Semantic Web Stack is depicted in the Figure 19. The conformity with the Semantic Web initiative is based on general requirements of machine accessible semantics, extensibility, reusability, standardization and seamlessness.

The Linked Data initiative was started by Tim Berners-Lee as an architectural vision for the Semantic Web. It explores the idea of Semantic Web as putting emphasis on making links explicit, so that both people and machines can explore a semantically interconnected web of data. If the data is linked, then "when you have some of it, you can find other, related, data"[59]. Just like in HTML where there are relationships and hypertext links between documents, the Linked Data initiative wants to encourage a similar approach in the case of general data content, represented in RDF. The key requirements for Linked Data are quite simple:

- Use URIs as names for things.
- Use HTTP URIs so people can look up those names.
- When someone looks up a URI, provide useful information, using standards (RDF, SPARQL).
- Include links to other URIs, so that they can discover more things.

[59] http://www.w3.org/DesignIssues/LinkedData.html

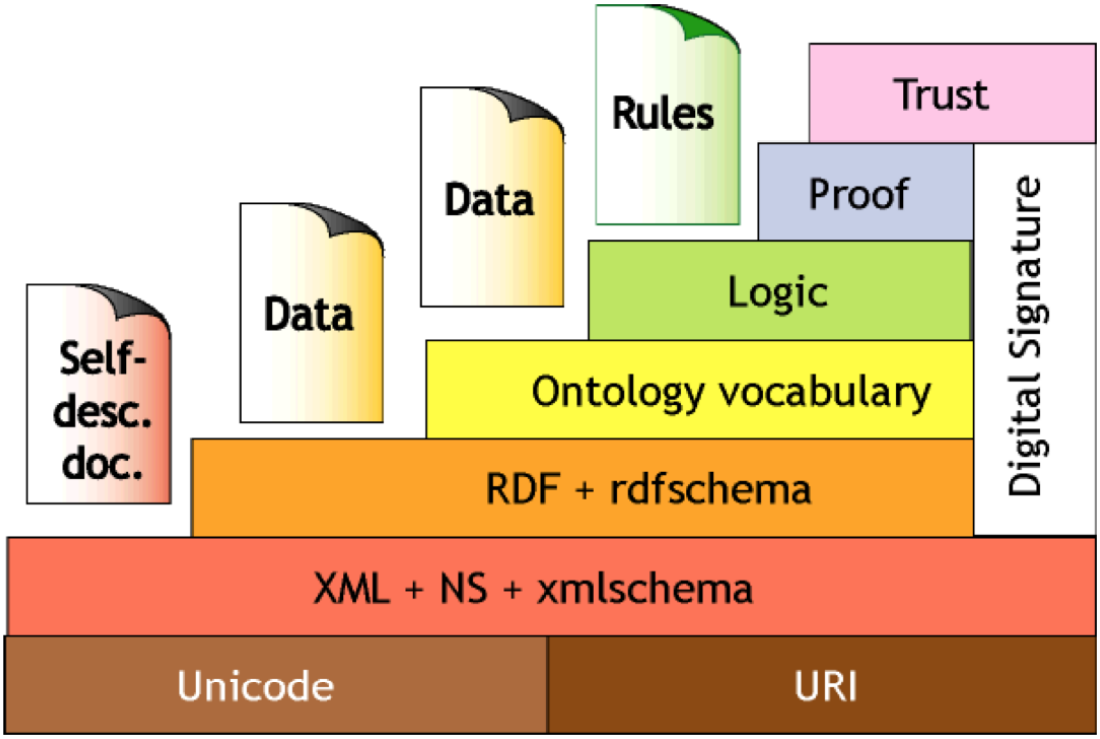


Figure 19: The Semantic Web Stack

Guidance provided by these general principles was later extended by technical documents[60] and papers [BHIBl08, BHBL09] by Bizer and Sauermann [SCV07] among others. Linked Data can be crawled with appropriate browsers by following RDF links. A search engine can also search these information sources similarly to conventional web sites. However, unlike HTML, which only provides a generic linking capability, links in Linked Data environment can have different types: we can e.g. specify that one person is an author of a paper, or that this person knows another one. General requirements of extensibility, reusability, standardization, seamlessness and unobtrusiveness imply requirement to conformity with Linked Data.

3.2.2 Requirement for broadcaster and media identification

The LinkedTV metadata model has to be able to provide tools for precise broadcaster and media identification. This includes:

- Broadcaster identification: company or institution providing the broadcast
- Broadcast service: individual service (e.g. logical channel)
- Medium / Channel: physical channel providing broadcast service

The BBC Programme ontology reviewed in the Section 2.1 fulfills this requirement.

3.2.3 Requirement for structured modeling of broadcast content

The LinkedTV metadata model should allow to distinguish the different structural components of broadcasted programmes. The important concepts with respect to the structure of content are: Brand (e.g. Red Dwarf), Series (e.g. Season 3) and Episode (e.g. Episode 15). Then, an episode can have several versions, and one version can be broadcasted several times. The BBC Programme ontology reviewed in the Section 2.1 fulfills this requirement.

[60] http://www4.wiwiss.fu-berlin.de/bizer/pub/LinkedDataTutorial/

3.2.4 Requirement for media resources modeling

The LinkedTV metadata model should contain properties for describing an entire media resource. This includes the unique identification of the resource (preferably with a URI) and general properties such as the Title, Description, Creator, Date of creation, Language, Genre and Publisher. Furthermore, the model should enable to describe the technical properties of the media resources. Finally, the model should enable to describe the content of the media resource at the media fragment level. The W3C Ontology for Media Resources reviewed in the Section 2.5 fulfills completely this requirement.

3.2.5 Requirement for annotation and tagging support

The LinkedTV metadata model should support annotation of multimedia resources with tagging as special type of annotation. Requirements for annotation are:

- Support for Annotations of various types.
- Support for tagging.
- Tracking of annotator.
- Tracking of annotation software.
- Tracking of annotation date and time.

The Open Annotation model reviewed in the Section 2.7 fulfills this requirement.

3.2.6 Requirement for representing multimedia analysis results

The LinkedTV platform has to deal with numerous multimedia analysis processes performed in WP1 such as shot or scene segmentation, concept detection, face detection and identification, automatic speech recognition, etc. Those results are serialized in the Exmaralda file described in the deliverable D1.1. Therefore, the LinkedTV metadata model should be able to represent this information. Candidate vocabularies are the Large Scale Concept Ontology for Multimedia (LSCOM[61] for representing concepts detected in video frames. Furthermore, the LinkedTV metadata model should formally define the concepts of shots or scenes.

3.2.7 Requirement for modeling event

As we have seen in the Section 2.6, event modeling can be used for different purposes: representing the metadata associated to a broadcast event or representing the content itself of a video program in terms of events. The requirements for modeling events can be decomposed according to multiple dimensions:

- **Basic temporal modeling.** Basic temporal modeling requires modeling of intervals and individual timeline. An important concern is to take care with timezone differences and date-time formats.
- **Basic description of events.** Lightweight metadata models used in the context of LinkedTV should be able to provide a way to describe events and their features. The events should be modeled with some basic features as temporal localization and temporal duration. This can be conducted using absolute or relative representation of points in time. Relative representation is typical for cases of audio-visual data where a user is often not interested in absolute point of time when an event happened but in the relative information from the start of a multimedia recording.
- **Participation of objects in events.** Along the simple modeling of events it's necessary to model also some basic kinds of participation objects in these events.
- **Structural relationships between events.** Scherp distinguishes three kinds of structural relations between events: mereological, causal and correlation [SFSS09]. Mereological aspect requires modeling events composed of other events or events as parts of other events. Causality between events requires modeling of causality in general [ltk83]. Correlation is here understood as situation when two events have a common cause.

It is unclear at this point how much the LinkedTV metadata model should comply with existing event models. This will be further investigate in the second year of the project.

[61] http://www.lscom.org/

3.2.8 Requirement for modeling provenance

Modeling of provenance amounts to provide means to describe that some agent realized some activity concerning some object at some date or time. The core of provenance tracking requirements is therefore defined by these features:

- agent: human, software or other agent actively causing changes or transformations
- activity: description of activity, change or transformation that takes place
- object: patient entity that is changed, transformed or is object of activity
- datetime: time when activity takes place

The PROV-O model reviewed in the Section **??** fulfills this requirement.

3.2.9 Requirement for modeling person information

The requirement to model personal information is based on the need to model individuals identified in broadcasted media. Hance, as part of the WP1 processing chain, an efficient face detection and identification is planned. The people detected can be be politicians in the case of news programs or persons working in the entertainment industry such as actors or singers. The model for representing such information should include:

- Name (given name and surname), gender, title(s) and even birthday of the person.
- Groups to which the person belongs to.
- Organization with which the person is associated with.
- Location where this person is know to live.
- Interests of the person.
- Products created by the person (e.g. works of art).
- Other persons related to the person.
- Web presence describing the person (e.g. a homepage).
- Photos and other media depicting the person.

The FOAF vocabulary reviewed in the Section 2.8 fulfills partially this requirement.

3.3 Requirements concerning IPR

The LinkedTV lightweight metadata infrastructure must be compliant with important requirements concerning legal and ethical issues connected with intellectual property related to media to be broadcasted. These requirements are:

- Support for rights management:
  - Type of copyright, licencing terms
  - Identification of copyright holder
- Provenance information
  - Source from which the original media was obtained
  - Tracking of events connected with media for possible compliance checking with respect to licensing terms
- Modeling personal information:
  - Information will concern only publicly active persons (politicians, actors, etc.) and will be obtained only from already public sources.
  - Provenance of personal information will be tracked.

It is unclear at this point what is the closest IPR model that the LinkedTV metadata model should rely on. This will be further investigate in the second year of the project.

4 Specification of the LinkedTV Ontology

After having surveyed the numerous multimedia metadata models proposed by various communities and industries in the chapter 2 and derive a set of requirements for the LinkedTV model in the chapter 3, we present in this chapter the LinkedTV ontology. This ontology makes use of several commonly used vocabularies and add its own terms (classes and properties) when necessary. The LinkedTV ontology is available at `http://data.linkedtv.eu/ontology/`.

We first describe this model in the Section 4.1. Then, for both the Sound & Vision and RBB scenarios, we describe how legacy metadata and automatic multimedia results are converted into RDF using this model (Section 4.2 and Section 4.3).

4.1 Description of the metamodel architecture of LinkedTV

The following vocabularies have been selected as a basis for the LinkedTV ontology:

- BBC Program ontology for representing broadcast related metadata: series, episodes, brands, categories, subtitles, physical channel, audio format, video compression, etc.
- Ontology for Media Resources for representing general properties about the content itself such as the title, description, format, license, etc. Also, it contains the classes for representing media items and fragments of media items (*ma:MediaResource* and *ma:MediaFragment*).
- Ninsuna ontology for describing explicitly the media fragments boundaries.
- Open Annotation ontology for linking the analysis results from WP1 (spatiotemporal segments, scene segmentation, shot segmentation, asr, etc.) with media fragments URI. It could also be used for representing additional information such as ratings or user preferences. Finally, it offers support for representing annotations of various types and simple tagging.
- NERD ontology for representing the general types of the named entities recognized by a Named Entity extractor.
- LSCOM ontology for representing the semantics of the visual concepts detected by multimedia analysis processes.
- FOAF ontology for representing the people recognized in video frames.
- PROV-O ontology for representing provenance information.
- LODE Ontology for representing events.

These ontologies are interlinked and import sometimes each other. The BBC Programmes ontology uses FOAF for the descriptions of actors and makes use of the Event ontology for modeling a broadcast as an event. The PROV-O ontology is used by the Core Annotation ontology to describe who has created an annotation and when this annotation has been generated.

The following vocabularies and datasets have also been selected for providing stable URIs of entities and concepts detected by automatic analysis tool:

- LSCOM: `http://www.lscom.org/ontology/index.html`
- DBpedia ontology: `http://dbpedia.org/ontology/`
- WordNet 3.0: `http://semanticweb.cs.vu.nl/lod/wn30/`

In the following sections, we will show how the metadata required by the LinkedTV scenarios can be represented using this Linked TV ontology. This includes: the legacy metadata that comes with the seed video content, the metadata resulting from automatic multimedia analysis and the metadata resulting from performing named entity recognition on texts associated with the seed video content (generally the program subtitles).

When converting metadata in RDF, one needs to re-use or generate new identifiers for the first class objects of the model. According to the linked data principles, those identifiers are dereferencable URIs. We follow the best practices of the linked data community and mint new URIs when necessary in the `http://data.linkedtv.eu` domain. Then, the first class objects in LinkedTV are dereferencable using the following scheme:

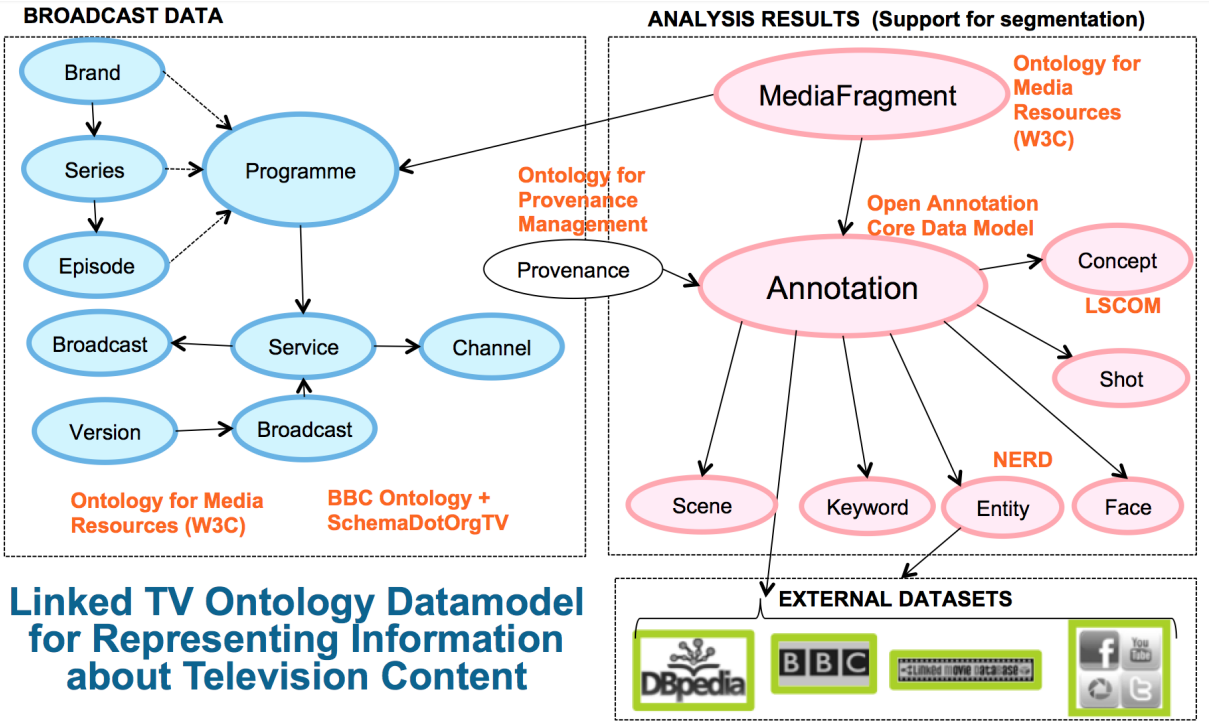


Figure 20: General LinkedTV metadata model

- `http://data.linkedtv.eu/episode/UUID` for the resources of type `po:Episode`
- `http://data.linkedtv.eu/brand/UUID` for the resources of type `po:Brand`
- `http://data.linkedtv.eu/broadcast/UUID` for the resources of type `po:Broadcast`
- `http://data.linkedtv.eu/version/UUID` for the resources of type `po:Version`
- `http://data.linkedtv.eu/media/UUID` for the resources of type `ma:MediaResource`
- `http://data.linkedtv.eu/annotation/UUID` for the resources of type `oa:Annotation`
- `http://data.linkedtv.eu/organization/UUID` for the resources of type `foaf:Organization`
- `http://data.linkedtv.eu/shot/UUID` for the resources of type `linked:Shot`
- `http://data.linkedtv.eu/person/UUID` for the resources of type `foaf:Person`
- `http://data.linkedtv.eu/entity/UUID` for the resources of type `linkedtv:Concept` or `nerd:Concept`
- `http://data.linkedtv.eu/asr/UUID` for the resources of type `linkedtv:ASR`

In the examples we give below, we generate artificially simple human readable identifiers for all primary objects in the LinkedTV model. However, when those instances will actually be generated by the converter, it will effectively by real UUID that will identify those objects.

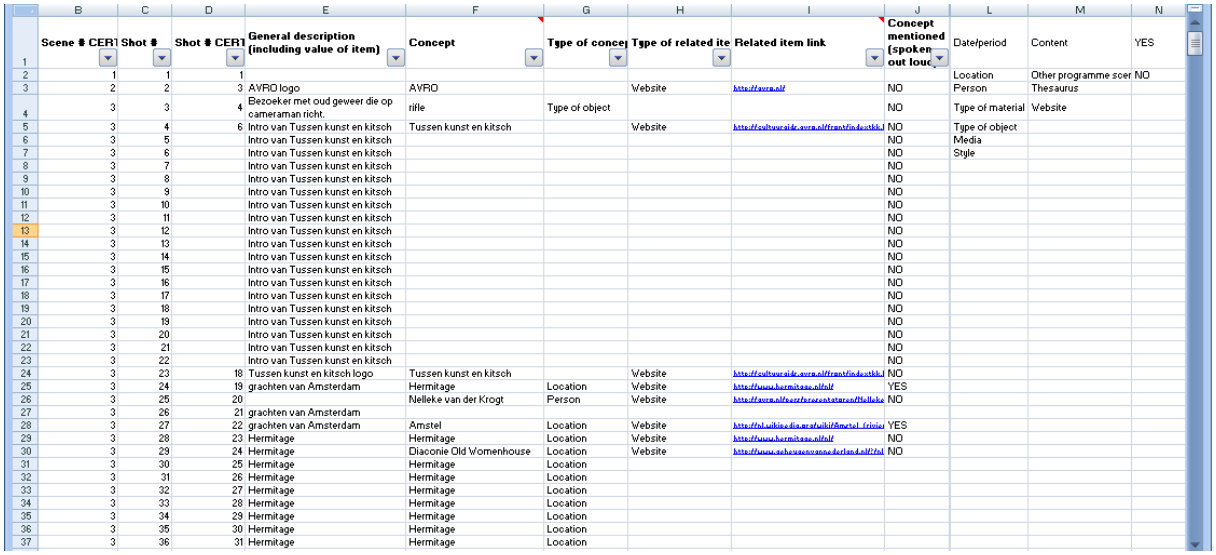
4.2 Sound and Vision Scenario

Sound and Vision has gained access to video of the Dutch TV program Tussen Kunst & Kitsch (Antiques Roadshow) which is a production of the public broadcaster AVRO[62]. To start with, the scenario has chosen a single episode of the show from 8 December 2010[63].

The Sound and Vision scenario has been described in the Deliverables D3.1 and D3.2. The general aim of the scenarios is to describe how the information need of the Antiques Roadshow viewers can be

[62] `http://www.avro.nl`
[63] `http://cultuurgids.avro.nl/front/detailtkk.html?item=8237850`

satisfied from both their couch and on-the-go, supporting both passive and more active needs. Linking to external information and content, such as Europeana, museum collections but also auction information has been incorporated in these scenarios.



	B	C	D	E	F	G	H	I	J	L	M	N
1	Scene # CER1	Shot #	Shot # CER1	General description (including value of item)	Concept	Type of concep	Type of related ite	Related item link	Concept mentioned (spoken out loud	Date/period	Content	YES
2	1	1	1							Location	Other programme scer	NO
3	2	2	3	AVRO logo	AVRO		Website	http://avro.nl/	NO	Person	Thesaurus	
4	3	3	4	Bezoeker met oud geweer die op cameraman richt.	rifle	Type of object			NO	Type of material	Website	
5	3	4	6	Intro van Tussen kunst en kitsch	Tussen kunst en kitsch		Website	http://cultuurwijs.avro.nl/frontfin.do#kkl	NO	Type of object		
6	3	5		Intro van Tussen kunst en kitsch					NO	Media		
7	3	6		Intro van Tussen kunst en kitsch					NO	Style		
8	3	7		Intro van Tussen kunst en kitsch					NO			
9	3	8		Intro van Tussen kunst en kitsch					NO			
10	3	9		Intro van Tussen kunst en kitsch					NO			
11	3	10		Intro van Tussen kunst en kitsch					NO			
12	3	11		Intro van Tussen kunst en kitsch					NO			
13	3	12		Intro van Tussen kunst en kitsch					NO			
14	3	13		Intro van Tussen kunst en kitsch					NO			
15	3	14		Intro van Tussen kunst en kitsch					NO			
16	3	15		Intro van Tussen kunst en kitsch					NO			
17	3	16		Intro van Tussen kunst en kitsch					NO			
18	3	17		Intro van Tussen kunst en kitsch					NO			
19	3	18		Intro van Tussen kunst en kitsch					NO			
20	3	19		Intro van Tussen kunst en kitsch					NO			
21	3	20		Intro van Tussen kunst en kitsch					NO			
22	3	21		Intro van Tussen kunst en kitsch					NO			
23	3	22		Intro van Tussen kunst en kitsch					NO			
24	3	23	18	Tussen kunst en kitsch logo	Tussen kunst en kitsch		Website	http://cultuurwijs.avro.nl/frontfin.do#kkl	NO			
25	3	24	19	grachten van Amsterdam	Hermitage	Location	Website	http://www.hermitage.nl/nl/	YES			
26	3	25	20		Nelleke van der Krogt	Person	Website	http://avro.nl/kunstenaarsgezichten/Nelleke	NO			
27	3	26	21	grachten van Amsterdam								
28	3	27	22	grachten van Amsterdam	Amstel	Location	Website	http://nl.wikipedia.org/wiki/Bestand:Amstel_frisia	YES			
29	3	28	23	Hermitage	Hermitage	Location	Website	http://www.hermitage.nl/nl/	NO			
30	3	29	24	Hermitage	Diaconie Old Womenhouse	Location	Website	http://www.geheugenvannederland.nl/?/nl	NO			
31	3	30	25	Hermitage	Hermitage	Location						
32	3	31	26	Hermitage	Hermitage	Location						
33	3	32	27	Hermitage	Hermitage	Location						
34	3	33	28	Hermitage	Hermitage	Location						
35	3	34	29	Hermitage	Hermitage	Location						
36	3	35	30	Hermitage	Hermitage	Location						
37	3	36	31	Hermitage	Hermitage	Location						

Figure 21: Ground truth metadata of automatic multimedia analysis

The legacy metadata for this program comes in the form of a spreadsheet. The automatic multimedia analysis results have been serialized in a Exmaralda file but also validated with ground truth results in another spreadsheet (Figure 21). In the following, we show how both type of metadata is converted in RDF using the LinkedTV ontology. The general overview of the resulting conversion is depicted in the Figure 22.

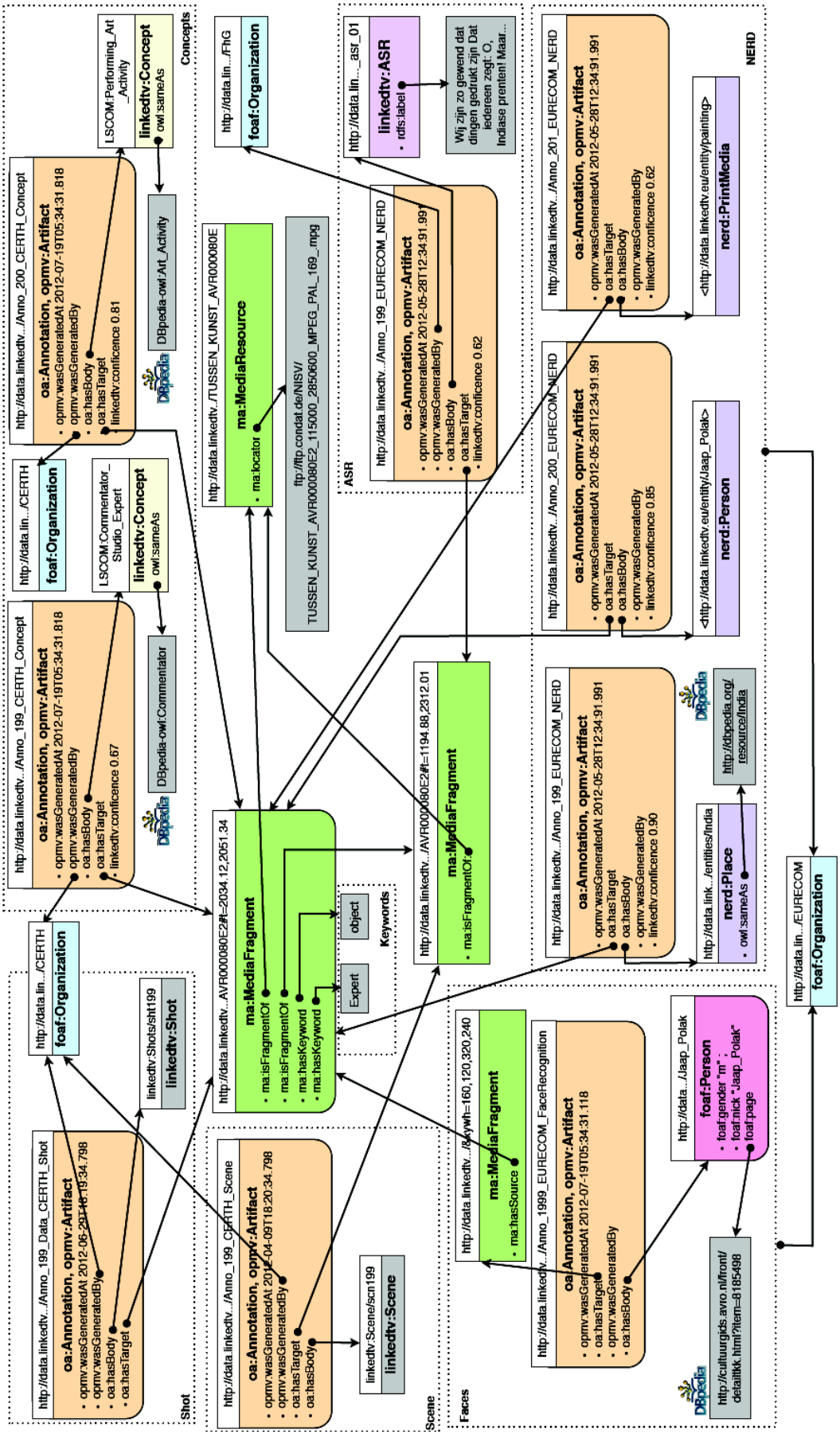


Figure 22: Instances involved in the Sound & Vision scenario

4.2.1 Legacy Metadata

For this scenario, there is not much information offered by the providers, apart from the name of the television content and the channel that broadcasts it, so some extra data has been added manually to illustrate the example. These are the instances involved:

– One instance of the class `po:Episode`, that stores the title, the synopsis, the related subjects, and other basic attributes for the current material.

```
<http://data.linkedtv.eu/episode/TUSSEN_KUNST_AVR000080E2_115000_2850600>
 a po:Episode ;
 dc:title "Najaar" ;
 po:id "AVR000080E2_115000_2850600" ;
 po:microsites <http://cultuurgids.avro.nl/front/indextkk.html> ;
 po:short_synopsis "De nieuwe opnamedata en locaties van Tussen Kunst & Kitsch zijn weer bekend. Of
      je spulletjes nu waardevol zijn of niet, je mag drie voorwerpen meenemen naar de" ;
 po:subject "Tussen Kunst & Kitsch" , "Nelleke van der Krogt" , "Programma" ;
 po:version <http://data.linkedtv.eu/version/1_AVR000080E2_115000_2850600> .
```

– One instance of the class `po:Brand`, that stores information about the brand this episode belongs to.

```
<http://data.linkedtv.eu/brand/AVRO>
  a po:Brand ;
  dc:title "Algemene Vereniging Radio Omroep" ;
  po:episode <http://data.linkedtv.eu/episode/TUSSEN_KUNST_AVR000080E2_115000_2850600> ;
  po:microsites <http://avro.nl/> .
```

– One instance of the class `po:Broadcast`, that establishes a relationship between a particular version of a program and the `po:Service` instance where this version is broadcasted on.

```
<http://data.linkedtv.eu/broadcast/1_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
  a po:Broadcast ;
  po:broadcast_of <http://data.linkedtv.eu/version/1_AVR000080E2_115000_2850600> ;
  po:broadcast_on <ftp://ftp.condat.de/NISV/> .
```

– One instance of the class `po:Service`, that represents the television channel where a particular program is broadcasted.

```
<ftp://ftp.condat.de/NISV/>
  a po:Service .
```

– One instance of the class `po:Version`, that represents the appearance of a program at a particular date and hour and in a particular format.

```
<http://data.linkedtv.eu/version/1_AVR000080E2_115000_2850600>
  a po:Version ;
  po:aspect_ratio "urn:ard:tva:metadata:cs:ARDFormatCS:2008:90.3" ;
  po:time [ a event:Interval ;
  event:end "2010-12-08T20:35:23"^^xsd:dateTime ;
  event:start "2010-12-08T21:20:48"^^xsd:dateTime ];
  linkedtv:hasMediaResource <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2> .
```

4.2.2 Multimedia Analysis Metadata

This video program has been completely processed by the WP1 multimedia analysis tool chain, yielding numerous metadata results serialized in the Exmaralda file. In the following, we show how each layer composing the Exmaralda file are converted in RDF using the LinkedTV ontology.

– First, we create an instance of the class `ma:MediaResource` that represents the particular media item and links it with its physical location in the LinkedTV platform.

```
<http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2>
  a ma:MediaResource ;
  ma:locator <ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg> .
```

– Instances of the class `ma:MediaFragment` represent the different spatio-temporal fragments that belong to a particular media resource. These media fragments could be related to other media fragments in a containment relationship (e.g. a scene contains shots). Keywords are also stored when the media fragment correspond to a shot.

```
<http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=2034.12,2051.34>
  a ma:MediaFragment ;
  ma:hasKeyword
    [ a  linkedtv:keyword ;
      rdf:label "Expert"
    ]:
    [ a  linkedtv:keyword ;
      rdf:label "Object"
    ];
    ma:isFragmentOf <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2> ;
    ma:isFragmentOf <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=1195,2312>.
```

– The media fragments boundaries are themselves described explicitly using the Ninsuna ontology.

```
<http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=2034,2051>
  a ma:MediaFragment, nsa:TemporalFragment ;
  nsa:temporalStart 2034^^xsd:int;
  nsa:temporalEnd 2051^^xsd:int.
```

– Instances of the class `oa:Annotation` describe the analysis result obtained from the different automatic processing tools. In this example, we can see an annotation that corresponds to a shot detected by CERTH in the media. The body of the annotation is an instance of a `linkedtv:Shot`, and the target is the media fragment this shot is related to. Provenance information is also included in this class through the use of the properties `opmv:wasGeneratedAt` and `opmv:wasGeneratedBy`.

```
<http://data.linkedtv.eu/annotation/Anno_199_CERTH_Shot>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:34.798Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
    opmv:wasPerformedBy <http://data.linkedtv.eu/organization/CERTH>
    ];
  oa:hasTarget <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=2034.12,2051.34> ;
  oa:hasBody <http://data.linkedtv.eu/shot/sht53> .
```

– The instance of the class `linkedtv:Shot` that is being referred in the previous annotation is explicitly typed.

```
<http://data.linkedtv.eu/shot/sht53>
  a linkedtv:Shot .
```

– Instances of the class `oa:Annotation` can correspond to a LSCOM concept detected by CERTH in the media, to which a level of confidence has been provided that will be represented using the `linkedtv:confidence` property.

```
<http://data.linkedtv.eu/annotation/Anno_199_CERTH_Concept>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:35.153Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/CERTH>
    ];
  linkedtv:confidence "0.67"^^xsd:float ;
  oa:hasTarget <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=2034.12,2051.34> ;
  oa:hasBody <lscom:Commentator_Studio_Expert> .
```

– The instance `lscom:Commentator_Studio_Expert` that is being referred in the previous annotation is also an instance of the `linkedtv:Concept` class.

```
<lscom:Commentator_Studio_Expert>
  a linkedtv:Concept .
```

– Instances of the class `oa:Annotation` can relate a particular media fragment with a face recognition result performed by EURECOM.

```
<http://data.linkedtv.eu/annotation/Anno_199_EURECOM_FaceRecognition>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:35.153Z"^^xsd:dateTime ; opmv:wasGeneratedBy
  [ a opmv:Process ;
    opmv:wasPerformedBy <http://data.linkedtv.eu/organization/EURECOM>
  ];
  oa:hasTarget <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=2045&xywh=144,112,300,250>
      ;
  oa:hasBody <http://data.linkedtv.eu/person/person3735> .
```

– The instance of the class `foaf:Person` that is being referred in the previous annotation is also an instance of a `linkedtv:Person`.

```
<http://data.linkedtv.eu/person/person3735>
    a foaf:Person ;
  foaf:gender "m" ;
  foaf:nick "Jaap Polak" ;
  foaf:page <http://cultuurgids.avro.nl/front/detailtkk.html?item=8185498> .
<http://cultuurgids.avro.nl/front/detailtkk.html?item=8185498>
    a foaf:Document .
```

– Instances of the class `oa:Annotation` may relate a particular media fragment with a name entity recognition result performed by EURECOM.

```
<http://data.linkedtv.eu/annotation/Anno_199_EURECOM_NERD>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-03-29T18:21:36.163Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/EURECOM>
    ];
  linkedtv:confidence "0.90"^^xsd:float ;
  oa:hasTarget <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=2034,2051> ;
  oa:hasBody <http://data.linkedtv.eu/entities/YI89GFAZ> .
```

– The instance of the class `linkedtv:Entity` that is being referred in the previous annotation has been typed as a nerd:Place, and disambiguated with a DBpedia resource.

```
<http://data.linkedtv.eu/entitity/YI89GFAZ>
  a nerd:Place ;
  owl:sameAs <http://dbpedia.org/resource/India> .
```

– The same entity recognition service can also also produce annotations of persons:

```
<http://data.linkedtv.eu/annotation/Anno_200_EURECOM_NERD>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-03-29T18:21:36.163Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/EURECOM>
    ];
  linkedtv:confidence "0.85"^^xsd:float ;
  oa:hasTarget <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=2034,2051> ;
  oa:hasBody <http://data.linkedtv.eu/entity/person3735>.
```

where `http://data.linkedtv.eu/entity/person3735` refers to Jaap Polak.

– Instances of the class `oa:Annotation` can relate a particular media fragment with a scene recognized by CERTH.

```
<http://data.linkedtv.eu/annotation/Anno_199_CERTH_Scene>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-01-22T18:21:40.153Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/CERTH>
    ];
  oa:hasTarget <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=1194,2312> ;
  oa:hasBody <http://data.linkedtv.eu/scene/scn199> .
```

– The instance of the class `linkedtv:Scene` that is being referred in the previous annotation can be explicitly typed.

```
<http://data.linkedtv.eu/scene/scn199>
  a linkedtv:Scene .
```

– The instance of the class `ma:MediaFragment` indicates the spatio-temporal aspects of the scene detected but also that this scene is a sub-fragment of the complete media resource as expressed with the property `ma:isFragmentOf`:

```
<http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=1195,2312>
  a ma:MediaFragment;
  ma:isFragmentOf <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2> .
```

– Instances of the class `oa:Annotation` can relate a particular media fragment with the transcription generated by Fraunhofer.

```
<http://data.linkedtv.eu/annotation/Anno_199_FhG_ASR>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:35.153Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/FhG>
    ];
  linkedtv:confidence "0.234"^^xsd:float ;
  oa:hasTarget <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000080E2#t=1195,2312> ;
  oa:hasBody <http://data.linkedtv.eu/asr/TUSSEN_KUNST_AVR000080E2_asr_01> .
```

– The instance of the class `linkedtv:ASR` that is being referred in the previous annotation enables to store the string containing the transcription.

```
<http://data.linkedtv.eu/asr/TUSSEN_KUNST_AVR000080E2_asr_01> a linkedtv:ASR ;
  rdfs:label "Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar
       het zijn geen prenten. Het zijn Indiase schilderingen. U bent in India geweest?Ja. Maar ik
      heb deze daar niet gekocht. Deze kocht ik op de veiling in Amsterdam. 15 jaar geleden. Nou, ik
       weet niet wat u betaald heeft, dat wil ik ook niet weten... Niet veel.Maar dat heeft u goed
      gedaan, denk ik. Want deze schildering... Een heel mooi vorstelijk portret. Het komt uit Noord
      -India. Hier heeft u een Indiaas miniatuur. Dat is ook uit het noorden. Ze zit daar prachtig
      op een mooie stoel. U ziet al dat het veel flamboyanter is dan de andere. Die doeken en dingen
       gaan al veel meer opzij. Dat vind je ook in het gebied van Jodhpur, Udaipur. Aan je goud zie
      je dat het een tamelijk late miniatuur is. Ze leggen er ook kleine pareltjes op. Die geven
      relief. En dat zit je al in de 19e eeuw. Als je goed kijkt heft het hier een kleine
      beschadiging. Miniaturen horen eigenlijk puntgaaf te zijn. Je moet denken aan 650 euro. Wel
      een hele mooie vondst. Welke periode is dit ongeveer? Ongeveer 1740. Hij is iets beschadigd.
      Dat heeft met de waarde te maken. Deze miniatuur: 1250 euro." .
```

4.3 RBB Scenario

RBB is the public broadcaster for the area of Berlin and Brandenburg in Germany. The basic idea of RBB's scenario is to enrich the local news program according to the needs and interests of the individual viewer. In some cases this may mean to just watch the daily news show as it is, in another case the viewer may prefer certain topics in some of the news items, and he or she may want to learn more about the topic in question or inform him/herself about one specific aspect.

RBB has chosen as its seed video content a number of episodes of its daily local news program "RBB Aktuell". The show is broadcast four times a day but for the project the late broadcast (at 21:45) is the most suitable as it is enhanced with subtitles which help to improve the results of the video analysis. For the purpose of training the technical components to be developed in the video analysis and annotation work, several shows were downloaded to a project repository in three time periods: November 2011, March 2012 and August 2012. On the one hand, RBB provides legacy metadata in the form of TV-Anytime like metadata. On the other hand, WP1 has processed some RBB videos in order to generate various EXMaRALDA files. Unfortunately, there is no yet any video that have legacy metadata, subtitle files and multimedia analysis results. Therefore, the examples used in this section correspond to the legacy information of the episode "Erlebe Deine Stadt" from the show "RBB Aktuell" broadcasted on 15 November 2011, 21:45h and to the Exmaralda file results of another show broadcasted on 13 November 2011. The general overview of the resulting conversion is depicted in the Figure 23.

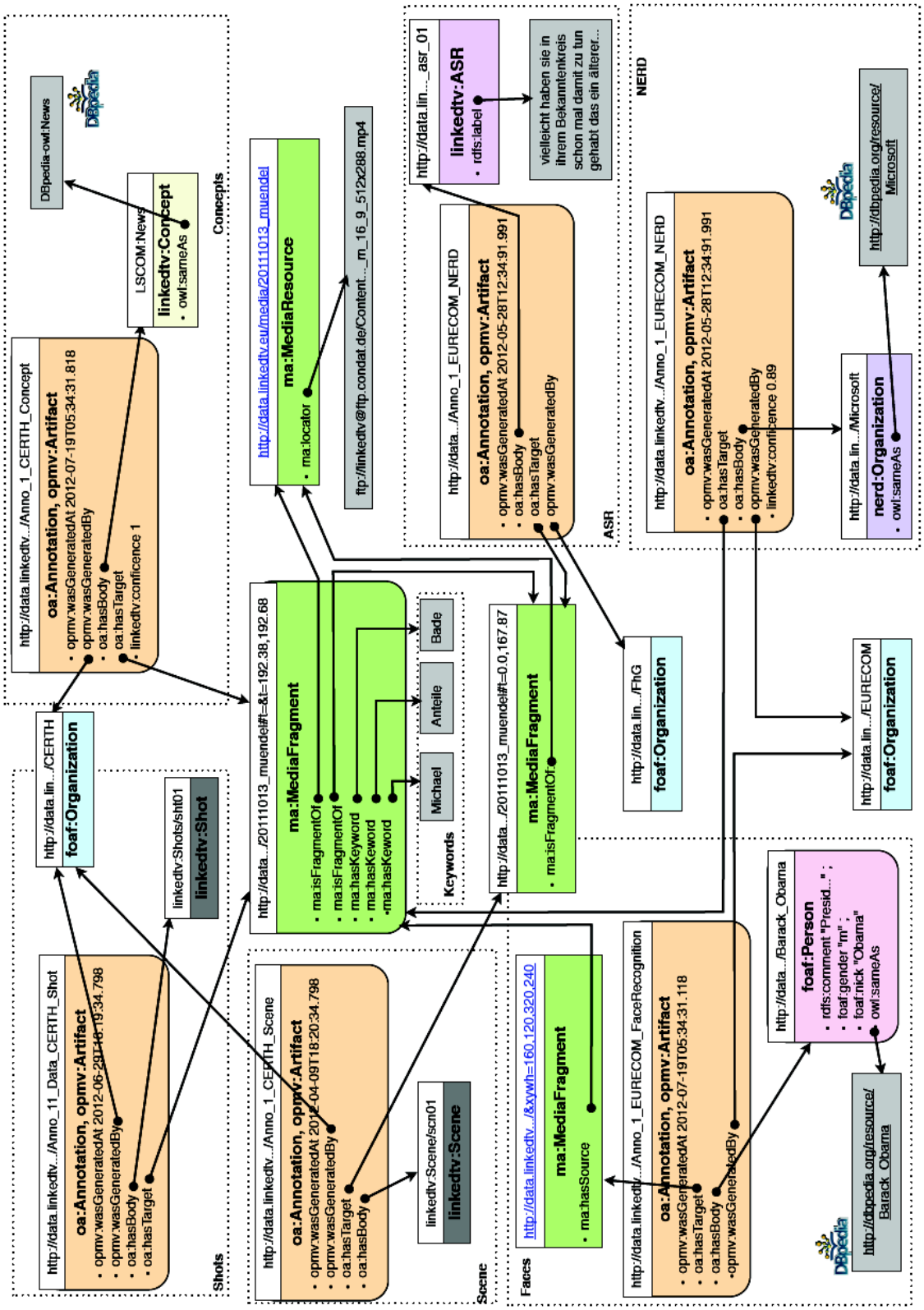


Figure 23: Instances involved in the RBB scenario

4.3.1 Legacy Metadata

The legacy metadata from RBB are expressed in a TV-Anytime like format which can be well translated according to the BBC Program Ontology. The instances created are:

– One instance of the class `po:Episode` that stores the title, the synopsis, the related subjects, and other basic attributes for the current material. Also, this individual has references to the different versions of the episode through the use of the `po:version` property.

```
<http://data.linkedtv.eu/episode/Erlebe_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
 a po:Episode ;
 dc:title "Hotel-Aktion \"Erlebe Deine Stadt\"" ;
 po:id "crid://rbb-online.de/rbbaktuell/7ffdb885-fcf4-44cd-80a7-7c137c8d457a" ;
 po:long_synopsis "Zu Jahresbeginn machen viele Hotels ein Berlin-Wochenende aus Touristensicht
      mglich: F?r 99 Euro knnen Berliner zu zweit in einem ausgewhlten Haus ?bernachten.
      Studiogast: Burkhard Kieker, visitBerlin. (Beitrag von Arndt Breitfeld)" ;
 po:masterbrand "Rundfunk Berlin Brandenburg" ;
 po:microsites <crid://ard.de/bewertbar> , <crid://rbb-online.de/rbbaktuell/0a566f0d- 27f4-9648-
      adf5-03a0cabf365a> ;
 po:short_synopsis "Zu Jahresbeginn machen viele Hotels ein Berlin-Wochenende aus Touristensicht
      mglich: F?r 99 Euro knnen Berliner zu zweit in einem ausgewhlten Haus ?bernachten.
      Studiogast: Burkhard Kieker, visitBerlin. (Beitrag von Arndt Breitfeld)" ;
 po:subject "Information" , "Politik" , "Kulturtipps" , "rbb AKTUELL" , "Neue Bundeslnder" , "
      Rundfunk Berlin-Brandenburg" , "Brandenburg" , "rbb online" , "rbb" , "Regionales" , "rbb
      Fernsehen" , "Berlin" , "TV" , "Nachrichten" ;
 po:version <http://data.linkedtv.eu/version/2_7ffdb885-fcf4-44cd-80a7-7c137c8d457a> , <http://data
      .linkedtv.eu/version/1_7ffdb885-fcf4-44cd-80a7-7c137c8d457a> , <http://data.linkedtv.eu/
      version/0_7ffdb885-fcf4-44cd-80a7-7c137c8d457a> .
```

– One instance of the class `po:Brand` that stores information about the brand this episode belongs to.

```
<http://data.linkedtv.eu/brand/rbb_AKTUELL_0a566f0d-27f4-9648-adf5-03a0cabf365a>
  a po:Brand ;
  dc:title "rbb AKTUELL" ;
  po:episode <http://data.linkedtv.eu/episode/Erlebe_7ffdb885-fcf4-44cd-80a7-7c137c8d457a> ;
  po:id "crid://rbb-online.de/rbbaktuell/0a566f0d-27f4-9648-adf5-03a0cabf365a" ;
  po:microsites <crid://ard.de/sendung> , <crid://rbb-online.de/rbbaktuell> .
```

– Instances of the class `po:Broadcast` which establish a relationship between a particular version of a program and the `po:Service` instance where this version is broadcasted on.

```
<http://data.linkedtv.eu/broadcast/0_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
  a po:Broadcast ;
  po:broadcast_of <http://data.linkedtv.eu/version/0_7ffdb885-fcf4-44cd-80a7-7c137c8d457a> ;
  po:broadcast_on <http://data.linkedtv.eu/brand/rbb_AKTUELL_0a566f0d-27f4-9648-adf5- 03a0cabf365a>
      .

<http://data.linkedtv.eu/broadcast/1_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
  a po:Broadcast ;
  po:broadcast_of <http://data.linkedtv.eu/version/1_7ffdb885-fcf4-44cd-80a7-7c137c8d457a> ;
  po:broadcast_on <rtmp://ondemand.rbb-online.de/ondemand/mp4> .

<http://data.linkedtv.eu/broadcast/2_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
  a po:Broadcast ;
  po:broadcast_of <http://data.linkedtv.eu/version/2_7ffdb885-fcf4-44cd-80a7-7c137c8d457a> ;
  po:broadcast_on <ftp://linkedtv@ftp.condat.de/rbb/rbbaktuell/> .
```

– Instances of the class `po:Service` which represent the television channel where a particular program is broadcasted.

```
<ftp://linkedtv@ftp.condat.de/rbb/rbbaktuell/>
  a po:Service .

<rtmp://ondemand.rbb-online.de/ondemand/mp4>
  a po:Service .
```

– Instances of the class `po:Version` which represent the appearance of a program at a particular date and hour and in a particular format.

```
<http://data.linkedtv.eu/version/0_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
  a po:Version ;
  po:time
    [ a event:Interval ;
      event:start "Tue Nov 15 22:45:00 CET 2011"^^xsd:dateTime
    ];
  linkedtv:hasMediaResource <http://data.linkedtv.eu/media/20111013_muendel> .

<http://data.linkedtv.eu/version/1_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
  a po:Version ;
  po:aspect_ratio "urn:ard:tva:metadata:cs:ARDFormatCS:2008:1.24" ;
  po:time
    [ a event:Interval ;
      event:end "2011-11-23T00:00:00"^^xsd:dateTime ;
      event:start "2011-11-15T21:45:00"^^xsd:dateTime
    ];
  linkedtv:hasMediaResource <http://data.linkedtv.eu/media/20111013_muendel> .

<http://data.linkedtv.eu/version/2_7ffdb885-fcf4-44cd-80a7-7c137c8d457a>
    a po:Version ;
  po:aspect_ratio "urn:ard:tva:metadata:cs:ARDFormatCS:2008:90.3" ;
  po:time
    [ a event:Interval ;
      event:end "2011-11-23T00:00:00"^^xsd:dateTime ;
      event:start "2011-11-15T21:45:00"^^xsd:dateTime
    ];
  linkedtv:hasMediaResource <http://data.linkedtv.eu/media/20111013_muendel> .
```

4.3.2 Multimedia Analysis Metadata

An “RBB Aktuel” program has been completely processed by the WP1 multimedia analysis tool chain, yielding numerous metadata results serialized in the Exmaralda file. In the following, we show how each layer composing the Exmaralda file are converted in RDF using the LinkedTV ontology.

– First, we create one instance of the class `ma:MediaResource` that represents the particular media item and links it with its physical location.

```
<http://data.linkedtv.eu/media/20111013_muendel>
  a ma:MediaResource ;
  ma:locator<ftp://linkedtv@ftp.condat.de/Content%20RBB%20News%20Scenario/RBB_AKTUELL_WEB_15_11_11/
       kontraste_20111013_muendel_m_16_9_512x288.mp4> .
```

– Instances of the class `ma:MediaFragment` represent the different spatio-temporal fragments that belong to a particular media resource. These media fragments could be related also to other media fragments in a containment relationship. Keywords are also stored, when the media fragment correspond to a shot.

```
<http://data.linkedtv.eu/media/20111013_muendel#t=80,83>
  a ma:MediaFragment ;
  ma:hasKeyword
    [ a linkedtv:keyword ;
      rdf:label "Michael"
    ];
  ma:hasKeyword
    [ a linkedtv:keyword ;
      rdf:label "Baden"
    ];
  ma:hasKeyword
    [ a linkedtv:keyword ;
      rdf:label "Anteile"
    ];
  ma:isFragmentOf <http://data.linkedtv.eu/media/20111013_muendel> ;
  ma:isFragmentOf <http://data.linkedtv.eu/media/20111013_muendel#t=0.0,167.87> .
```

– Instances of the class `oa:Annotation` describe the analysis result obtained from the different automatic processing tools. In this example, we can see an annotation that corresponds to a shot detected by CERTH in the media. The body of the annotation is then an instance of a shot, and the target is the media fragment this shot is related to. Provenance information is also included in this class through the use of the properties `opmv:wasGeneratedAt` and `opmv:wasGeneratedBy`.

```
<http://data.linkedtv.eu/annotation/Anno_1_CERTH_Shot>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:34.798Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
```

```
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/CERTH>
    ];
  oa:hasTarget <http://data.linkedtv.eu/media/20111013_muendel#t=80,83> ;
  oa:hasBody <http://data.linkedtv.eu/shot/sht01> .
```

– The instance of the class `linkedtv:Shot` that is being referred in the previous annotation is explicitly typed.

```
<http://data.linkedtv.eu/shot/sht01>
  a linkedtv:Shot .
```

– Instances of the class `oa:Annotation` can correspond to a LSCOM concept detected by CERTH in the media with a level of confidence represented by the `linkedtv:confidence` property.

```
<http://data.linkedtv.eu/annotation/Anno_1_CERTH_Concept>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:35.153Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/CERTH>
    ];
  linkedtv:confidence "1.0"^^xsd:float ;
  oa:hasTarget <http://data.linkedtv.eu/media/20111013_muendel#t=80,83> ;
  oa:hasBody <lscom:News> .
```

– The instance `lscom:News` that is being referred in the previous annotation is also an instance of the `linkedtv:Concept` class.

```
<lscom:News>
  a linkedtv:Concept .
```

– Instances of the class `oa:Annotation` can relate a particular media fragment with a face recognition result performed by EURECOM.

```
<http://data.linkedtv.eu/annotation/Anno_1_EURECOM_FaceRecognition>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:35.153Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/EURECOM>
    ];
  oa:hasTarget <http://data.linkedtv.eu/media/20111013_muendel#t=80&xywh=160,120,320,240> ;
  oa:hasBody <http://data.linkedtv.eu/person/person98032> .
```

– The instance of the class `foaf:Person` that is being referred in the previous annotation is also an instance of a `linkedtv:Person` class.

```
<http://data.linkedtv.eu/person/person98032>
  a foaf:Person ;
  foaf:gender "m" ;
  foaf:nick "Obama" ;
  owl:sameAs <http://dbpedia.org/resource/Barack_Obama> .
```

– Instances of the class `oa:Annotation` can relate a particular media fragment with a name entity recognition result performed by EURECOM.

```
<http://data.linkedtv.eu/annotation/Anno_1_EURECOM_NERD>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-03-29T18:21:36.163Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/EURECOM>
    ];
  linkedtv:confidence "0.89"^^xsd:float ;
  oa:hasTarget <http://data.linkedtv.eu/media/20111013_muendel#t=80,83> ;
  oa:hasBody <http://data.linkedtv.eu/entity/KOP67GT98> .
```

– The instance of the class `linkedtv:Entity` that is being referred in the previous annotation has been typed as a `nerd:Organization` and disambiguated with a DBpedia resource.

```
<http://data.linkedtv.eu/entity/KOP67GT98>
  a nerd:Organization ;
  owl:sameAs <http://dbpedia.org/resource/Microsoft> .
```

– Instances of the class `oa:Annotation` can relate a particular media fragment with a scene recognized by CERTH.

```
<http://data.linkedtv.eu/annotation/Anno_1_CERTH_Scene>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-01-22T18:21:40.153Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/CERTH>
    ];
  oa:hasTarget <http://data.linkedtv.eu/media/20111013_muendel#t=0,168> ;
  oa:hasBody <http://data.linkedtv.eu/scene/scn01> .
```

– The instance of the class `linkedtv:Scene` that is being referred in the previous annotation can be explicitly typed.

```
<http://data.linkedtv.eu/scene/scn01>
  a linkedtv:Scene .
```

– The instance of the class `ma:MediaFragment` indicates the spatio-temporal aspects of the scene detected but also that this scene is a subfragment of the complete media resource as expressed with the property `ma:isFragmentOf`.

```
<http://data.linkedtv.eu/media/20111013_muendel#t=0,168>
  a ma:MediaFragment;
  ma:isFragmentOf <http://data.linkedtv.eu/media/20111013_muendel> .
```

– Instances of the class `oa:Annotation` can relate a particular media fragment with the transcription generated by Fraunhofer.

```
<http://data.linkedtv.eu/annotation/Anno_1_FhG_ASR>
  a oa:Annotation , opmv:Artifact ;
  opmv:wasGeneratedAt "2012-06-29T18:19:35.153Z"^^xsd:dateTime ;
  opmv:wasGeneratedBy
    [ a opmv:Process ;
      opmv:wasPerformedBy <http://data.linkedtv.eu/organization/FhG>
    ];
  linkedtv:confidence "0.234"^^xsd:float ;
  oa:hasTarget <http://data.linkedtv.eu/media/20111013_muendel#t=0,168> ;
  oa:hasBody <http://data.linkedtv.eu/asr/20111013_muendel_asr_01> .
```

– The instance of the class `linkedtv:ASR` that is being referred in the previous annotation enables to store the string with the transcription.

```
<http://data.linkedtv.eu/asr/20111013_muendel_asr_01>
  a linkedtv:ASR ;
  rdfs:label "vielleicht haben sie in ihrem Bekanntenkreis schon mal damit zu tun gehabt dass ein
       lterer Mensch Geschfts unfhig wird etwa auf Grund einer schweren Krankheit wie Alzheimer
       oder Demenz" .
```

5 Conclusion and Future Work

In this deliverable, we described the first version of the LinkedTV metadata ontology available at `http://data.linkedtv.eu/ontology/`. The main design decision has always been to design a lightweight model that would re-use as much as possible existing vocabularies and defining new classes and properties only when necessary.

We have started to produce instances of this model using legacy metadata provided by the content provider (RBB, Sound & Vision), multimedia analysis results provided by WP1 and named entities extraction results provided by NERD. We have populated a triple store with those instances in order to test a number of useful SPARQL queries that we detail in the Appendix 6. We observe that currently, the RDF annotations represent a direct mapping of the WP1 analysis results while we foresee in a next iteration of the RDF generator additional modules capable of inferring new annotations, e.g. if within the same shot, one can find an annotation concerning the detection of a `foaf:Person` and another annotation concerning the detection of a particular person in the transcript.

We have now to automatize the RDF conversion of the metadata coming from those various sources (Figure 24):

- Legacy metadata: RBB manages internally TV Anytime like metadata. The conversion of this format to the LinkedTV model is trivial and has been implemented; Sound & Vision tends to manage legacy metadata in an ad-hoc way, and has just exported spreadsheets so far. We have to find out how we can automatically retrieve and convert this metadata in the future.
- Multimedia analysis metadata: WP1 serializes all its important result in an XML format called Exmaralda composed of different layers corresponding to the different analysis processes. We have already implemented a generic converter from Exmaralda to RDF following the LinkedTV metadata ontology;
- NERD is the named entity recognition framework used in LinkedTV for extracting, typing and disambiguating named entities from textual resources including video subtitles (see the deliverable D2.3). For both content providers, subtitles come in the .stl format. We have re-used a .stl to .srt converter and implement the logic in NERD for extrapolating named entities in a video given a timed text. The results are currently serialized in JSON and we are currently implementing an export in NIF in order to comply with the LinkedTV ontology.

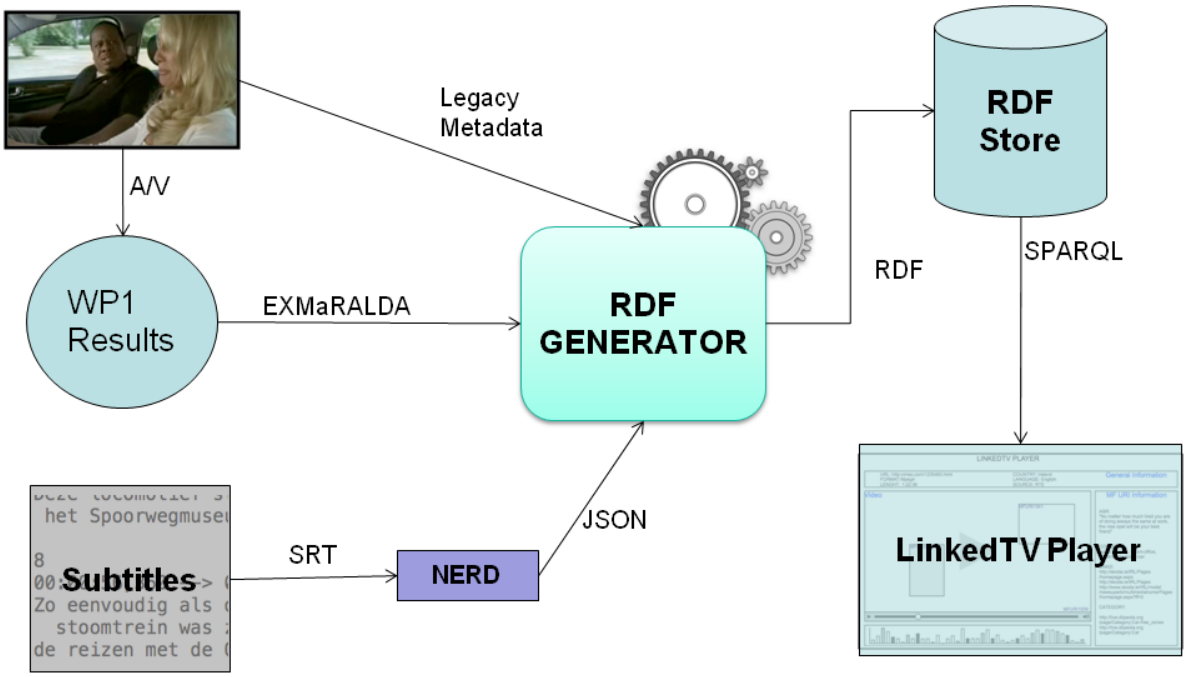


Figure 24: LinkedTV metadata conversion process

Finally, we are developing a software tool to control and manage the entire conversion process. The Figure 25 depicts a sketch of this tool. Next, we will implement the LinkedTV API in order to not only generate static RDF files but also directly feed the LinkedTV metadata store managed by WP5.

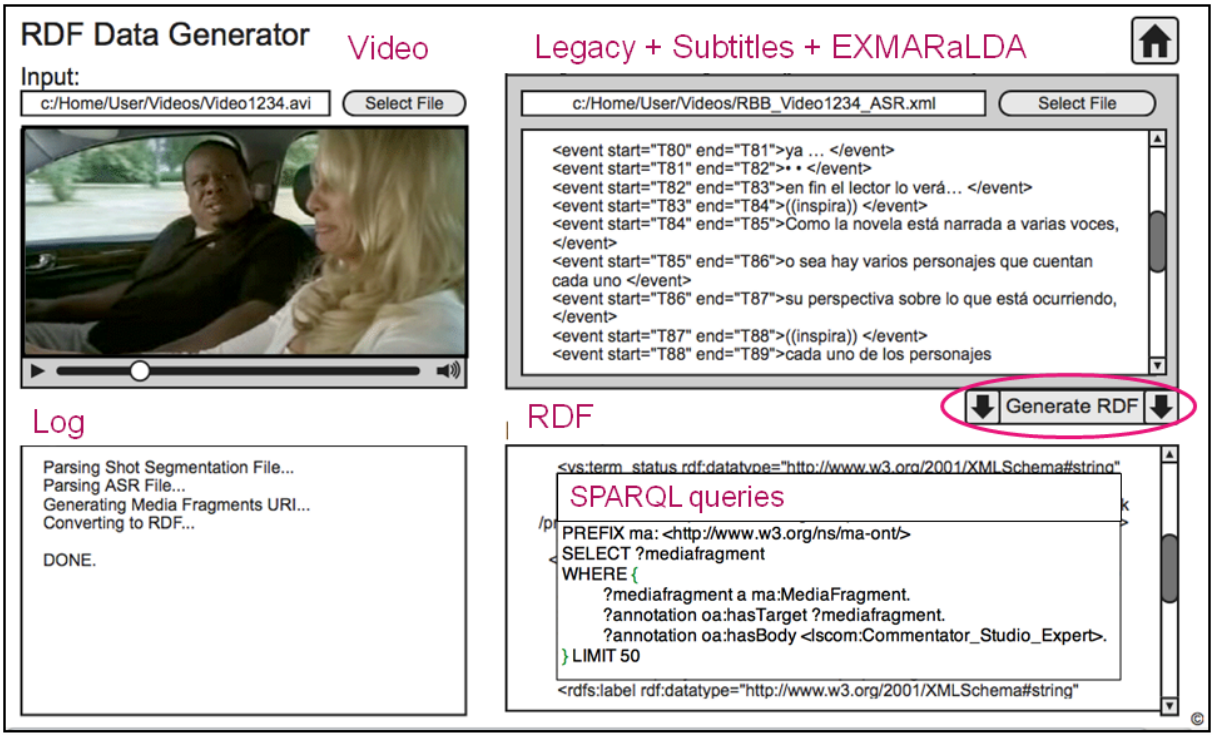


Figure 25: Sketch of the LinkedTV RDF generator

6 Appendix

This section aims to show how the RDF information generated by WP2 can be accessed by using SPARQL queries. In order to achieve this goal, twelve representative queries are proposed. All these queries have been executed over real data feed to a local triple store powered by Virtuoso. The dataset corresponds to the automatic conversion of the legacy and automatic analysis results of the Sound & Visions scenario. For each query:

- we provide the SPARQL query.
- we provide the results obtained after the query execution.
- we highlight which entities in the LinkedTV metadata model are involved in order to have a clearer vision of how the LinkedTV ontology works.

6.1 QUERY 1

6.1.1 Query

Get all the media fragments where the person "Jaap Polak" appears on.

6.1.2 SPARQL code

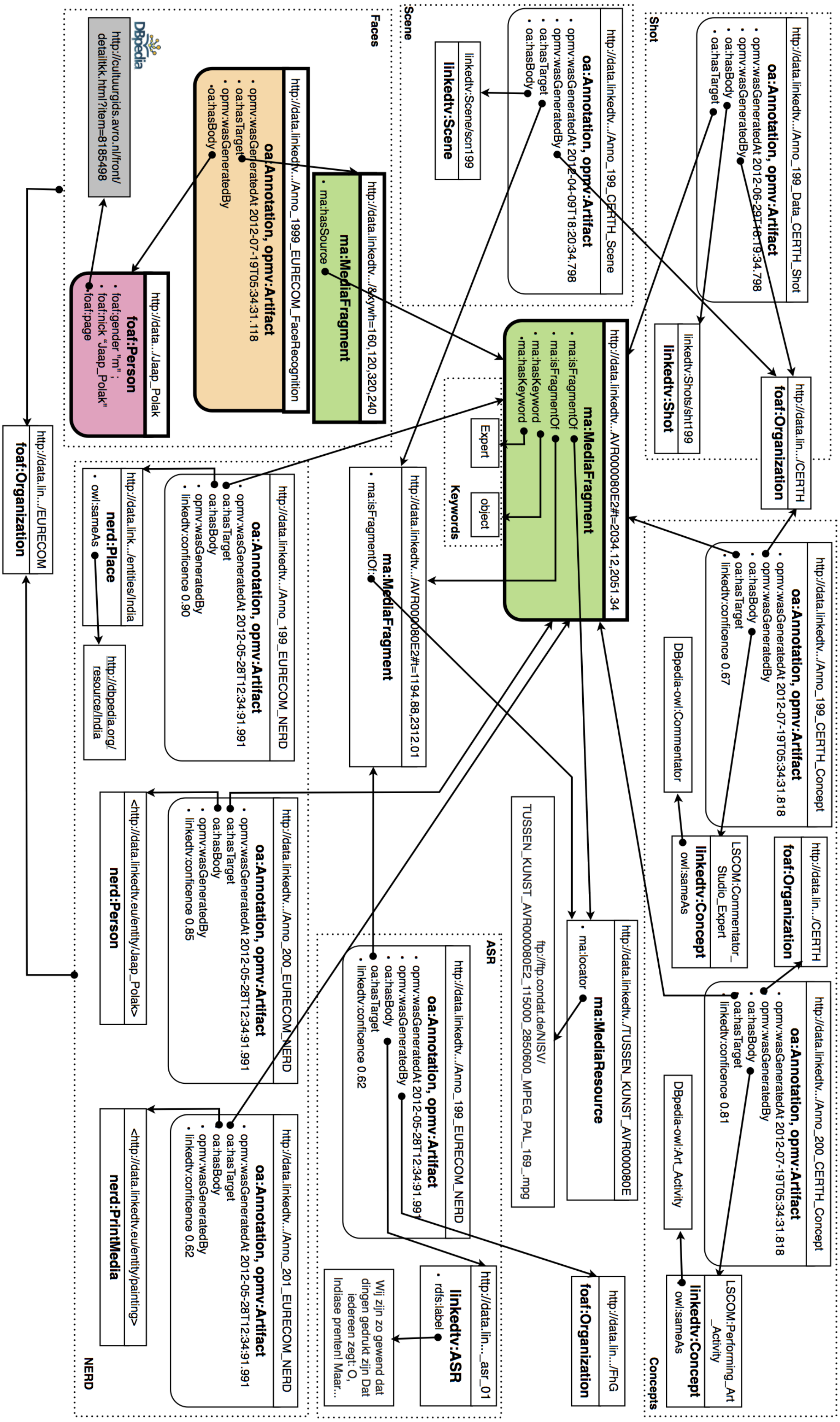
```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>

SELECT ?mediafragment
WHERE {
  ?mediafragment a ma:MediaFragment.
  ?annotation oa:hasTarget ?mediafragment.
  ?annotation oa:hasBody ?person.
  ?person a foaf:Person.
  {?person foaf:name "Jaap Polak"}
    UNION { ?person foaf:nick "Jaap Polak"}.
} LIMIT 50
```

6.1.3 Results

Table 11: Results obtained after the execution

mediafragment
http://data.linkedtv.eu/media/TUSSEN_KUNST_A VR000080E2#t=204489,204719&xywh=144,112,300,250

6.1.4 Involved classes in the LinkedTV datamodel


Shot
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-06-29T18:19:34.798
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:Shots/sht199
linkedtv:Shot
http://data.lin.../CERTH
foaf:Organization
Scene
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-04-09T18:20:34.798
opmv:wasGeneratedBy
oa:hasTarget
oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
Faces
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.118
oa:hasTarget
opmv:wasGeneratedBy
oa:hasBody
http://data.linkedtv.../&xywh=160,120,320,240
ma:MediaFragment
ma:hasSource
http://data.../Jaap_Polak
foaf:Person
foaf:gender "m" ;
foaf:nick "Jaap_Polak"
foaf:page
DBpedia
http://cultureguids.avro.nl/front/detailkk.html?item=8185498
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv...AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
ma:isFragmentOf
ma:isFragmentOf
ma:hasKeyword
ma:hasKeyword
Expert
object
Keywords
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.90
http://data.link.../entities/India
nerd:Place
owl:sameAs
http://dbpedia.org/resource/India
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
NERD
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.818
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:conficence 0.67
DBpedia-owl:Commentator
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
http://data.lin.../CERTH
foaf:Organization
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.818
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:conficence 0.81
DBpedia-owl:Art_Activity
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
Concepts
TUSSEN_KUNST_AVR000080E2_115000_285600_MPEG_PAL_169_mpg
ftp://ftp.condat.de/NISV/
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
ma:locator
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.997
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:conficence 0.62
ASR
http://data.lin..._asr_01
linkedtv:ASR
rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.lin.../FhG
foaf:Organization

6.2 QUERY 2

6.2.1 Query

Get the media fragments where the concept `lscom:Commentator_Studio_Expert` *has been detected.*

6.2.2 SPARQL code

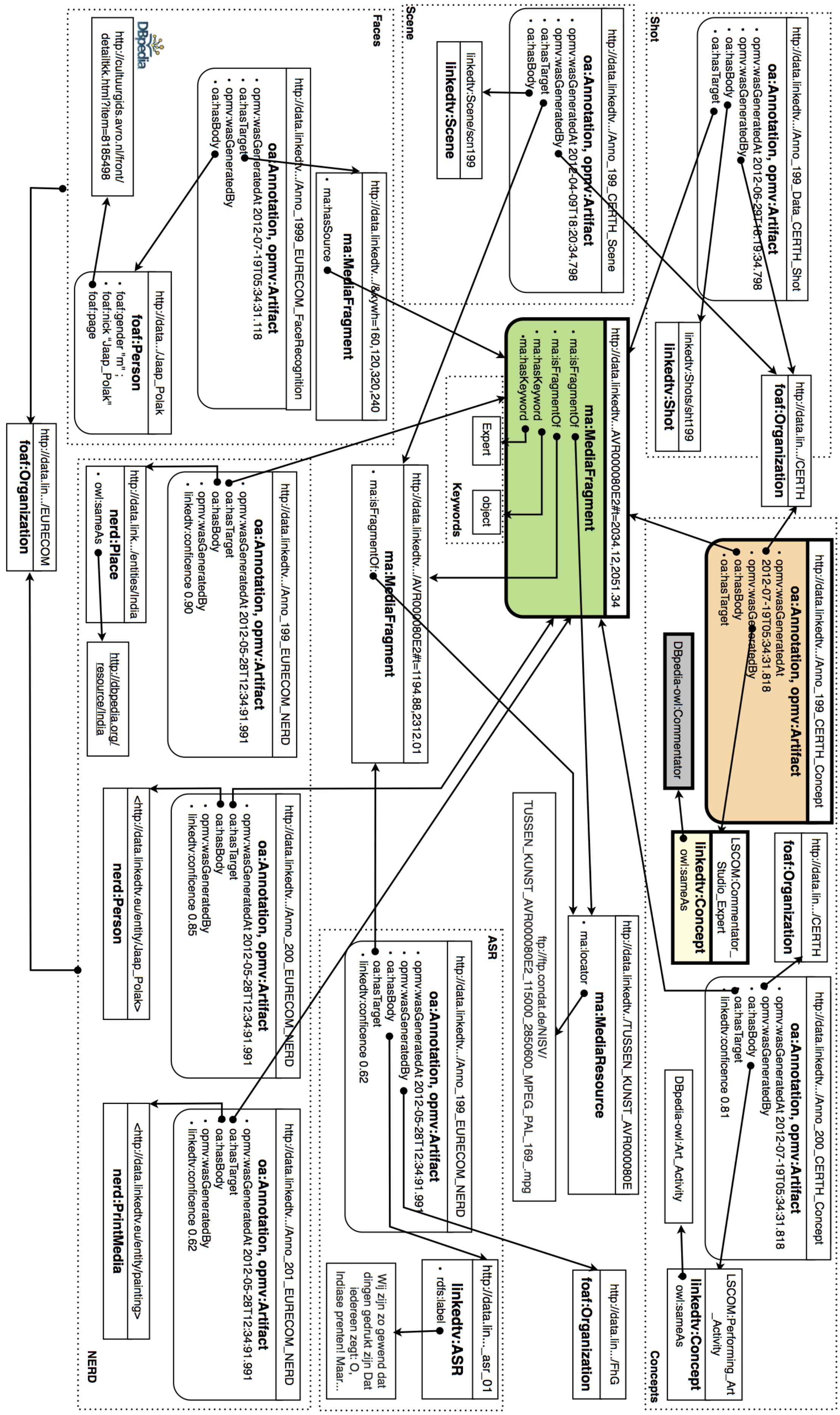
```
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/> PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?mediafragment
WHERE {
  ?mediafragment a ma:MediaFragment.
  ?annotation oa:hasTarget ?mediafragment.
  ?annotation oa:hasBody <lscom:Commentator_Studio_Expert>.
} LIMIT 50
```

6.2.3 Results

Table 12: Results obtained after the execution

mediafragment
http://data.linkedtv.eu/media/TUSSEN_KUNST_A VR000080E2#t=203412,205134

6.2.4 Involved classes in the LinkedTV datamodel


Shot
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-06-29T18:19:34.798
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:Shots/sht199
linkedtv:Shot
http://data.lin.../CERTH
foaf:Organization
Scene
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-04-09T18:20:34.798
opmv:wasGeneratedBy
oa:hasTarget
oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
Faces
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.118
oa:hasTarget
opmv:wasGeneratedBy
oa:hasBody
http://data.linkedtv.../&xywh=160,120,320,240
ma:MediaFragment
ma:hasSource
http://data.../Jaap_Polak
foaf:Person
foaf:gender "m" ;
foaf:nick "Jaap_Polak"
foaf:page
DBpedia
http://cultuurgids.avro.nl/front/detailtkk.html?item=8185498
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv...AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
ma:isFragmentOf
ma:isFragmentOf
ma:hasKeyword
ma:hasKeyword
Keywords
Expert
object
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.90
http://data.link.../entities/India
nerd:Place
owl:sameAs
http://dbpedia.org/resource/India
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.818
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
DBpedia-owl:Commentator
http://data.lin.../CERTH
foaf:Organization
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
TUSSEN_KUNST_AVR000080E2_115000_285600_MPEG_PAL_169_mpg
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
ma:locator
ftp://ftp.condat.de/NISV/
ASR
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:conficence 0.62
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
NERD
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.818
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:conficence 0.81
DBpedia-owl:Art_Activity
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
Concepts
http://data.lin.../FhG
foaf:Organization
http://data.lin..._asr_01
linkedtv:ASR
rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...

6.3 QUERY 3

6.3.1 Query

Get all the entities that appear on a certain Shot, no matter the type they have.

6.3.2 SPARQL code

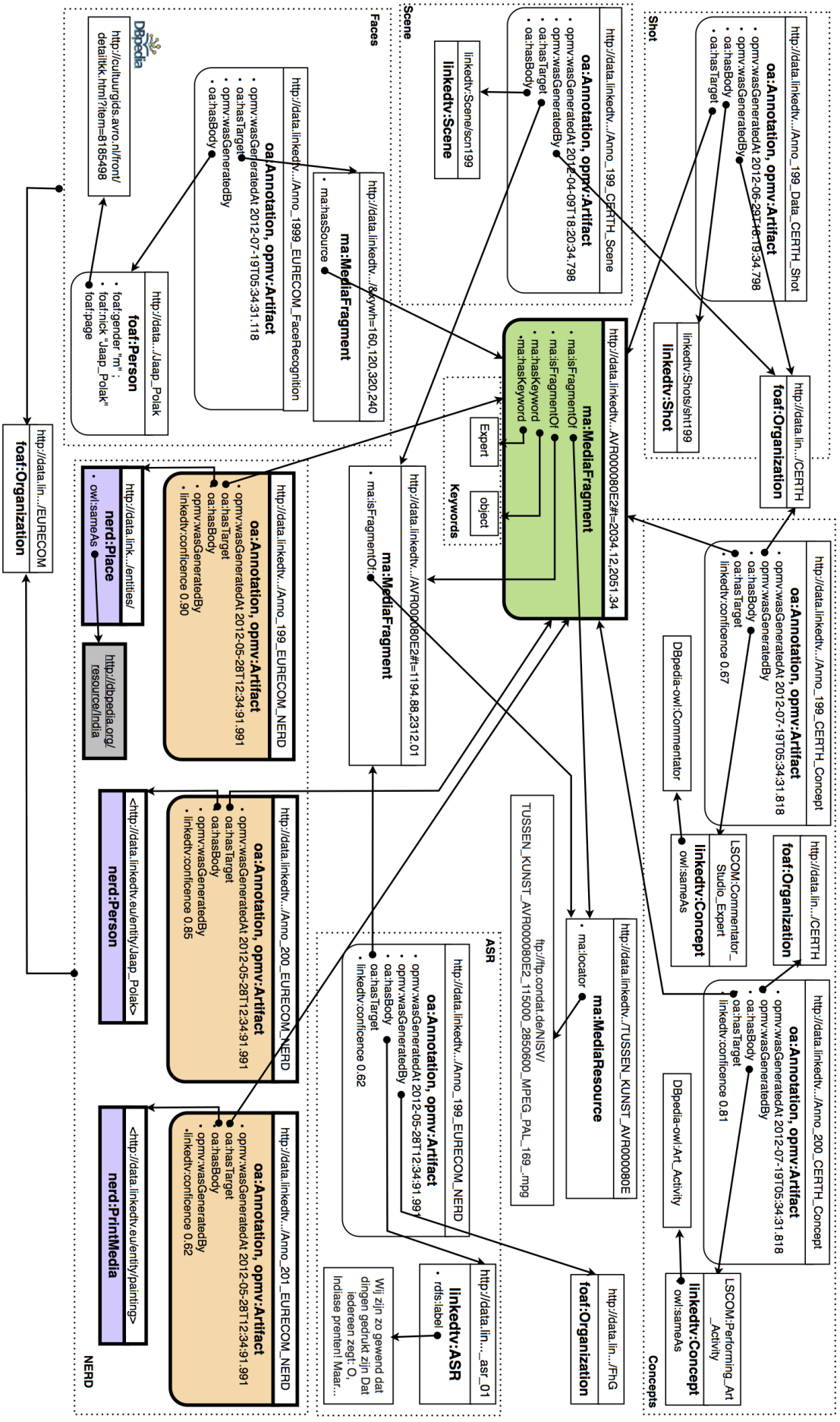
```
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?entity
WHERE {
  ?entity a linkedtv:Entity.
  ?annotation oa:hasBody ?entity.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?annotation2 oa:hasTarget ?mediafragment.
  ?annotation2 oa:hasBody <http://data.linkedtv.eu/shot/sht53>.
} LIMIT 50
```

6.3.3 Results

Table 13: Results obtained after the execution

entity
http://data.linkedtv.eu/entity/YI89GFAZ (*India*)
http://data.linkedtv.eu/entity/person3735 (*Jaap Polak*)
http://data.linkedtv.eu/entity/wn348789 (*painting*)

6.3.4 Involved classes in the LinkedTV datamodel


Shot
Scene
Faces
Keywords
ASR
NERD
Concepts
oa:Annotation, opmv:Artifact
ma:MediaFragment
foaf:Organization
foaf:Person
nerd:Place
nerd:Person
nerd:PrintMedia
linkedtv:Shot
linkedtv:Scene
linkedtv:Concept
linkedtv:ASR
ma:MediaResource
Expert
object
DBpedia
LSCOM:Commentator_Studio_Expert
LSCOM:Performing_Art_Activity
DBpedia-owl:Commentator
DBpedia-owl:Art_Activity

6.4 QUERY 4

6.4.1 Query

Get all the shots that belong to a certain scene.

6.4.2 SPARQL code

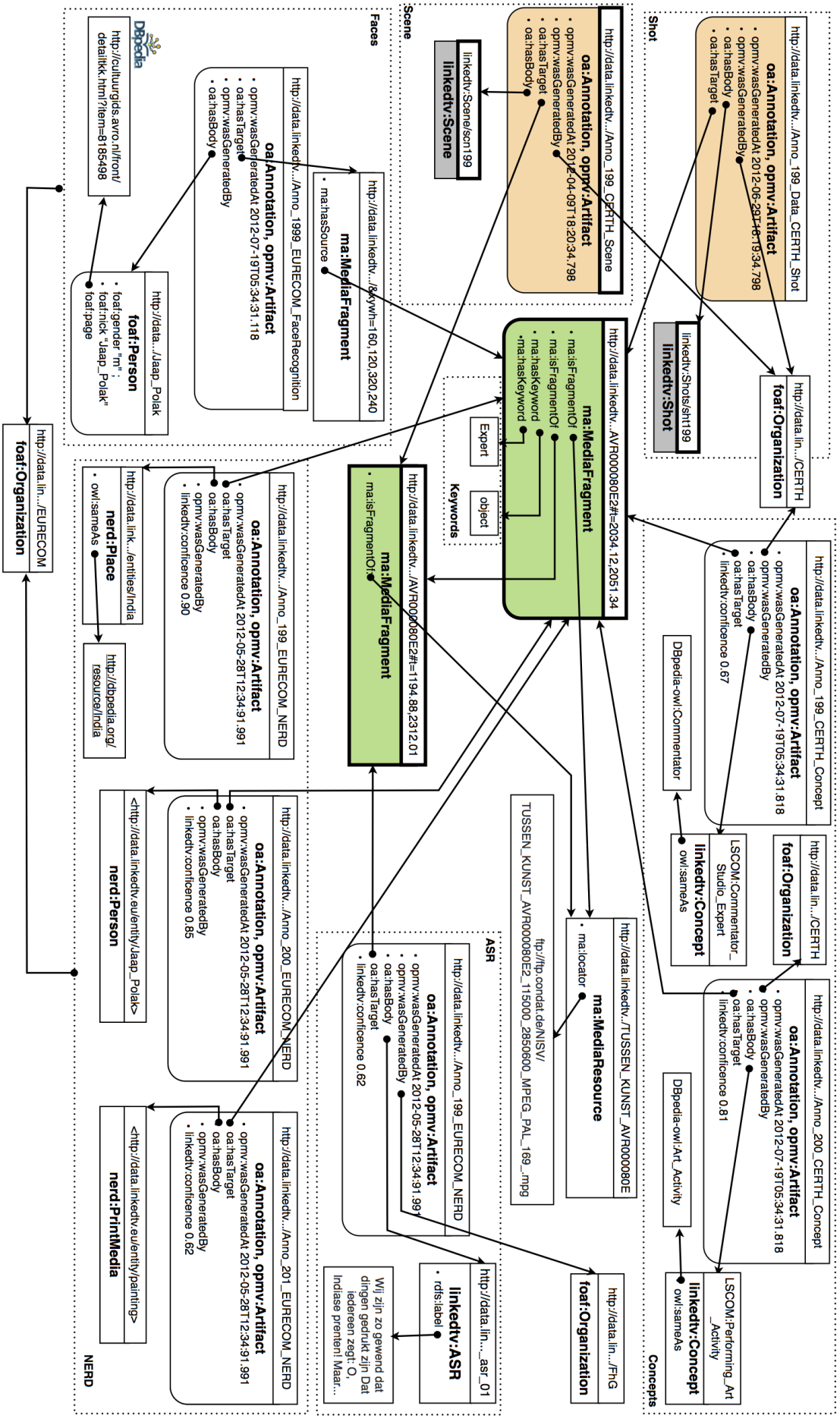
```
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?shot
WHERE {
  ?shot a linkedtv:Shot.
  ?annotation oa:hasBody ?shot.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?mediafragment ma:isFragmentOf ?mediafragment2.
  ?annotation2 oa:hasTarget ?mediafragment2.
  ?annotation2 oa:hasBody <http://data.linkedtv.eu/scene/scn199>.
} LIMIT 50
```

6.4.3 Results

Table 14: Results obtained after the execution

shot
http://data.linkedtv.eu/shot/sht53

6.4.4 Involved classes in the LinkedTV datamodel


http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-06-28T16:19:34.798
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
Shot
linkedtv:Shots/sht199
linkedtv:Shot
http://data.lin.../CERTH
foaf:Organization
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.818
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:confidence 0.67
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-04-09T18:20:34.798
opmv:wasGeneratedBy
oa:hasTarget
oa:hasBody
Scene
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv...AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
ma:isFragmentOf
ma:hasKeyword
ma:hasKeyword
Expert
object
Keywords
DBpedia-owl:Commentator
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
ma:locator
ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.818
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:confidence 0.81
DBpedia-owl:Art_Activity
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
Concepts
http://data.lin.../FhG
foaf:Organization
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-07-19T05:34:31.118
opmv:wasGeneratedBy
oa:hasBody
Faces
http://data.linkedtv.../8&xywh=160,120,320,240
ma:MediaFragment
ma:hasSource
http://data.../Jaap_Polak
foaf:Person
foaf:gender "m" ;
foaf:nick "Jaap_Polak"
foaf:page
DBpedia
http://cultuurgids.avro.nl/front/detailkk.html?item=8185498
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.90
http://data.link.../entities/India
nerd:Place
owl:sameAs
http://dbpedia.org/resource/India
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.99
opmv:wasGeneratedBy
oa:hasBody
oa:hasTarget
linkedtv:conficence 0.62
ASR
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.62
http://data.lin..._asr_01
linkedtv:ASR
rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
opmv:wasGeneratedAt 2012-05-28T12:34:91.991
oa:hasTarget
oa:hasBody
opmv:wasGeneratedBy
linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
NERD

6.5 QUERY 5

6.5.1 Query

Get all the shots that have information about "places".

6.5.2 SPARQL code

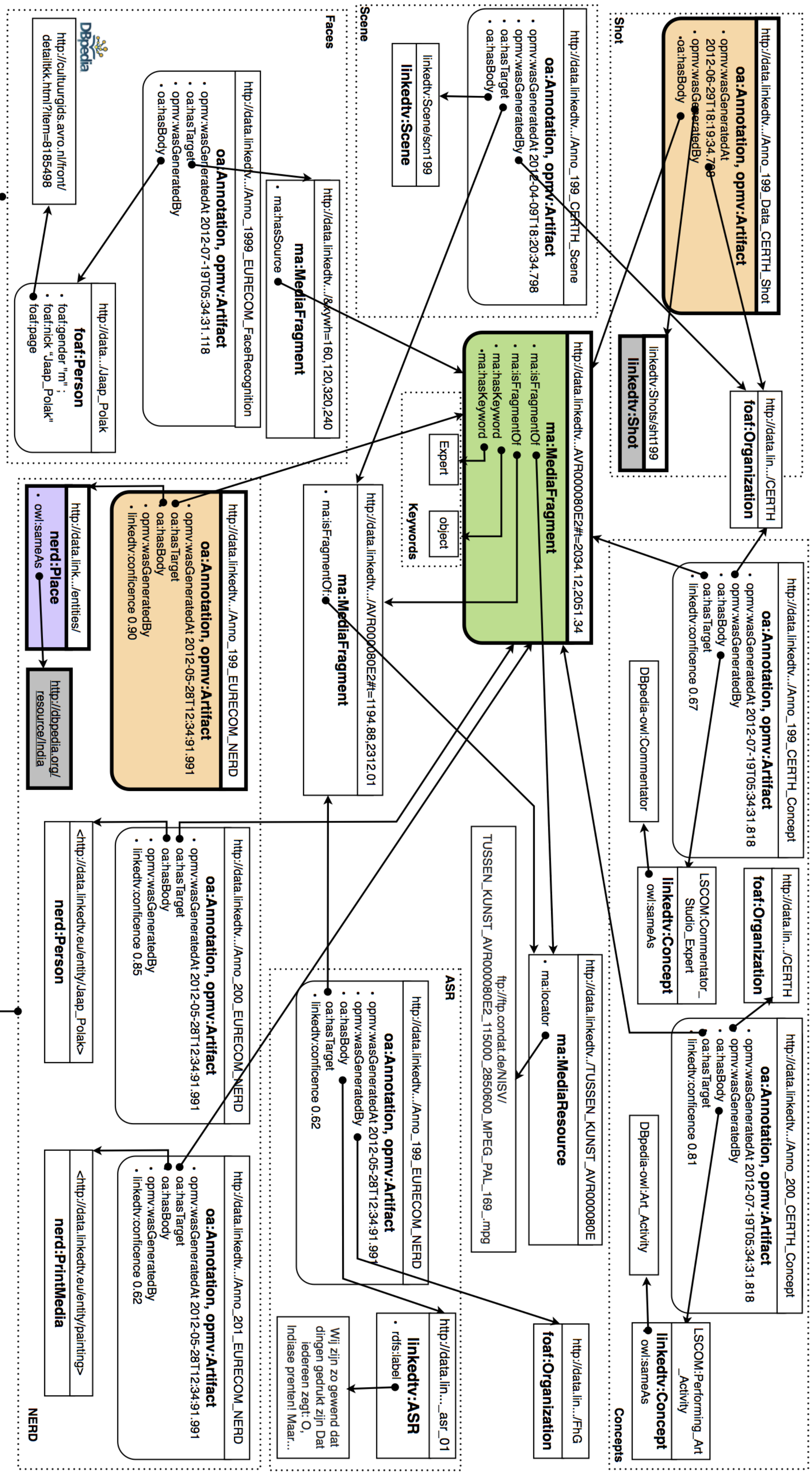
```
PREFIX nerd: <http://nerd.eurecom.fr/ontology>
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: http://www.w3.org/ns/ma-ont/
SELECT ?shot
WHERE {
  ?shot a linkedtv:Shot.
  ?annotation oa:hasBody ?shot.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?annotation2 oa:hasTarget ?mediafragment.
  ?annotation2 oa:hasBody ?entity.
  ?entity a nerd:Place.
} LIMIT 50
```

6.5.3 Results

Table 15: Results obtained after the execution

shot
http://data.linkedtv.eu/shot/sht53

6.5.4 Involved classes in the LinkedTV datamodel


Shot
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-06-29T18:19:34.798
• opmv:wasGeneratedBy
• oa:hasBody
linkedtv:Shots/sht199
linkedtv:Shot
http://data.lin.../CERTH
foaf:Organization
Scene
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-04-09T18:20:34.798
• opmv:wasGeneratedBy
• oa:hasTarget
• oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv...AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
• ma:isFragmentOf
• ma:isFragmentOf
• ma:hasKeyword
• ma:hasKeyword
Keywords
Expert
object
Faces
http://data.linkedtv.../&xywh=160,120,320,240
ma:MediaFragment
• ma:hasSource
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.118
• oa:hasTarget
• opmv:wasGeneratedBy
• oa:hasBody
http://data.../Jaap_Polak
foaf:Person
• foaf:gender "m" ;
• foaf:nick "Jaap_Polak"
• foaf:page
DBpedia
http://cultuurgids.avro.nl/front/detailtkk.html?item=8185498
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
• ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90
http://data.link.../entities/
nerd:Place
• owl:sameAs
http://dbpedia.org/resource/India
Concepts
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:conficence 0.67
DBpedia-owl:Commentator
http://data.lin.../CERTH
foaf:Organization
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
• owl:sameAs
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:conficence 0.81
DBpedia-owl:Art_Activity
LSCOM:Performing_Art_Activity
linkedtv:Concept
• owl:sameAs
TUSSEN_KUNST_AVR000080E2_115000_285600_MPEG_PAL_169_.mpg
ftp://ftp.condat.de/NISV/
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
• ma:locator
ASR
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:conficence 0.62
http://data.lin.../FhG
foaf:Organization
http://data.lin..._asr_01
linkedtv:ASR
• rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
NERD
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia

6.6 QUERY 6

6.6.1 Query

Get all possible places where the person "Jaap Polak" appears on.

6.6.2 SPARQL code

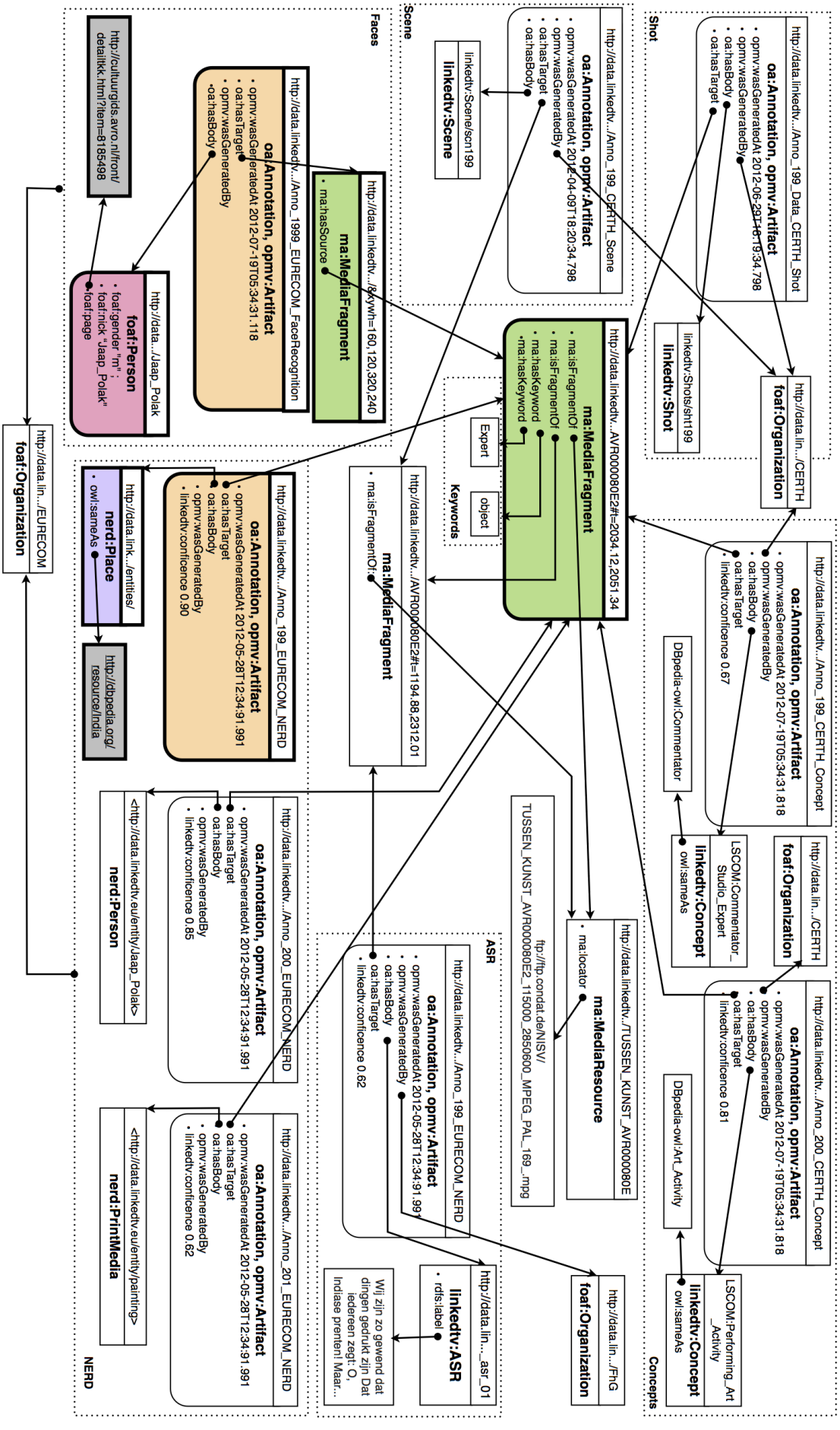
```
PREFIX nerd: http://nerd.eurecom.fr/ontology
PREFIX linkedtv: http://data.linkedtv.eu/ontology/
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?place
WHERE {
  ?person a foaf:Person .
   { ?person foaf:name "Jaap Polak"}
    UNION { ?person foaf:nick "Jaap Polak"}.
  ?annotation oa:hasBody ?person.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?mediafragment ma:isFragmentOf
  ?mediafragmentShot.
  ?annotation2 oa:hasTarget ?mediafragmentShot.
  ?annotation2 oa:hasBody ?place.
  ?place a nerd:Place.
} LIMIT 50
```

6.6.3 Results

Table 16: Results obtained after the execution

place
http://data.linkedtv.eu/entity/YI89GFAZ (*India*)

6.6.4 Involved classes in the LinkedTV datamodel


Shot
Scene
Faces
Keywords
Concepts
ASR
NERD
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-06-28T18:19:34.798
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
http://data.lin.../CERTH
foaf:Organization
linkedtv:Shots/sht199
linkedtv:Shot
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.67
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-04-09T18:20:34.798
• opmv:wasGeneratedBy
• oa:hasTarget
• oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv.../AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
• ma:isFragmentOf
• ma:hasKeyword
• ma:hasKeyword
Expert
object
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
• ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.118
• oa:hasTarget
• opmv:wasGeneratedBy
•oa:hasBody
http://data.linkedtv.../8&xywh=160,120,320,240
ma:MediaFragment
• ma:hasSource
http://data.../Jaap_Polak
foaf:Person
• foaf:gender "m" ;
• foaf:nick "Jaap_Polak"
•foaf:page
http://cultuurgids.avro.nl/front/detailkk.html?item=8185498
http://data.lin.../EURECOM
foaf:Organization
http://data.link.../entities/
nerd:Place
• owl:sameAs
http://dbpedia.org/resource/India
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:conficence 0.81
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
DBpedia-owl:Commentator
DBpedia-owl:Art_Activity
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
• ma:locator
ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg
http://data.lin.../FhG
foaf:Organization
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
http://data.lin.../asr_01
linkedtv:ASR
• rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia

6.7 QUERY 7

6.7.1 Query

Get all the annotations performed by EURECOM on a particular Shot.

6.7.2 SPARQL code

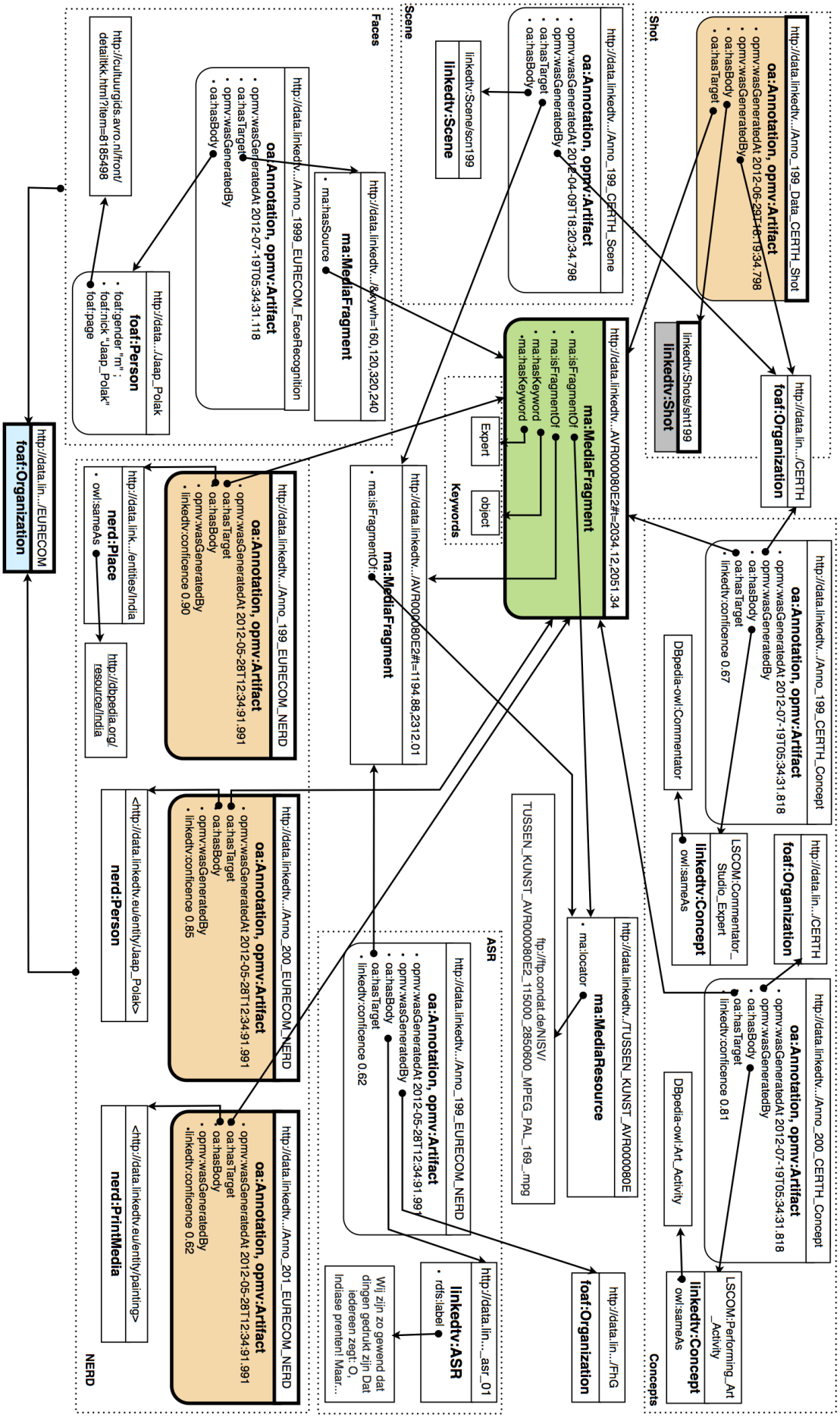
```
PREFIX opmv: <http://purl.org/net/opmv/ns/>
PREFIX linkedtv: http://data.linkedtv.eu/ontology/
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?annotation_eurecom
WHERE {
  ?annotation oa:hasBody <http://data.linkedtv.eu/shot/sht53>.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?annotation_eurecom oa:hasTarget ?mediafragment.
  ?annotation_eurecom opmv:wasGeneratedBy ?blanknode.
  ?blanknode  opmv:wasPerformedBy
    <http://data.linkedtv.eu/organization/EURECOM>.
} LIMIT 50
```

6.7.3 Results

Table 17: Results obtained after the execution

annotation_eurecom
http://data.linkedtv.eu/annotation/Anno_199_EURECOM_NERD
http://data.linkedtv.eu/annotation/Anno_200_EURECOM_NERD
http://data.linkedtv.eu/annotation/Anno_201_EURECOM_NERD

6.7.4 Involved classes in the LinkedTV datamodel


Shot
Scene
Faces
Keywords
Concepts
ASR
NERD
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-06-28T16:19:34.798
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
http://data.lin.../CERTH
foaf:Organization
linkedtv:Shots/sht199
linkedtv:Shot
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-04-09T18:20:34.798
• opmv:wasGeneratedBy
• oa:hasTarget
• oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv.../AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
• ma:isFragmentOf
• ma:hasKeyword
• ma:hasKeyword
Expert
object
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.67
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
DBpedia-owl:Commentator
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.81
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
DBpedia-owl:Art_Activity
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
• ma:locator
ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg
http://data.lin.../FhG
foaf:Organization
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.118
• opmv:wasGeneratedBy
• oa:hasBody
http://data.linkedtv.../84,wh=160,120,320,240
ma:MediaFragment
• ma:hasSource
http://data.../Jaap_Polak
foaf:Person
• foaf:gender "m" ;
• foaf:nick "Jaap_Polak"
foaf:page
http://cultuurgids.avro.nl/front/detail/kk.html?item=8185498
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90
http://data.link.../entities/India
nerd:Place
• owl:sameAs
http://dbpedia.org/resource/India
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
• ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
http://data.lin.../EURECOM
foaf:Organization
http://data.lin..._asr_01
linkedtv:ASR
• rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...

6.8 QUERY 8

6.8.1 Query

Get the subtitles of what is being said when “Jaap Polak” is appearing on the screen.

6.8.2 SPARQL code

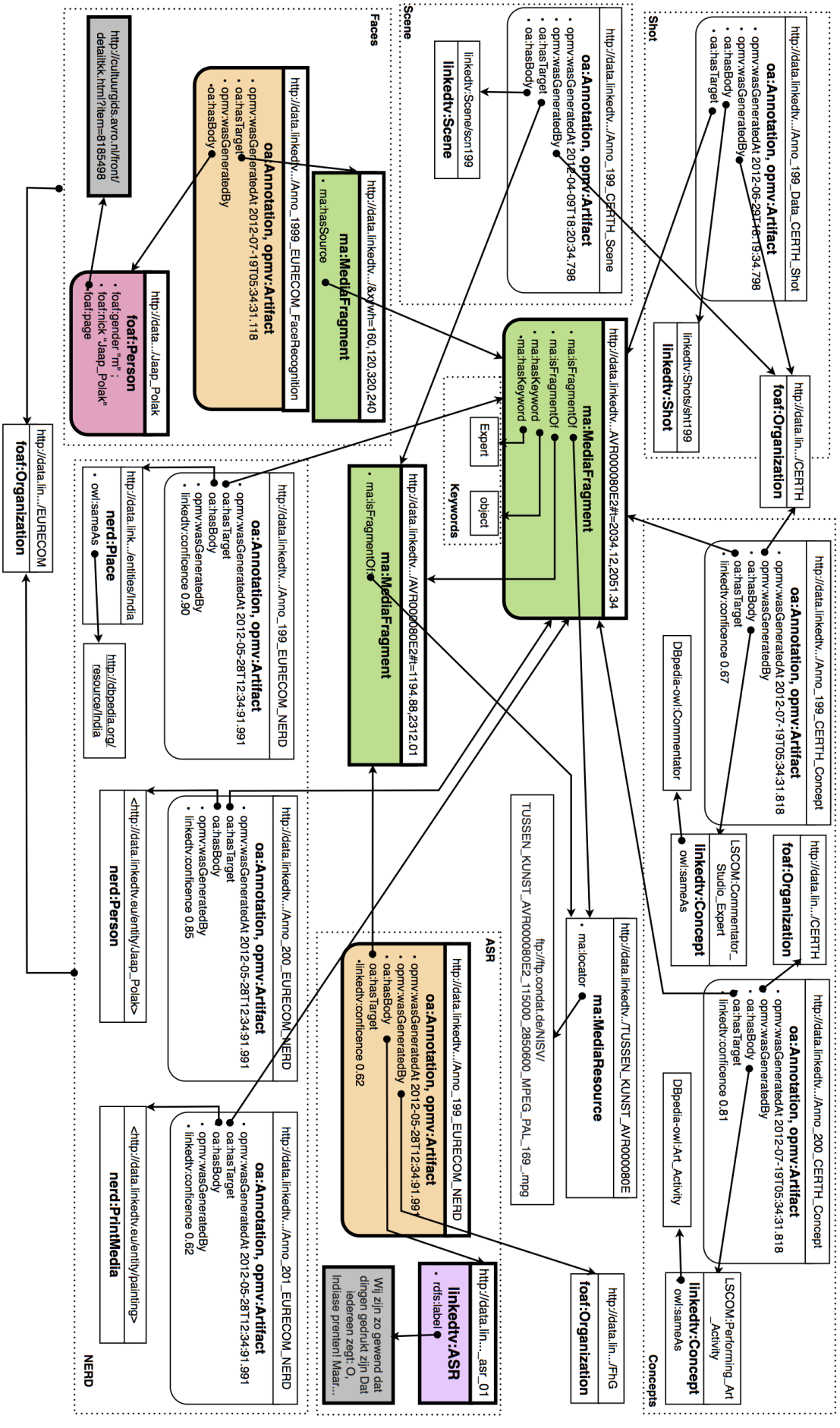
```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX linkedtv: http://data.linkedtv.eu/ontology/
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?asr, ?asrtext
WHERE {
  ?person a foaf:Person.
  { ?person foaf:name "Jaap Polak"}
    UNION { ?person foaf:nick "Jaap Polak"}.
  ?annotation oa:hasBody ?person.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?mediafragment ma:isFragmentOf ?mediafragmentshot.
  ?mediafragmentshot ma:isFragmentOf ?mediafragmentscene.
  ?annotation2 oa:hasTarget ?mediafragmentscene.
  ?annotation2 oa:hasBody ?asr.
  ?asr a linkedtv:ASR.
  ?asr rdfs:label ?asrtext.
} LIMIT 50
```

6.8.3 Results

Table 18: Results obtained after the execution

asr	asrtext
http://data.linkedtv.eu/asr/TUSBENK1NGSTA VR000080E2_asr_01	Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar het zijn geen prenten. Het zijn Indiase schilderingen. U bent in India geweest?Ja. Maar ik heb deze daar niet gekocht. Deze kocht ik op de veiling in Amsterdam. 15 jaar geleden. Nou, ik weet niet wat u betaald heeft, dat wil ik ook niet weten... Niet veel.Maar dat heeft u goed gedaan, denk ik. Want deze schildering... Een heel mooi vorstelijk portret. Het komt uit Noord-India. Hier heeft u een Indiaas miniatuur. Dat is ook uit het noorden. Ze zit daar prachtig op een mooie stoel. U ziet al dat het veel flamboyanter is dan de andere. Die doeken en dingen gaan al veel meer opzij. Dat vind je ook in het gebied van Jodhpur, Udaipur. Aan je goud zie je dat het een tamelijk late miniatuur is. Ze leggen er ook kleine pareltjes op. Die geven relief.

6.8.4 Involved classes in the LinkedTV datamodel


Shot
Scene
Faces
Keywords
Concepts
ASR
NERD
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-06-28T18:19:34.798
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
http://data.lin.../CERTH
foaf:Organization
linkedtv:Shots/sht199
linkedtv:Shot
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-04-09T18:20:34.798
• opmv:wasGeneratedBy
• oa:hasTarget
• oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv.../AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
• ma:isFragmentOf
• ma:hasKeyword
• ma:hasKeyword
Expert
object
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.67
http://data.lin.../CERTH
foaf:Organization
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.81
LSCOM:Commentator_Studio_Expert
owl:sameAs
linkedtv:Concept
DBpedia-owl:Commentator
DBpedia-owl:Art_Activity
LSCOM:Performing_Art_Activity
owl:sameAs
linkedtv:Concept
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
• ma:locator
ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.118
• oa:hasTarget
• opmv:wasGeneratedBy
• oa:hasBody
http://data.linkedtv...#xywh=160,120,320,240
ma:MediaFragment
• ma:hasSource
http://data.../Jaap_Polak
foaf:Person
• foaf:gender "m" ;
• foaf:nick "Jaap_Polak"
• foaf:page
http://cultuurgids.avro.nl/front/detailkk.html?item=8185498
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:confidence 0.90
http://data.link.../entities/India
nerd:Place
• owl:sameAs
http://dbpedia.org/resource/India
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
• ma:isFragmentOf
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:confidence 0.62
http://data.lin..._asr_01
linkedtv:ASR
• rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:confidence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:confidence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
http://data.lin.../FhG
foaf:Organization

6.9 QUERY 9

6.9.1 Query

Get all the keywords related to a particular media fragment.

6.9.2 SPARQL code

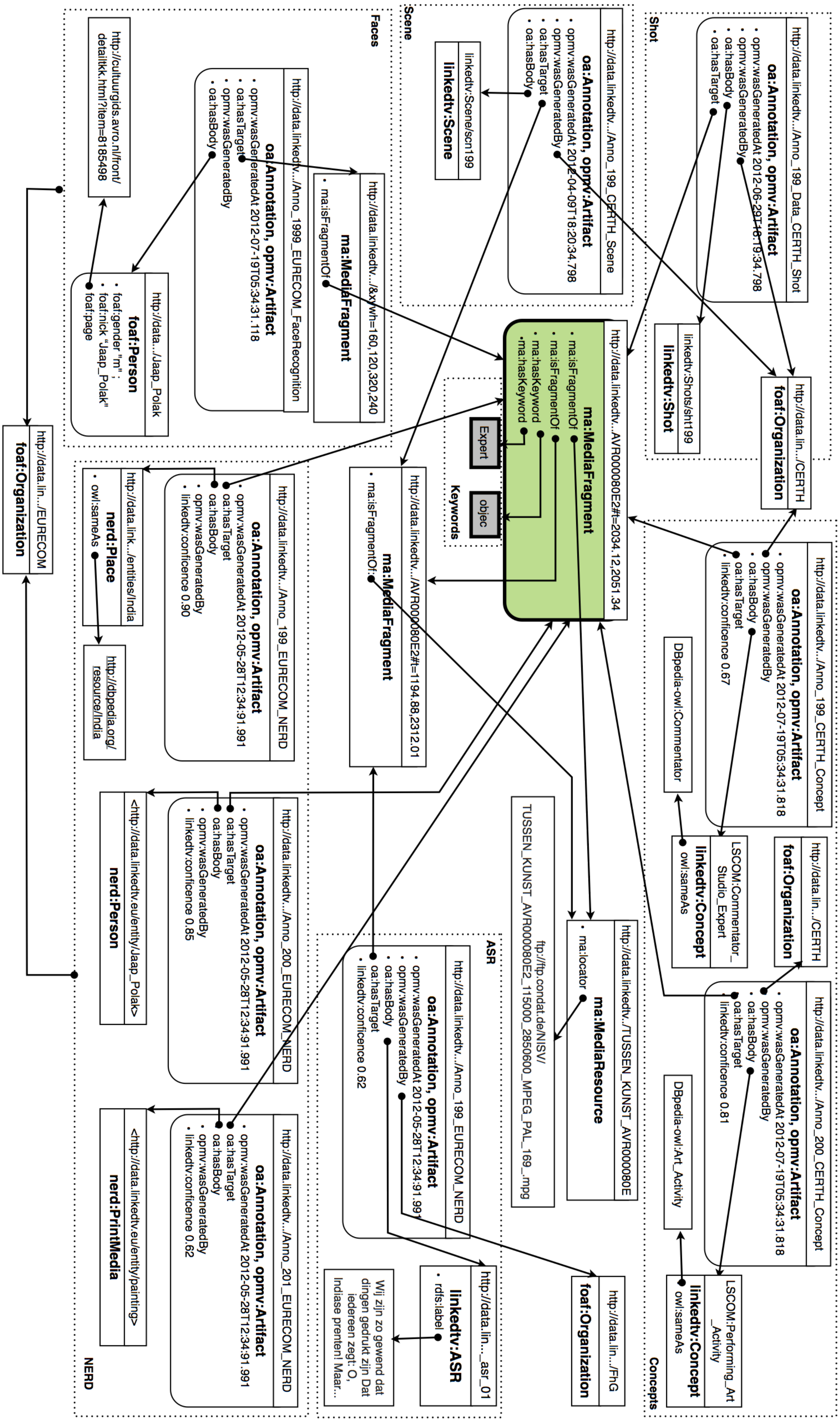
```
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?keywordtext
WHERE {
  <http://data.linkedtv.eu/media/TUSSEN_KUNST_AVR000 080E2#t=2034.12,2051.34>
    ma:hasKeyword ?keyword.
  ?keyword a linkedtv:Keyword.
  ?keyword rdf:label ?keywordtext.
} LIMIT 50
```

6.9.3 Results

Table 19: Results obtained after the execution

keywordtext
Expert
Object

6.9.4 Involved classes in the LinkedTV datamodel


Shot
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
linkedtv:Shots/sht199
linkedtv:Shot
http://data.lin.../CERTH
foaf:Organization
Scene
http://data.linkedtv.../Anno_199_CERTH_Scene
linkedtv:Scene/scn199
linkedtv:Scene
Faces
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
http://data.linkedtv.../&xywh=160,120,320,240
ma:MediaFragment
http://data.../Jaap_Polak
foaf:Person
http://cultuurgids.avro.nl/front/detailtkk.html?item=8185498
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv...AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
Keywords
Expert
objec
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
http://data.linkedtv.../Anno_199_EURECOM_NERD
http://data.link.../entities/India
nerd:Place
http://dbpedia.org/resource/India
http://data.linkedtv.../Anno_199_CERTH_Concept
DBpedia-owl:Commentator
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
http://data.linkedtv.../Anno_200_CERTH_Concept
DBpedia-owl:Art_Activity
LSCOM:Performing_Art_Activity
Concepts
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_285600_MPEG_PAL_169_.mpg
http://data.lin.../FhG
foaf:Organization
ASR
http://data.linkedtv.../Anno_199_EURECOM_NERD
http://data.lin..._asr_01
linkedtv:ASR
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.linkedtv.../Anno_200_EURECOM_NERD
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_201_EURECOM_NERD
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
NERD

6.10 QUERY 10

6.10.1 Query

Get all the media fragments inside a particular scene where a certain place appears on.

6.10.2 SPARQL code

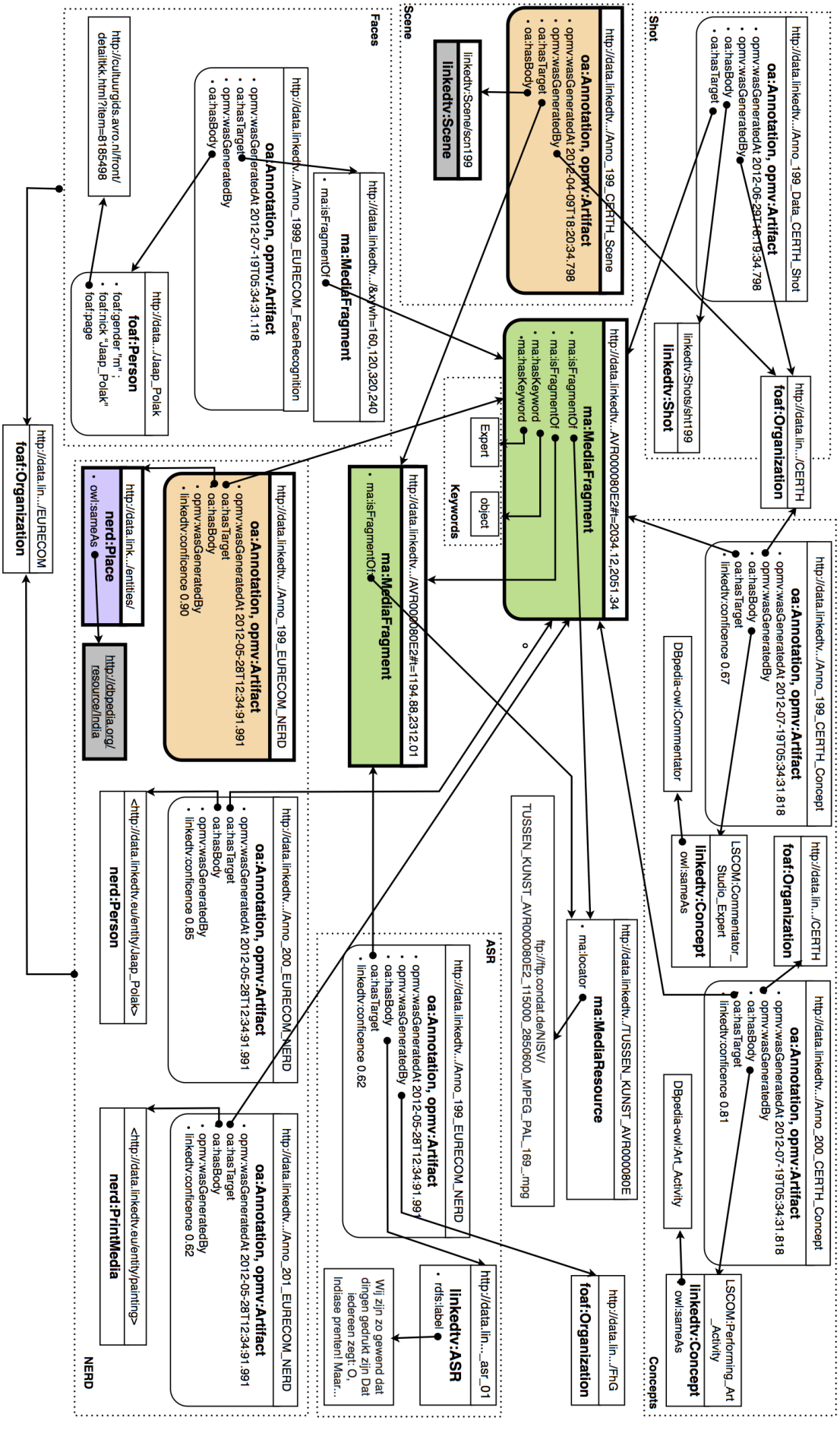
```
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?mediafragment
WHERE {
  ?mediafragment a ma:MediaFragment.
  ?annotation oa:hasTarget ?mediafragment.
  ?annotation oa:hasBody <http://data.linkedtv.eu/entity/India> .
  ?mediafragment ma:isFragmentOf ?mediafragmentscene.
  ?annotation2 oa:hasTarget ?mediafragmentscene.
  ?annotation2 oa:hasBody <http://data.linkedtv.eu/scene/scn199>.
} LIMIT 50
```

6.10.3 Results

Table 20: Results obtained after the execution

mediafragment
http://data.linkedtv.eu/media/TUSSEN_KUNST_A VR000080E2#t=203412,205134

6.10.4 Involved classes in the LinkedTV datamodel


Shot
Concepts
Scene
Faces
Keywords
ASR
NERD
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-06-28T14:19:34.798
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
http://data.lin.../CERTH
foaf:Organization
linkedtv:Shots/sht199
linkedtv:Shot
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.67
http://data.lin.../CERTH
foaf:Organization
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-04-09T18:20:34.798
• opmv:wasGeneratedBy
• oa:hasTarget
• oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv.../AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
• ma:isFragmentOf
• ma:isFragmentOf
• ma:hasKeyword
• ma:hasKeyword
Expert
object
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.81
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
DBpedia-owl:Art_Activity
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
DBpedia-owl:Commentator
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
• ma:locator
ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg
http://data.lin.../FhG
foaf:Organization
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.118
• opmv:wasGeneratedBy
• oa:hasBody
http://data.linkedtv.../8xywh=160,120,320,240
ma:MediaFragment
• ma:isFragmentOf
http://data.../Jaap_Polak
foaf:Person
• foaf:gender "m" ;
• foaf:nick "Jaap_Polak"
foaf:page
http://cultuurgids.avro.nl/front/detailkk.html?item=8185498
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
• ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90
http://data.link.../entities/
nerd:Place
• owl:sameAs
http://dbpedia.org/resource/India
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
http://data.lin.../asr_01
linkedtv:ASR
• rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62

6.11 QUERY 11

6.11.1 Query

Look for persons that appear at least two times in the same scene.

6.11.2 SPARQL code

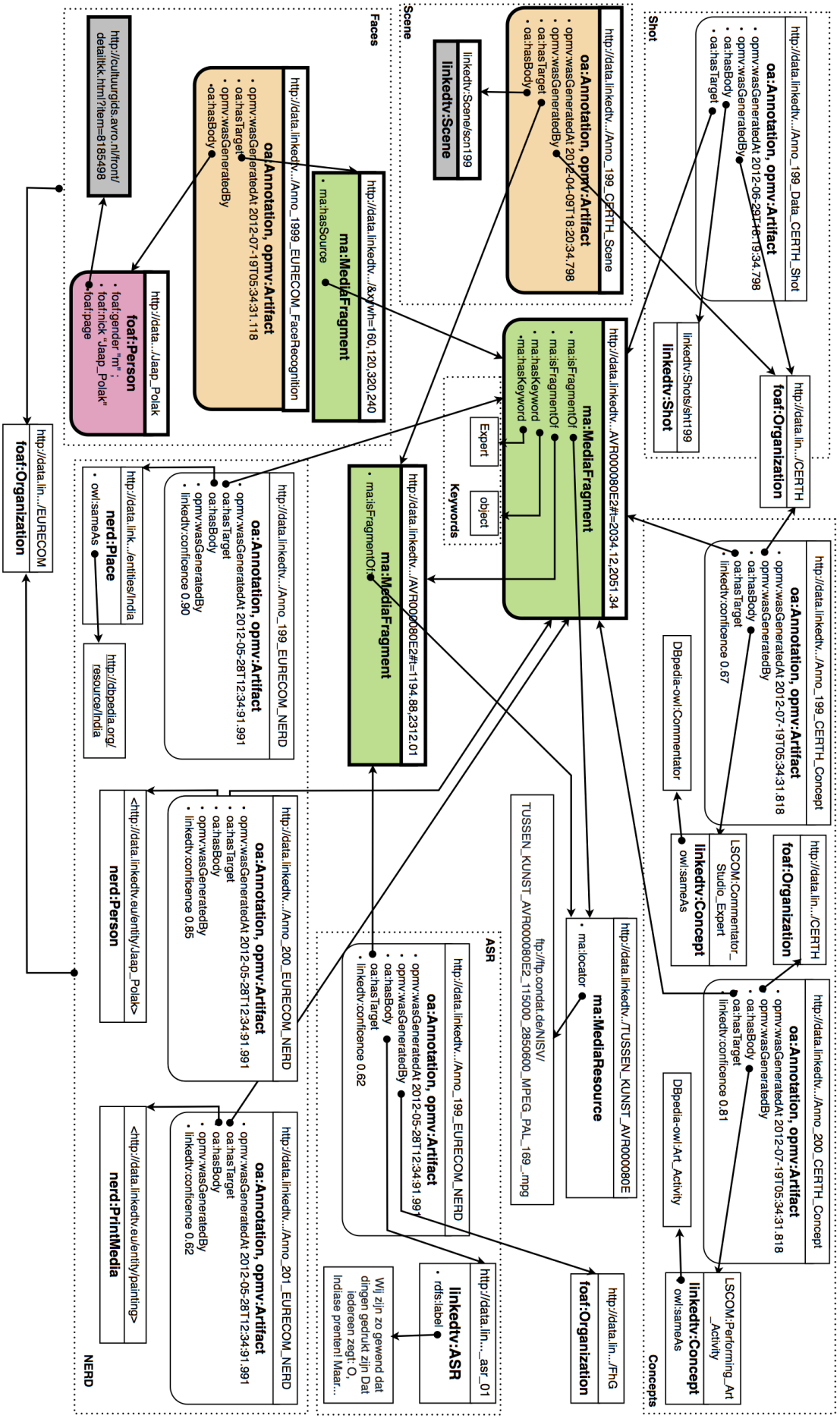
```
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?person
WHERE {
  ?person a foaf:Person.
  ?annotation oa:hasBody ?person.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?mediafragment ma:isFragmentOf ?mediafragmentshot.
  ?mediafragmentshot ma:isFragmentOf ?mediafragmentscene.
  ?annotation2 oa:hasTarget ?mediafragmentscene.
  ?annotation2 oa:hasBody <http://data.linkedtv.eu/scene/scn199>.
}
GROUP BY ?person
HAVING (COUNT(*)>= 2)
```

6.11.3 Results

Table 21: Results obtained after the execution

person
http://data.linkedtv.eu/person/person3735 (*Jaap Polak*)

6.11.4 Involved classes in the LinkedTV datamodel


Shot
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-06-28T16:19:34.798
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
http://data.lin.../CERTH
foaf:Organization
linkedtv:Shots/sht199
linkedtv:Shot
Scene
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-04-09T18:20:34.798
• opmv:wasGeneratedBy
• oa:hasTarget
• oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv.../AVR000080E2#t=2034.12,2051.34
ma:MediaFragment
• ma:isFragmentOf
• ma:hasKeyword
•ma:hasKeyword
Expert
object
Keywords
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.67
http://data.lin.../CERTH
foaf:Organization
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
DBpedia-owl:Commentator
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.81
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
DBpedia-owl:Art_Activity
Concepts
Faces
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.118
• oa:hasTarget
• opmv:wasGeneratedBy
•oa:hasBody
http://data.linkedtv.../&xywh=160,120,320,240
ma:MediaFragment
• ma:hasSource
http://data.../Jaap_Polak
foaf:Person
• foaf:gender "m" ;
• foaf:nick "Jaap_Polak"
•foaf:page
http://cultuurgids.avro.nl/front/detailkk.html?item=8185498
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
• ma:isFragmentOf
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90
http://data.link.../entities/India
nerd:Place
• owl:sameAs
http://dbpedia.org/resource/India
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
• ma:locator
ftp://ftp.condat.de/NISV/TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg
http://data.lin.../EURECOM
foaf:Organization
http://data.lin.../FhG
foaf:Organization
ASR
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:conficence 0.62
http://data.lin..._asr_01
linkedtv:ASR
• rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
NERD

6.12 QUERY 12

6.12.1 Query

Get the name of one place that appears at least in three different scenes.

6.12.2 SPARQL code

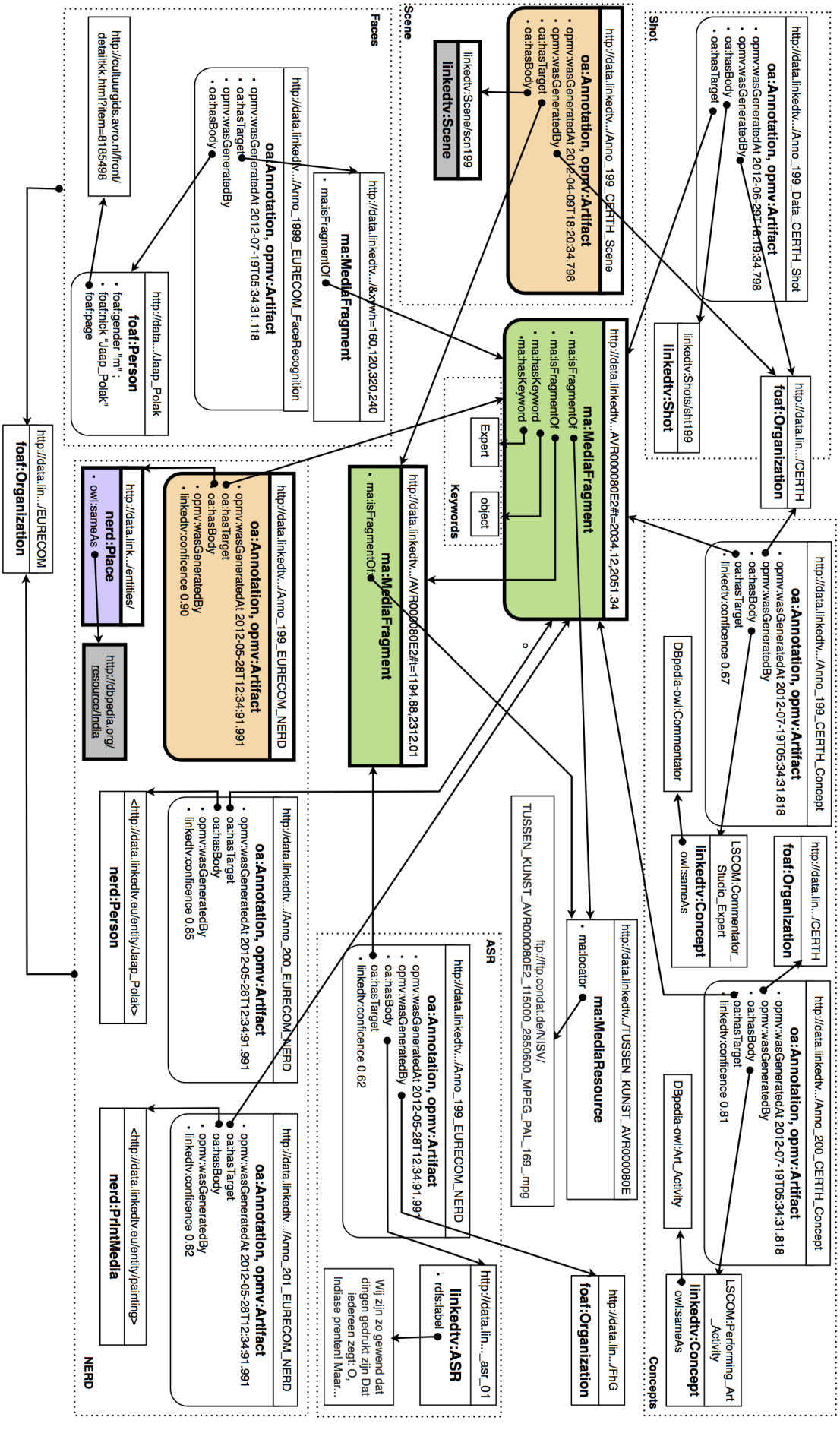
```
PREFIX nerd: <http://nerd.eurecom.fr/ontology>
PREFIX linkedtv: <http://data.linkedtv.eu/ontology/>
PREFIX oa: <http://www.w3.org/ns/openannotation/core/>
PREFIX ma: <http://www.w3.org/ns/ma-ont/>
SELECT ?place
WHERE {
  ?place a nerd:Place.
  ?annotation oa:hasBody ?place.
  ?annotation oa:hasTarget ?mediafragment.
  ?mediafragment a ma:MediaFragment.
  ?mediafragment ma:isFragmentOf ?mediafragmentscene.
  ?annotation2 oa:hasTarget ?mediafragmentscene.
  ?annotation2 oa:hasBody ?scene.
  ?scene a linkedtv:Scene.
}
GROUP BY ?place
HAVING (COUNT(DISTINCT(?scene))> 3)
```

6.12.3 Results

Table 22: Results obtained after the execution

place
http://data.linkedtv.eu/entity/YI89GFAZ (*India*)

6.12.4 Involved classes in the LinkedTV datamodel


Shot
Concepts
Scene
Faces
Keywords
ASR
NERD
http://data.linkedtv.../Anno_199_Data_CERTH_Shot
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-06-28T14:19:34.798
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
http://data.lin.../CERTH
foaf:Organization
linkedtv:Shots/sht199
linkedtv:Shot
http://data.linkedtv.../Anno_199_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.67
LSCOM:Commentator_Studio_Expert
linkedtv:Concept
owl:sameAs
DBpedia-owl:Commentator
http://data.linkedtv.../Anno_199_CERTH_Scene
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-04-09T18:20:34.798
• opmv:wasGeneratedBy
• oa:hasTarget
• oa:hasBody
linkedtv:Scene/scn199
linkedtv:Scene
http://data.linkedtv.../AVR000080E2#t=2034.12,2051.34
• ma:isFragmentOf
• ma:isFragmentOf
• ma:hasKeyword
• ma:hasKeyword
Expert
object
http://data.linkedtv.../AVR000080E2#t=1194.88,2312.01
ma:MediaFragment
• ma:isFragmentOf
http://data.linkedtv.../TUSSEN_KUNST_AVR000080E
ma:MediaResource
• ma:locator
ftp://ftp.condat.de/NISV/
TUSSEN_KUNST_AVR000080E2_115000_2850600_MPEG_PAL_169_.mpg
http://data.linkedtv.../Anno_200_CERTH_Concept
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.818
• opmv:wasGeneratedBy
• oa:hasBody
• oa:hasTarget
• linkedtv:confidence 0.81
LSCOM:Performing_Art_Activity
linkedtv:Concept
owl:sameAs
DBpedia-owl:Art_Activity
http://data.linkedtv.../Anno_1999_EURECOM_FaceRecognition
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-07-19T05:34:31.118
• opmv:wasGeneratedBy
• oa:hasBody
http://data.linkedtv.../&xywh=160,120,320,240
ma:MediaFragment
• ma:isFragmentOf
http://data.../Jaap_Polak
foaf:Person
• foaf:gender "m" ;
• foaf:nick "Jaap_Polak"
foaf:page
http://cultuurgids.avro.nl/front/detailkk.html?item=8185498
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90
http://data.link.../entities/
nerd:Place
• owl:sameAs
http://dbpedia.org/resource/India
http://data.lin.../EURECOM
foaf:Organization
http://data.linkedtv.../Anno_200_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.85
<http://data.linkedtv.eu/entity/Jaap_Polak>
nerd:Person
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
http://data.lin.../FhG
foaf:Organization
http://data.linkedtv.../Anno_201_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
<http://data.linkedtv.eu/entity/painting>
nerd:PrintMedia
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.62
http://data.lin.../asr_01
linkedtv:ASR
• rdfs:label
Wij zijn zo gewend dat dingen gedrukt zijn Dat iedereen zegt: O, Indiase prenten! Maar...
http://data.linkedtv.../Anno_199_EURECOM_NERD
oa:Annotation, opmv:Artifact
• opmv:wasGeneratedAt 2012-05-28T12:34:91.991
• oa:hasTarget
• oa:hasBody
• opmv:wasGeneratedBy
• linkedtv:conficence 0.90

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