Enhancing and Re-Purposing TV Content for Trans-Vector Engagement

Deliverable 4.1 (M12)

Trans-Vector Platform, Technology Roadmap and Initial Prototype

Version 1.0

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Statement of Originality

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Executive Summary

The ReTV project has deployed an initial version of the Trans-Vector Platform (TVP) at the end of its first year. The TVP will help broadcasters and other digital content owners to decide when in what form and on what platforms to deliver their content in order to achieve the maximum reach and engagement with their audience.

The target architecture for the fully functional TVP is described in detail in this deliverable. Based on this target architecture and the scope of the initial deployment, we develop a roadmap for the development of each of the components that make up the TVP, their alignment and integration into an overall "trans-vector publishing" workflow, and their configuration into several scenarios that will demonstrate the added value of the TVP, with the target architecture as the final outcome.

The resulting roadmap is aligned with the deliverables and milestones of the Description of Work of the ReTV project. As such, it will support the technical project management in ensuring that TVP development proceeds according to plan, staying in the scope of the final target architecture and delivering on time.

1 INTRODUCTION

In the ReTV project, we will build a Trans-Vector Platform (TVP), which will be a system of modular components that can be used together in different configurations by digital content stakeholders to recommend and repurpose their media semi-automatically and distribute it optimally across multiple publication vectors.

In this deliverable, we present the technology roadmap of the TVP, which will bring us from the prototype already deployed at the end of the first year of the project to the fully functional TVP at project end (at M36, in 24 months from now).

The TVP encompasses everything that ReTV builds, set up as a system of independent distributed modules that communicate with each other through APIs. Each of the two use cases and four scenarios is contained within the TVP. See D5.1 and D6.1 for detailed descriptions of both the use cases and the scenarios. Not all of them communicate with the same modules, but the vast majority of modules is used by all of the four scenarios. The TVP consists of three types of components:

1. Individual Web services (in ReTV, delivered by WPs 1-3) which could also operate standalone via REST APIs. Those components provide data management (collection, annotation), predict usage patterns (based on events, Web and social media metrics, TV audience figures) and analyse and repurpose digital media for recommendation and (re)publication across vectors.

2. Components for the integration of individual services into a workflow and a data mapping between the data generated by consumed by distinct components (in ReTV, delivered by WP4). Different integration choices define the configuration of multiple components into a TVP instance.

3. Various TVP instances for supporting different use cases in trans-vector publication, including their own scenario-specific user interfaces on top of TVP components, in order to provide access to TVP data and services to both professional users on the media stakeholder side as well as content consumers on the public side (in ReTV, WPs 5 and 6 define, design and evaluate a set of scenarios for the TVP to support).

The remainder of this document goes through each of these components and describes the goal of its implementation, the version currently deployed and the roadmap going forward from the current deployment to the technical goal. This process is guided by the definition of the TVP target architecture and its comparison to the first TVP deployment at the end of the first year of ReTV. We refer to *Appendix A: Simplified Architecture* and *Appendix B: Detailed Architecture* for orientation. The simplified architecture omits certain data flows in favour of higher readability. We end this deliverable with a conclusion and an outlook for the future technical development work of ReTV.

2 Content Aggregation and Alignment (WP1)

2.1 Target Architecture

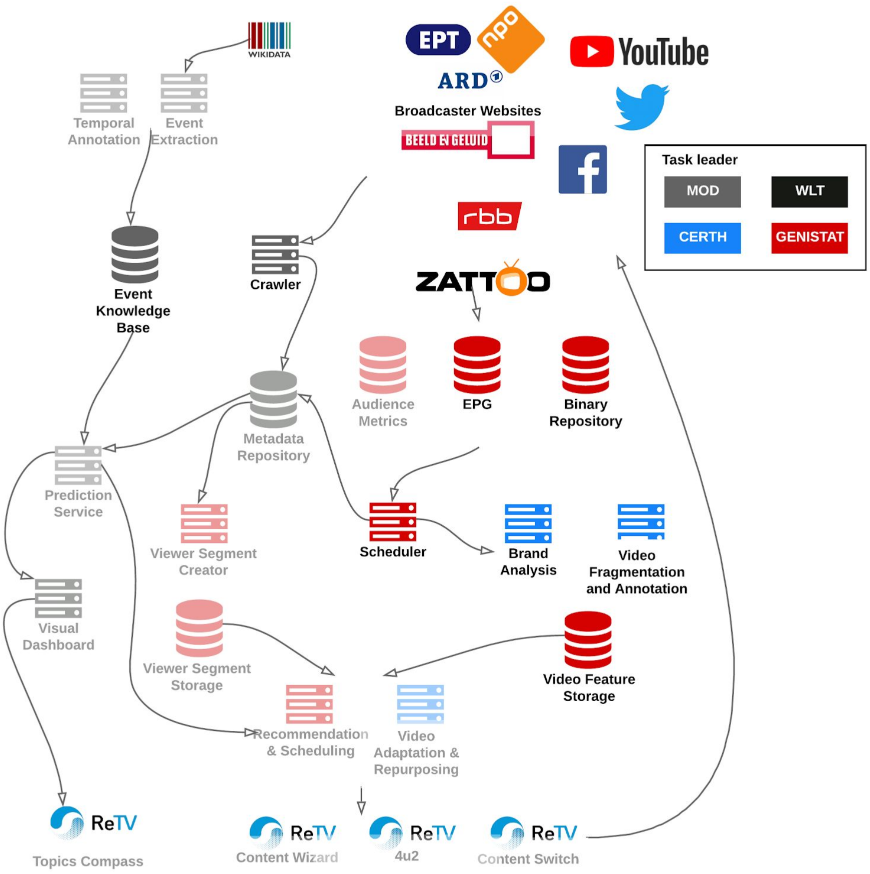


Figure 1: Target architecture with components from WP1 highlighted

The content aggregation can be split into four different areas:

1. Text content on tv shows: This includes descriptions and reactions online, as well as the broadcaster schedule.
2. Event data on tv shows: Information on what event a tv show belongs to. Examples of events are the FIFA World Cup or a terrorist attack.
3. Video content: The actual video content that was broadcasted and metadata information extracted from it.
4. Feature extraction on video content: By analysing the video content we can extract features like brands and celebrities.

The *Crawler* scrapes different data sources for information relevant to ReTV. Its targets are social media, websites and archives and it can be configured to listen for certain keywords. It can, for example, listen to keywords or hashtags like #Tatort, which usually accompany posts on the famous German crime show. It writes all of this information into the *Metadata Repository*.

Another source of text content is the Electronic Program Guide (EPG) data that Genistat receives from Zattoo. It is stored in the *EPG* database. It is enriched and the start and end times are sharpened before the *Scheduler* pushes it into the *Metadata Repository* at regular intervals.

The *Event Knowledge Base* stores all the information on relevant events. This includes what they are called when they occur and if they repeat or not. It is fed by the metadata enrichment of WP2 and is used by the *Prediction Service*.

The source for the raw video material is Zattoo. It is stored in the *Binary Repository.* In compliance with copyright laws, this video data is treated as a private recording and is therefore not redistributed without the explicit approval of the copyright holder. The *Video and Fragmentation and Annotation* Module and the *Brand Analysis* split the videos into scenes and extract information on objects and brands detected in the video. This metadata is stored in the *Feature Storage* and the *Metadata Repository.*

2.2 Initial Prototype And Roadmap

Work Package 1 has delivered the first version of *Data Ingestion, Analysis and Annotation* components with *D1.1*. Version 2 (*D1.2*) will follow in month 20 and the third and final version (*D1.3)* in month 30.

Component	**Current version**	**Future versions**
EPG	The current version loads EPG data from Zattoo and stores it in an internal database of Genistat. The top 10 TV channels in Germany and Switzerland are currently loaded. Those are ARD, ZDF, Prosieben, RTL 2, Sat 1, SRF 1, SRF zwei, VOX, ZDF. Additionally, we also push the EPG data of consortium partner RBB. We decided to focus on those channels, as their popularity means that there will be a significant amount of Zattoo audience data to match to the content.	Operational. Will be extended as needed.
Binary repository	The binary repository is currently being fed with the the video data from ARD, ZDF, RBB, Prosieben, SRF 1 and SRF zwei. At the time of writing, it contains more than 90 TB of video content. The video segments are stored in chunks of 15 minutes. GENISTAT provides an API that can be used to find the desired video chunk for a specific time and channel.	*D1.2* Currently, the video chunks cannot be loaded over HTTP, but require the use of the S3 protocol. To make the loading of those chunks simpler, we will provide a service that makes them accessible over HTTP.

Scheduler	The current version is pushing audience data from *Audience Metrics* to *Audience Metrics* and from *EPG* to the *Metadata Repository.*	*D1.2* Push video data to *Brand Analysis* and *Video Annotation and Fragmentation* at regular intervals.
Brand Analysis	Collected a list of relevant brands and deployed the first version of brand detection.	*D1.2* Extend the brand detection algorithms with an inductive transfer in our Convolutional Neural Network architectures, more brand labels and advanced fusion methods for the final video-level brand detection. *D1.3* Updates to support the final model and vocabulary aligned to work package 2 and 3. Support all media vectors, and Knowledge Graph optimizations needed by modelling and analytics processes in work package 3. Store the extracted features in the *Video Feature Storage.*
Video Annotation and Fragmentation	The first version deployed. This version includes a) segmenting the video to scenes, shots and subshots, b) selection of keyframes for each segment, and c) concept annotation of all selected keyframes. The concept annotation currently uses the “places365”[1] and the “trecvid SIN task”[2] concept pools. Results for general terms are good. For productive use by content partners like RBB, the concepts need to be more fine-grained and specific. This will be addressed in *D1.2.*	*D1.2* The updated and extended versions of concept-based video abstractions. Specifically, Multi-Task Learning and structured outputs will be introduced in our deep learning architectures targeting more accurate concept detection, improved fine-tuning algorithms will be developed that consider the commonalities between the source and target domain, the developed algorithms will be scaled to a bigger pool of target concepts. *D1.3* Updates to support the final model and vocabulary aligned to work package 2 and 3. Support all media vectors, and Knowledge Graph optimizations needed by modelling and analytics processes in work package 3. Store the extracted features in the *Video Feature Storage.*

[1] http://places2.csail.mit.edu/index.html
[2] https://www-nlpir.nist.gov/projects/tv2015/tv2015.html#sin

Crawler	An initial list of content sources is being crawled. Sources are semantically annotated according to available metadata.	*D1.2* Extend the list of sources to be crawled based on the extended list of content sources we have prepared. The annotation pipeline is extended to support annotations of Events and Works (such as TV programmes). *D1.2, 3* Iterative extensions of the entity coverage of a Semantic Knowledge Base which is used in the semantic annotation. Iterative training and improvements in annotation accuracy.
Event Knowledge Base	The knowledge base can store events that are written by *Temporal Annotation* and *Event Extraction.*	*D1.2* Extending the type and range of events collected.
Video Feature Storage	No first version deployed yet. This is not critical at this point in time, as the component is only needed to speed up the creation of the summaries by storing precomputed results.	*D1.2* Store features extracted from *Brand Analysis* *Video Annotation and Fragmentation* as binary files to speed up the creation of video summaries.

3 Content Enhancement and Predictive Analytics (WP2)

The goal of this work package is to enrich the data gathered in work package 1 and to gather audience data and predict audience behaviour.

3.1 Target Architecture

Aggregated audience data is provided by Zattoo and stored in the *Audience Metrics* database. It is pushed into the *Metadata Repository* database at regular intervals.

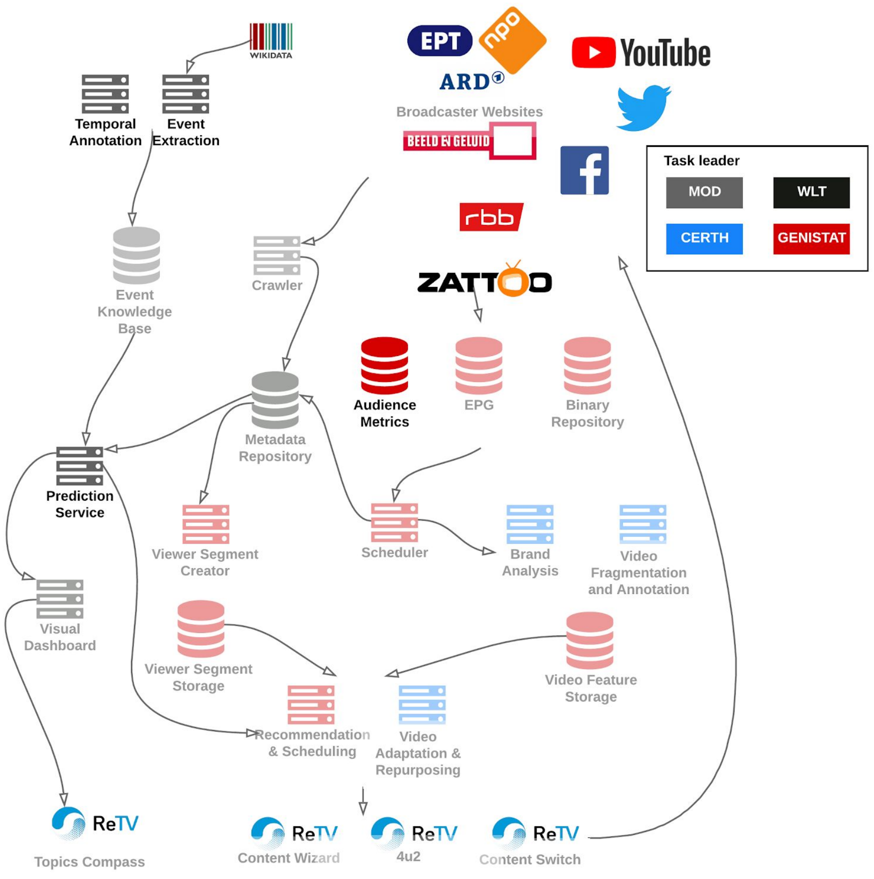


Figure 2: Target architecture with components from WP2 highlighted

Customized to a media organization's evolving dissemination and positioning goals, the content-based success metrics will be adaptive and regularly refined. They will help choose the best re-use and re-purposing strategy in WP3 and are the result of knowledge extraction services applied to the various secondary content channels (news Websites and social media vectors) and stored in the *ReTV Metadata Repository* hosted by WLT.

The *Temporal Annotation* and *Event Extraction* update the *Event Knowledge Base* at regular intervals. They take their information from WikiData[3] and other sources such as news articles or public calendars.

[3] www.wikidata.org

The *Event Knowledge Base* is used by the *Prediction Service*. This service additionally takes into account viewer segments and metadata on the content and the audience reaction. Based on those pieces of information it predicts the success of content for a particular audience on a particular vector.

3.2 Initial Prototype And Roadmap

Work package 2 has delivered *D2.1 Temporal Annotation and Metrics Extraction* in Month 10. In month 20 and 30 we will deliver *D2.2* and *D2.3* the first and second version of *Metrics-based Success Factors and Predictive Analytics*.

Component	Current version	Future versions
Event Extraction	Events from WikiData are extracted and stored in the *Event Knowledge Base*.	*D2.2* Extend the number of sources that events are being scraped from.
Temporal Annotation	Presented the plans for implementing the event extraction capabilities on top of MOD's entity extraction tool Recognize for the temporal annotation of content items.	*D2.2* As part of event extraction from unstructured data, perform temporal annotation for both relative and absolute time references.
Content-based Success Metrics	Identified the metrics to be measured and outlined the intended approach to achieve the metric extraction across published vectors. Initial evaluations of the existing sentiment analysis module provided insights into how to best increase precision and recall. In addition to identifying and updating specific entries in the sentiment lexicon, we have enabled bigram processing for the negation module - this helps to avoid that such as "not only" trigger a negation (up until now, n-grams were only considered for the sentiment lexicons, but not for negation triggers and similar modifiers).	*D2.2* Trend detection for the success metrics based on historical audience and viewer data. Improved keyword extraction with a special focus on compound nouns and part-of-speech validity checks. Daily intervals replaced by a shorter timespan granular enough to track the impact of short-term interventions, e.g. changes in advertising strategies. *D2.3* Success factors calculated based on multiple emotional categories (in addition to bipolar sentiment annotations) and measures of disagreement calculated for arbitrary time intervals and with an on-the-fly reconfiguration of weights.
Genistat Audience Metrics	The Zattoo audience data for Switzerland and Germany is being aggregated into 5-minute slices and then pushed to the *Metadata Repository*	Completed.
Prediction Service	A first concept has been developed in how the event-based approach from	*D2.2* Generic prediction model independent

	MOD, the content-based success metrics from WLT and the time-series-based approach from GENISTAT can be combined.	of the publication vector. Prediction of future audience figures due to past trends and external events. *D2.3* A hybrid prediction model based on the most accurately evaluated analytics for each combination of vector and metric. This combined model is retrained dynamically depending on the amount of new data.

4 Content Adaptation, Re-Purposing and Scheduling (WP3)

This work package uses the services from WP1 and WP2 to re-purpose content and then recommend and schedule it for optimal publication across vectors.

4.1 Target Architecture

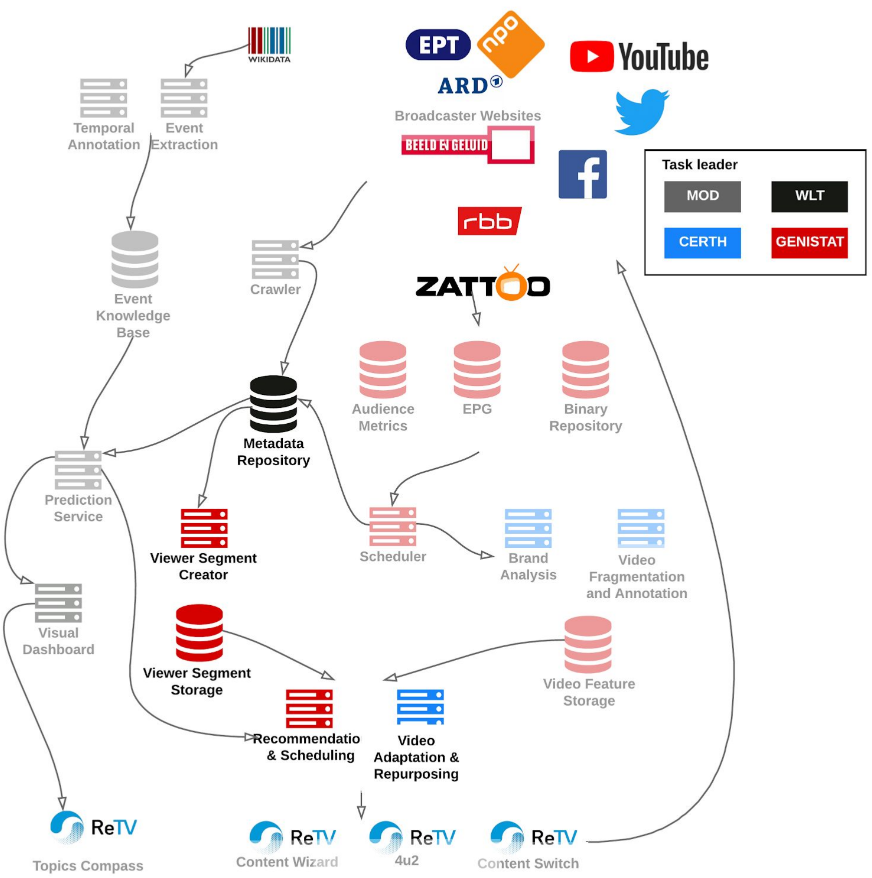


Figure 3: Target architecture with components from WP3 highlighted

The *Metadata Model* is the conceptual backbone of the TVP data storage. It structures and aligns the relevant metadata in a flexible manner so that the different types of data can be combined and stored in the *Metadata Repository* (hosted and evolved in WP4).

The *Viewer Segment Creator* uses the metadata on the content and the audience metrics from the *Metadata Repository* to create privacy-safe viewer segments (created by aggregating groups of users in a manner that does not allow to identify individuals). Those segments are stored in the *Viewer Segment Storage.*

The viewer segments, as well as the combined metadata, are used by *Recommendation & Scheduling.* This service needs to decide on the content that should be recommended to viewers and how it should be scheduled. To predict the future success of a piece of content, it also uses the *Prediction Service.* When the *Recommendation & Scheduling* service has found a suitable combination of raw content and publication schedule it calls *Video Adaptation and Repurposing*.

Video Adaptation and Repurposing receives a list of raw videos that should be repurposed into a piece of content that is relevant to the target audience.

4.2 Initial Prototype And Roadmap

Work package 3 has delivered *D3.1 Metadata and Viewer Profiling.* In *D3.2* and *D3.3* it will deliver the first and second versions of *Content Adaptation, Re-Purposing and Scheduling.*

Component	**Current version**	**Future versions**
Metadata Model	The metadata model is described in *D3.1,* encompassing datasets collected and extracted in WP1 and WP2. The Elasticsearch cluster of WP4 is used to store the data.	*D3.2* Final version of the shared metadata model, based on the aggregation of required properties and value spaces across all data produced in ReTV.
Recommendation & Scheduling	A first prototype of how content can be adapted based on viewer segments developed. Deployed in a prototype of the Content Switch use case: Given an ad-break of dynamic length, a set of candidate ads and a viewer segment we choose the best ad and shorten it to fit precisely.	*D3.2* First deployment and evaluation of repurposing and scheduling on a best effort basis using the *D2.2* version of the *Prediction Service.* *D3.3* The final version of repurposing and scheduling, using the latest version of the *Prediction Service* deployed for *D2.3.*
Video Adaptation and Repurposing	The first version of static video summarisation API deployed and tested. A first concept of benchmarking has been developed.	*D3.2* First deployment and evaluation of repurposing on a best effort basis. *D3.3* More accurate video skimming by using high-light detection in combination with the visual concept detection results and more discriminative text-to-vector representations that will be combined with improved CNN architectures for hot-spot detection.
Viewer Segment Creator	Metadata model for viewer segments described in *D3.1.*	*D3.2* The final version of viewer segments.
Viewer Segment Storage	Not implemented yet.	*D3.2* Storage deployed.

5 Trans-Vector Platform Integration and Dashboard (WP4)

ReTV provides a number of individual components for content aggregation, alignment and enhancement (WP1+2), predictive services (WP2) as well as content adaptation and re-purposing, including scheduling (WP3). WP4 will develop the infrastructure to host a central data repository that will contain the ingested content as well as the extracted metadata.

Most of these services operate on volatile content streams, will be provided by different partners and subsequently applied to multiple use cases. The success of the ReTV project, therefore, depends on how well the developed components can be integrated into a consistent framework.

5.1 Target Architecture

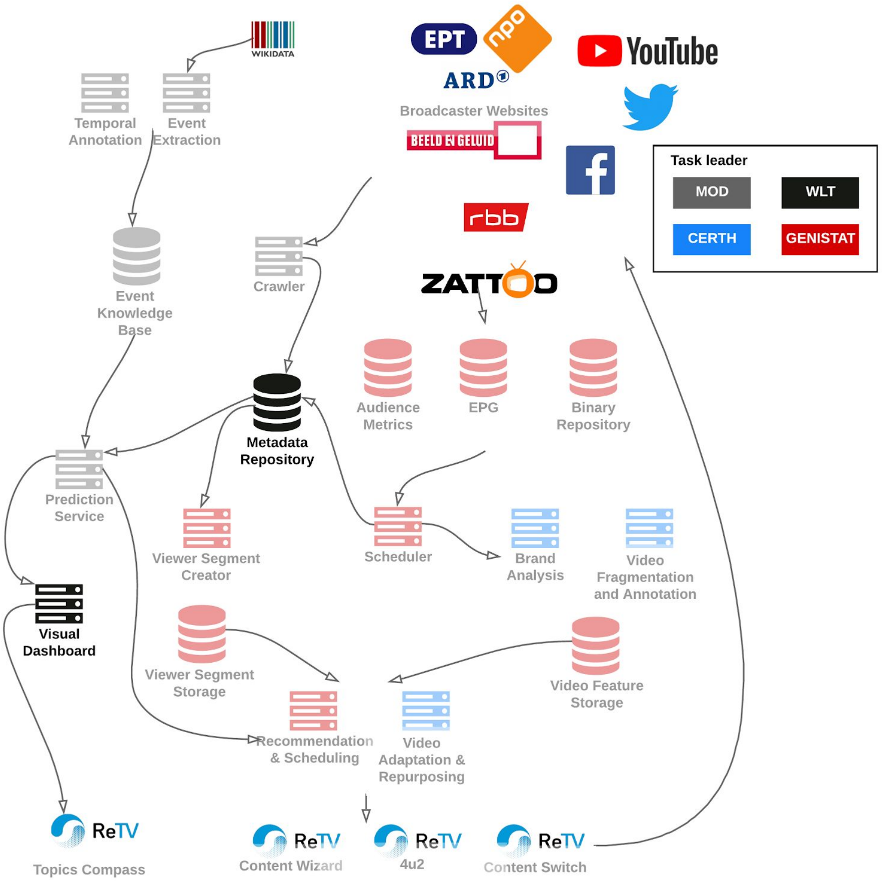


Figure 4: Target architecture with components from WP4 highlighted

The overall integration strategy for ReTV is to design all components in a modular, flexible manner, and provide their output via scalable REST APIs to be accessed by the use case applications. This system of components, which we refer to as the TVP, can be configured in various ways to work together and enable different scenarios. This reduces the dependency on a single point of failure, without compromising the seamless integration of all components into a consistent architecture.

For this purpose, vector-specific metadata needs to be collected, aligned, normalized and stored in a *Metadata Repository* (the underlying metadata model is specified in WP3, while the hosting and continuous updates of the metadata repository are part of WP4). Granular data structures will help to manage this metadata together with the collected content. The data structures include unstructured data (news articles, social media postings), semi-structured data (calendar entries, event databases) and structured data (knowledge graph).

The *TVP Visual Dashboard*, developed in WP4 as well, will provide access to the processed content streams from the Web sites and social media vectors of media organizations, enabling interactive exploration along various semantic dimensions - using multiple coordinated view technology for the desktop version and a cross-platform HTML5 application to access analytic function through smart-phones and other mobile devices (while less powerful in its analytic capabilities, the WP5 survey revealed that many professional users need ways to access the system via their smartphone as well). The dashboard will integrate advanced search operators with the ability to explore content and audience metrics in visual form. Users will be able to customise the representation according to their specific requirements, selecting the most relevant indicators and time intervals. Particular emphasis will be placed on the rendering of predicted values based on extracted future events, and on analytics services that operate on these predicted values.

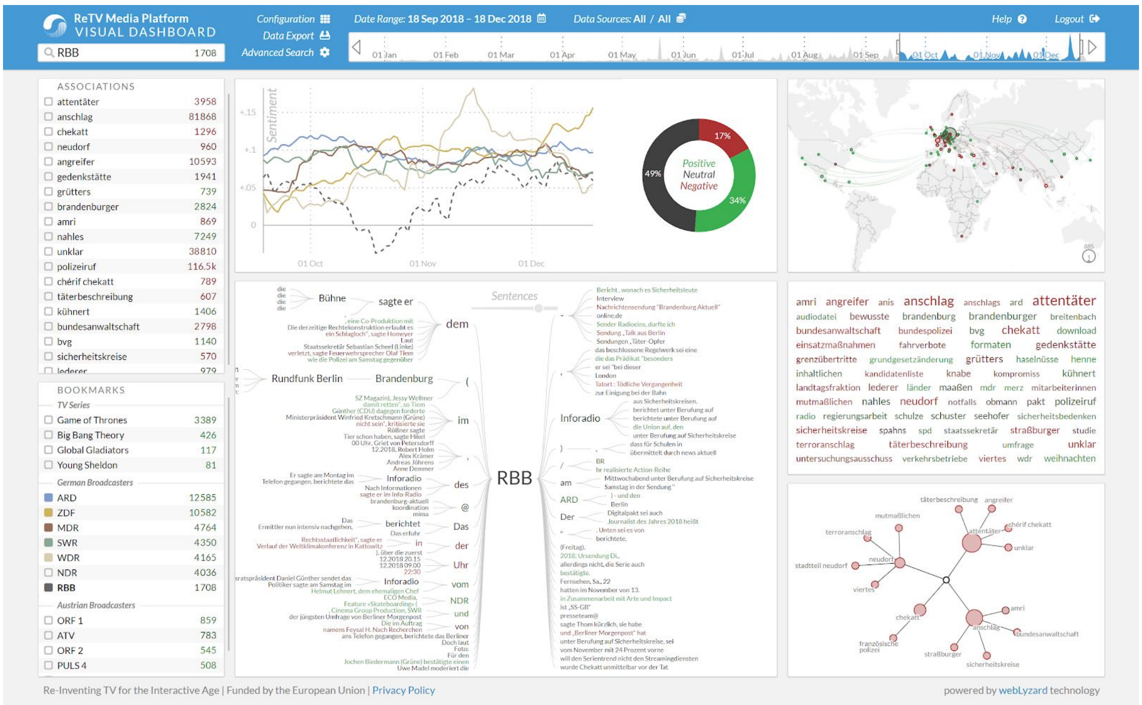


Figure 5: Screenshot of the ReTV Dashboard, showing the results for a query for “RBB” across Austrian, German, Swiss and Anglo-American media sources (Sep - Dec 2018)

5.2 Initial Prototype And Roadmap

This deliverable is the first one for work package 4. In *D4.2* we will deliver *Trans-Vector Platform, TVP Dashboard and Revised Prototype* and in *D4.3* we will deliver *Trans-Vector Platform, TVP Dashboard and Revised Prototype.*

Component	**Current version**	**Future versions**
REST API Framework	Initial deployment of the REST API framework to manage content assets and extracted metadata. The REST API Framework covers both data ingestion (a first live connection between the data services of Genistat and webLyzard was established in Q4-2018) and well as information retrieval operations to query for documents, stories, events and metrics (content, audience). For these queries, we observed significant performance increase thanks to the new WLT server cluster and a migration from Elasticsearch 1.7 to 6.x. Single request performance improved by almost 50%. For 100 concurrent users, the media response time improvement turned out to be even more significant (85%).	*D4.2* An updated version of the REST API framework, compatible with changes and new developments of the technical work packages 1-3 and supporting predictive analytics. *D4.3* Optimized system architecture in terms of throughput and response time, tested in concrete use case scenarios. Final API specification.
Visualization Components	One of the first tasks completed was a complete rewrite of the WYSDOM chart component to eliminate third-party dependencies - consolidating the code base, increasing scalability and minimizing the initial load time (which is especially important when embedding visualization components into third-party applications). Building on the consolidated code base, the data model extension and the required user interface elements were completed in December 2018.	Working towards the goal of providing an integrated visualization for content and audience metrics, and considering the requirements of the use cases and scenarios discussed within the consortium, we will extend the underlying data model to not only provide a global default setting for the configuration of the WYSDOM chart in terms of desired and undesired associations, but also allow users to store these settings together with each topic definition.
TVP Visual Dashboard	After configuration and activation, the initial version of the TVP Visual Dashboard has been made available to all project partners in M12 of the project, including a collection of predefined topics adapted to the use cases. The goal of providing a unified	*D4.2* Support of predictive analytics by offering two additional modes to select whether to use *published dates* or *referenced dates* to anchor the documents contained in the search results along the temporal axis. The

	interface for both historic and future data, in order to show the results of ReTV's predictive services, required important structural changes that were the focus of the development work in Y1 (initially in T4.2 to extend the various individual components - trend chart, left sidebar, and the visualizations on the right - and then in T4.3 to implement the required user interface controls to switch between the different "modes". The new structure allows users to determine whether the total number of references or just co-occurrences with the current search term are used for presenting results.	referenced dates will enable the display of predicted topics, as they can point to both past and future events. D4.2 will also include the T4.2 chart and optimize the user interaction design based on feedback from the use cases. *D4.3* Revised versions of all the embedded visual tools. The dashboard will support cross-lingual exploration and visualization of content streams across *vectors*, *languages* (English, Dutch, German), and other *context dimensions*. Advanced interactive controls will support drill down operations and on-the-fly query refinements.

6 Engagement Monitoring for Content Owners (WP5)

The ReTV scenarios service both the media professionals working for content owners and the end users that consume the content. Since all of the use cases aim to at some point benefit the end user (for the mutual benefit of the content owner) the distinction is not clear-cut. In this section, we focus on the one scenario that does not directly produce content for the end-user and is therefore purely aiming at media professionals. In Section 8 we will look at the scenarios that produced content for the end-users.

The *Topics Compass* is the component that media professionals will use to guide them in their efforts to repurpose and schedule content on multiple vectors. Its goal is to help them in understanding how their content performs and also guide them in the creation of new content.

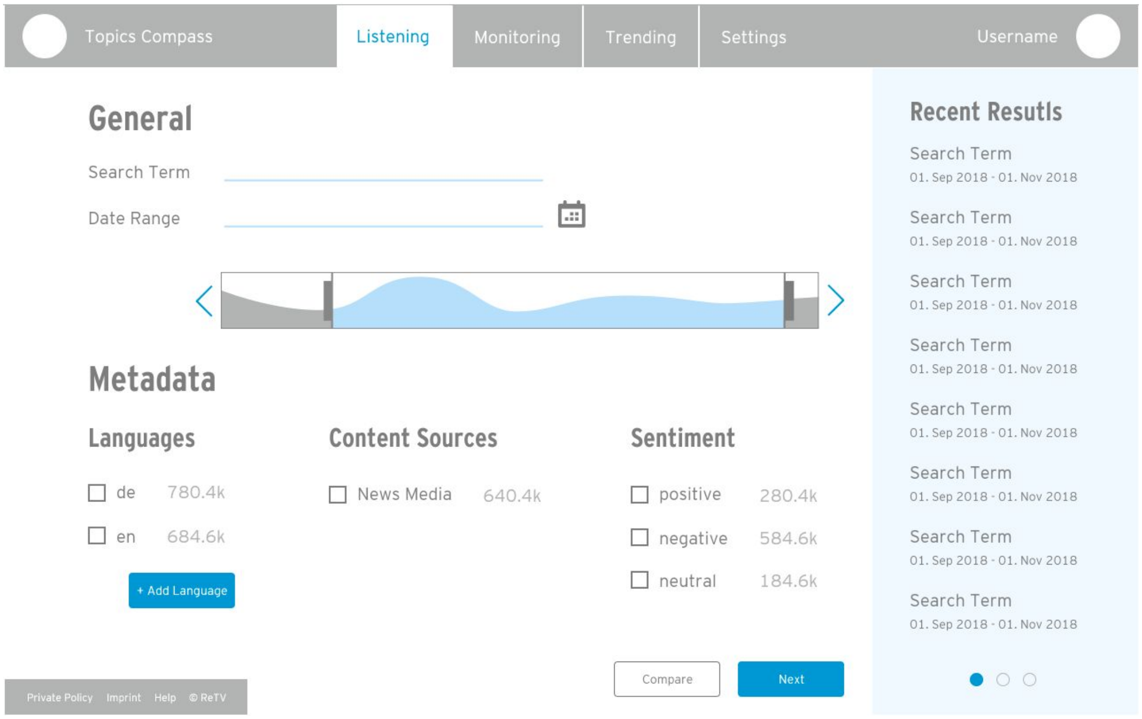


Figure 6: Wireframe of the Topics Compass listening feature

6.1 Target Architecture

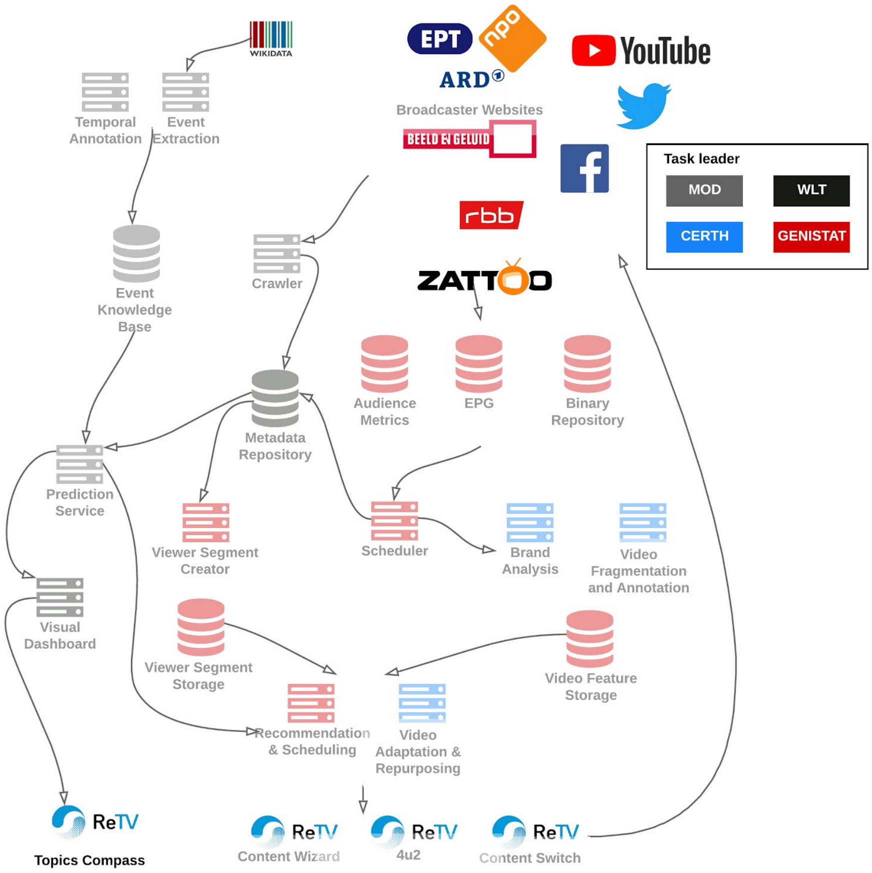


Figure 7: Target architecture with components from WP5 highlighted

The Topics Compass will be a stand-alone web-app that uses the data from the *TVP Visual Dashboard.* We are planning to build it using a modern frontend JavaScript Framework like React. This will allow for fast loading times, responsive user interaction and the possibility to store and manage complex data dependencies.

The visualisations and the data will be loaded from the *TVP Visual Dashboard*, the *Metadata Repository* and the *Prediction Service.*

6.2 Initial Prototype And Roadmap

Work package 5 delivered *D5.1 Requirements for Content Owner Use Case*. The next deliverables will be *D5.2 First validation of Engagement Monitoring Prototype (M20)* and *D5.3 Second Validation of Engagement Monitoring Prototype (M36).*

Component	**Current version**	**Future versions**
Topics Compass	Detailed list of requirements collected. Use case scenarios defined and mocked-up in wireframes. First surveys of professional users.	*D5.2* The first prototype will make use of the functionalities provided by the *D4.2 TVP Visual Dashboard*. Validation results will comprise qualitative and quantitative data and include a comparative analysis of user interfaces and the applicability in daily use by content owners and media professionals (gathered from selected professionals of the project partners). *D5.3* The second version will profit from improved visuals, better predictions and richer data. validation results will comprise qualitative and quantitative data and include a comparative analysis of user interfaces and the applicability in daily use by media professionals (reporting on extended use among a wider audience of professionals, gathering their feedback and suggesting final improvements).

7 Content and Ad Personalization for Consumers (WP6)

7.1 Target Architecture

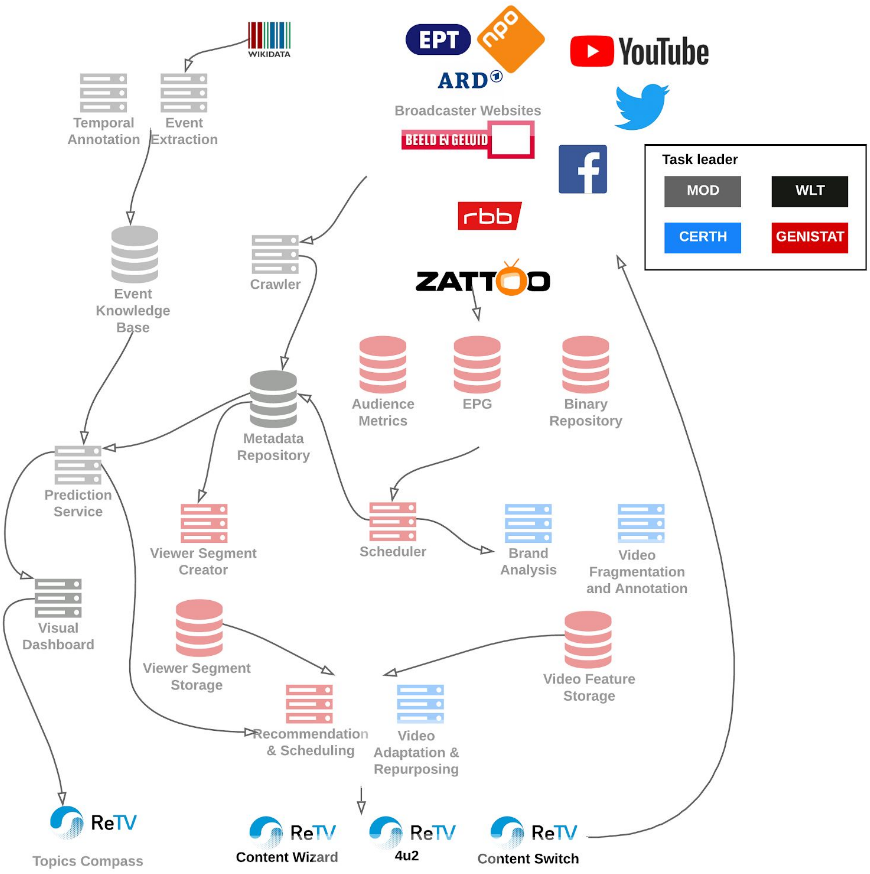


Figure 8: Target architecture with components from WP6 highlighted

Work package 6 has three components. Each corresponds to one of the scenarios that were defined in *D6.1 Requirements for Consumer Use Case.* 4u2 will be a recommendation plugin for Content Management Systems and could be used on the RBB website. *Content sWitch* and *Content Wizard* will be stand-alone web-apps. All three scenarios use APIs of the other components in the TVP to access the required data.

4u2 uses *Recommendation & Scheduling* and *Video Adaptation and Repurposing* to recommend relevant summarised content to end users on RBB and within the NISV archive.

Content Switch uses *Recommendation & Scheduling* and *Video Adaptation and Repurposing* as well. The vector that it publishes to is the Zattoo TV stream.

Content Wizard will allow editors to create summarised content and then have it published optimally across multiple content vectors.

7.2 Initial Prototype And Roadmap

Work package 6 delivered *D6.1 Requirements for Consumer Use Case*. The next deliverables will be *D6.2 First validation of Personalization Prototype* and *D6.3 Second validation of Personalization Prototype.*

Component	Current version	Future versions
Content sWitch	Detailed list of requirements collected. Use case scenarios defined and mocked-up in wireframes. First surveys of end users.	*D6.2* The first prototype will use the D3.2 versions of the *Prediction Service, Recommendation and Scheduling* as well as *Video Adaptation and Repurposing.* We will also report on the results of the first longitudinal user tests which informs WPs 1-3 on required frontend and backend improvements and will deliver updated insights on acceptance, including usability and ethical issues. *D6.3* The updated prototype will use the D3.3 versions of the *Prediction Service, Recommendation and Scheduling* as well as *Video Adaptation and Repurposing.* Richer and more accurate models should translate into improved user satisfaction and engagement. The evaluation report will focus on overall project results with respect to customer acceptance and provide guidance for future application of the TVP.
4u2		
Content Wizard		

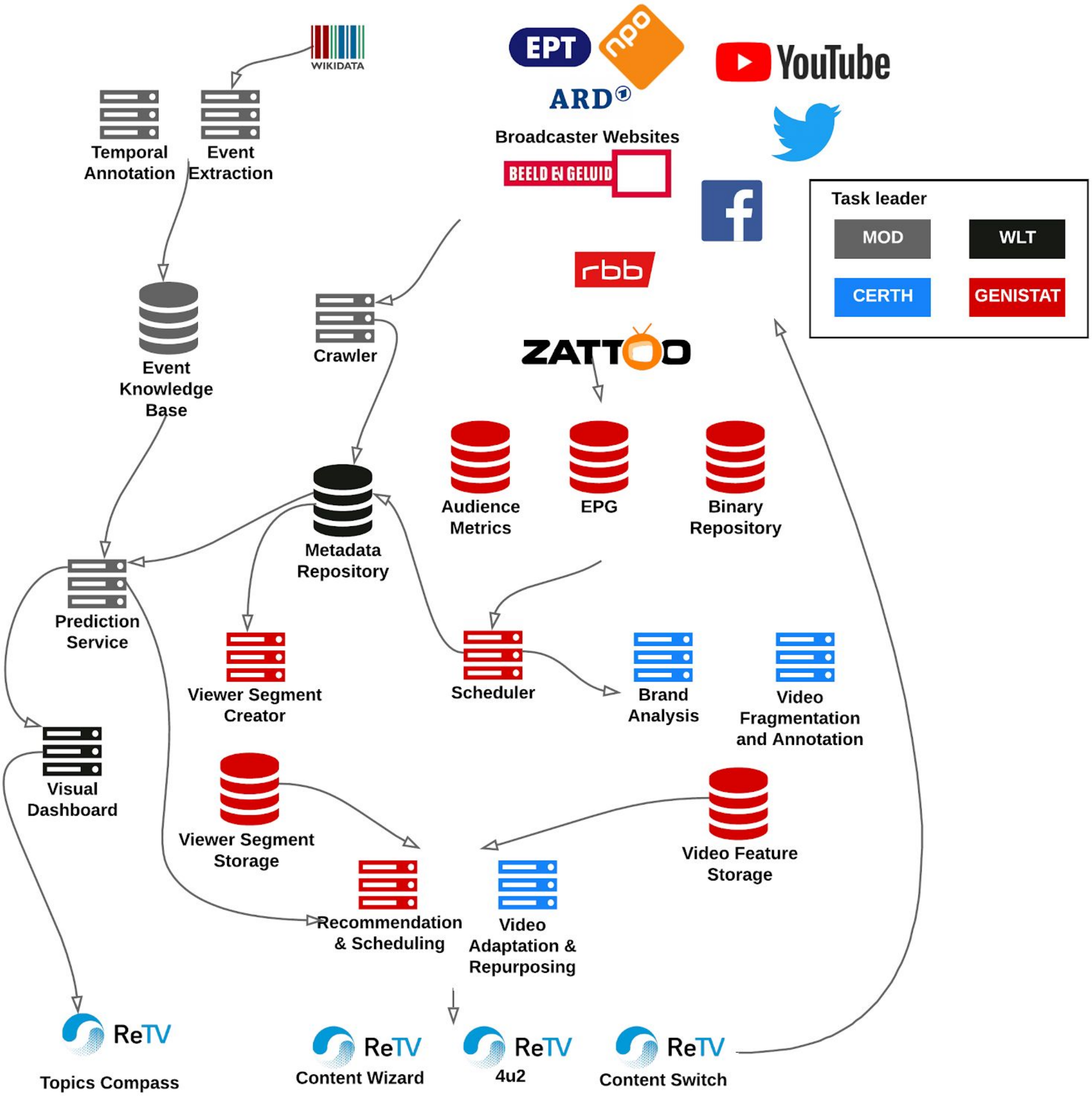
8 Conclusion And Outlook

This deliverable presents a first technically detailed view of the TVP architecture that consists of independent modules that communicate using APIs. First versions of all of the required components have been deployed. The future roadmap is in sync with the next set of deliverables that will be due in month 20. This is also the time point where a revised architecture would be presented, which will combine both technical developments in the component implementations as well as functional requirements identified in the first scenario pilot. This will also be an opportunity to measure progress, adapt the roadmap as necessary and ensure the smooth completion of the TVP Target Architecture by the end of the project.

GLOSSARY

Term	Abbreviation or Description
Trans-Vector Platform	TVP
Electronic Program Guide	EPG
Vector	A place where content can be published. This can be a social media vector like Facebook or Twitter or a more traditional vector like linear TV.

Appendix A: Simplified Architecture



APPENDIX B: DETAILED ARCHITECTURE