Chapter 11
TV-Anytime Cloud Computing Concept in Modern Digital Television

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Abstract. With the increase in the demand for digital television (DTV) in various standards, high quality content (HDTV), mobile TV, video-on-demand services and interactive TV, a new problem of much more complexity in various TV technologies appeared that makes cross platform solutions very difficult to achieve. One of the main factors increasing complexity is wide use of the Internet for delivering such TV services beside the traditional broadcast of TV content. To make the connection of these technologies feasible and in this way to provide the TV users with easy and convenient access to TV content from as many sources as possible some kind of unification and standardization needed to be introduced. This paper provides an overview of global standardization approach, namely the TV-Anytime (TVA) standard [6]. The aim of the TVA standard is to enable a flexible use of TV across a wide range of networks and connected devices. One of the main assumptions of TVA is that user should be fully agnostic of technology and source of the requested content in the same way as in cloud computing domain. We describe the motivation of its use, its principles as well as the base features defined by this standard to satisfy the most recent TV domain trends. We provide also the practical example of the TVA system usage for better understanding the theoretical principles.

11.1 Introduction: Trends for TV-Anytime and TV-Anywhere

Nowadays the television (the commercial as well as non-commercial one) available for regular recipient differs significantly from that existing a decade or two in the past. The change from the analogous television to the digital one enabled a lot of new pos-

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sibilities as better quality or transmitting more channels in the similar infrastructure (e.g. on the same frequency of given satellite transponder). But probably the most important new feature of the innovative digital television is the possibility to transmit the additional data and services together with audio/video content that allows deliver it to the recipient in much more flexible and sophisticated way than in the past [1]. The crucial application of that is delivering so called "non-linear" content to the user.

To explain the difference between linear and non-linear content let us imagine the standard way of watching television. The television broadcaster (the company delivering the content to user) transmits the event of particular channel on the specific transponder on the specific frequency at specific time. At that specific time the user can tune his TV receiver (TV set or set-top-box) to that specific frequency and watch the event. Although the access to the schedule for events is now public and easy (as a basic feature of each modern TV set or set-top-box) the major inconvenience is that user must be in front of his device at that specific transmission time. If this is not possible at that time the user must miss the event and wait till broadcaster will transmit it again. As an opposite, the non-linear content is delivered to the user at the users explicit request at the users best convenient moment. Such way of delivering content to the user is also commonly called video-on-demand (VOD). There are various ways of delivering VOD. One of the options is pushing content to the users receiver by storing it on the internal storage (e.g. HDD) without user awareness. After content is stored on receiver, the user is offered to select content to watch. Such scenario is called push-VOD. Another way is the direct streaming of the content at the users request without storing it on internal storage (in other word the content is being consumed at the moment of the content transmission). The difference between linear content and streaming is that for the latter one the content is dedicated for particular user at the time selected by that user. The "in-between" solution for linear and non-linear content is the Personal Video Recording (PVR) which relies on manual recording of linear content on the internal storage of users receiver exactly at the time while linear content is being transmitted. The operation of recording the content is triggered by user and once completed the recoded content is available locally on receiver so that the user could watch the content at any time he wants. The special version of PVR is its network form which is called Network PVR, recently developed also in cloud model [2, 3]. In this case the user initiates the recording of content as usual PVR but the content is stored on the remote server in the network. At any time the user wants to watch the content, the streaming is initiated and user consumes the content directly from the network. There are many different varieties of VOD and PVR solutions but here there were mentioned only basic ones, just for general feeling of the new way of content delivery and consumption time. The common advantage of all these new ways of non-linear content delivery over linear content is the possibility to pause, rewind and forward the playback of content with different rate (e.g. from x2 to x64 times as normal playback). These actions on playback are commonly called "trick-plays".

Another change introduced by recent digital technology is strong role of the Internet in the content delivery. One or two decades before there were only three basic carriers of transmissions: terrestrial, satellite and cable broadcast . At the end of last

century there was usually only on-way communication broadcast of content from broadcaster to users receiver . More less ten years ago the IP connection started to be commonly available on the set-top-boxes (and not so often on TV sets). Initially this possibility (called "return channel") was only used for simple functions as registering the customers of broadcaster or simple feedback from customers. But during last ten years, the IP connection in digital TV industry became to play the crucial role in content delivery. It is not any more the simple "return channel" of receivers but can completely replace the standard carriers of transmission (beside the terrestrial, satellite or cable broadcast). The transmission of content (or any accompanying data) by IP is called "broadband" to differentiate it from traditional "broadcast". The one strong advantage of broadband (comparing to the broadcast) is that it is bi-directional by default so the TV operator has usually the similar capabilities of transmission of data (or content) to the end user as the user to the opposite direction.

The third change in TV industry is possibility to watch the delivered content on more kinds of devices than before. Nowadays apart from traditional TV sets or set-top-boxes, the content can be handled on PC computers, tablets and even on mobile phones. Additionally the progress in the Internet providing technology allows the content to be easily caught in almost every causal place the user is currently staying. This is strong advantage comparing to the traditional watching the television at home in the past.

Described above those three big changes in television industry enabled the flexible and convenient mean to consume the content but on the other hand they introduced a lot of complexity to the whole TV world. Especially that the current trends in TV industry (driven mostly by users demands) require to consume content anytime and anywhere. These two last concepts (any-time and anywhere) became the official name of technology and means respectively watching content any time the user wants and on any device the user has currently access to (TV set, tablet, mobile or any other device capable of viewing the content).

To make the any-time and anywhere concepts feasible in practice the different technologies need to find the "common language" to communicate about the content in similar way [5, 4]. In other words the common standardization needs to be proposed. In the rest of this article we focus mostly on solutions proposed for anytime concept having in mind that this must be valid also for any device to satisfy the any-where concept.

The main assumption of standardization described in this chapter is that user should be agnostic of the location of the content and the time when that content is available (there can be no even plan in the broadcaster schedule transmission of this content in the future). The user just wants to see the content (by simple and human-readable indication) on the casual device he owns at the moment. Once the system has an access to such content it will offer it to the user for watching. Such approach is similar to the cloud concept in standard computing and data management domains.

The following sections provide the general overview of main concept introduced by TV-Anytime standard. It provides the way of treating content in unified way in

different environments. First of all the basic principles of TV-Anytime standard are described with pointing new functions that standard requires from its implementations to follow the current market needs. Additionally the practical example of TV-Anytime use-case is presented to allow the reader for better understanding how such solution can work in practice.

11.2 Principles of TV-Anytime Standard

In general the TV Anytime standard is set of complementing specifications defining the search, selection, acquisition and consumption of content delivered to the user by broadcast or broadband (online) services. The main purpose of this is to propose the context and architecture that should be implemented by systems that are intended to work properly in TV Anytime environment.

The following sub-sections describe two basic models of TV-Anytime system: the simple broadcast model as well as more complex fully interactive one. Next, the basic TV-Anytime functions such content referencing and metadata are described in details. At the end the general usage template of TV-Anytime system is defined.

11.2.1 Simple Broadcast Model

In the simplest TV-Anytime system offering just the broadcast of content, there can be identified three major elements:

- service provider delivers TV-Anytime service;
- transport provider carries the service
- users equipment stores the content and plays it back for the user;

These major elements must commonly realize the set of functions that can be defined as follows:

- search and navigation;
- location resolution;
- user interaction
- content presentation;
- local storage management;

The simple broadcast model is depicted on the Fig. 11.1. Each component on that diagram represents the particular functions of the TV-Anytime system and can be implemented in different ways in practice. The connections between the components represent the information flows between the functions. This simple broadcast model represents typical PDR receiver - the device (e.g. at users home) for recording and view the content. Such device receives the content in traditional way (by broadcast)

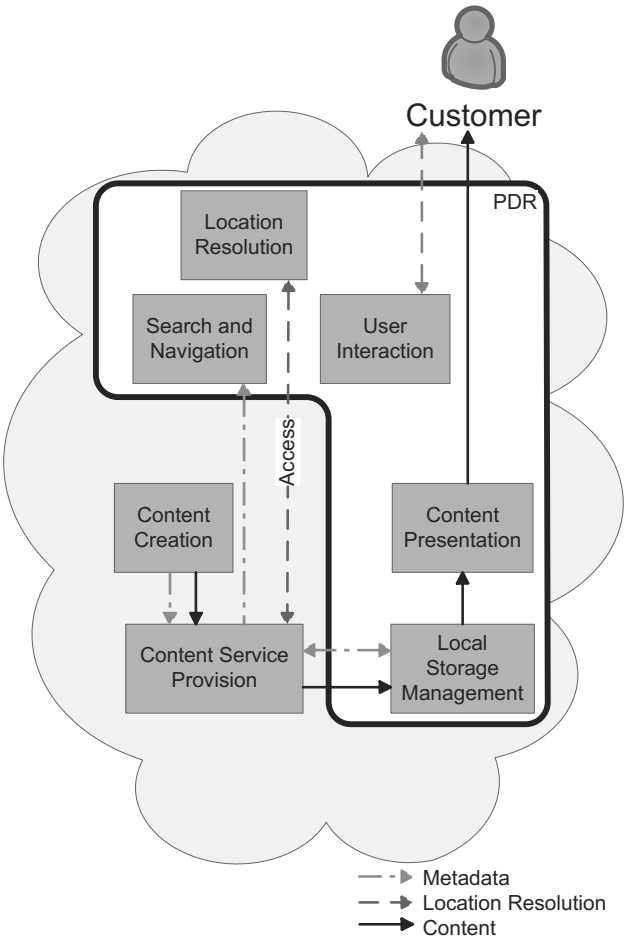

Fig. 11.1 Simple broadcast model of TV-Anytime system

and stores it on the local storage. Stored content can be later played back at the users request.

The only functions realized outside the PDR are: content creation, content service provision and access. The remaining functions are embedded (resident) on the PDR device.

As consequence, with use of above elements of the system and functions they offer, the user is able to perform following actions (before the content will be ready to be viewed):

Search → **Select** → **Locate** → **Acquire** → *content is ready for watching*

Below there is description how TV-Anytime standard propose to realize each of above actions.

- **Search and selection**
  It can be realized by Electronic Program Guide (EPG) embedded on the PDR receiver. For that use the special data (so called metadata) are defined that advertises the available content to the user. Usually the broadcaster or content creator is the one who add these metadata to the broadcast.
- **Locate**
  The location of content can be realized with use of special identifier called Content Reference Identifier (CRID). This CRID can be obtained by previous "Search and selection" action basing on the metadata available in broadcast [11]. The special function of location resolution resident on the PDR results in physical location the content.
- **Acquire**
  Finally, once the physical location of selected content is obtained, the PDR device can tune to the specified frequency at specified time and store the content on internal storage.

  More details on above actions will be described in next sections.

11.2.2 Fully Interactive Model

In fully interactive model only three basic functions are resident on PDR: user interaction, content presentation and local storage management. Remaining function can be remote (external to the PDR) and the PDR receiver has bi-directional connection to these functions. The carrier for the content and additional data transmission can be also the broadband (not only broadcast). The fully interactive broadcast model is depicted on the Fig. 11.2. In this model more actions performed by the user can be realized remotely (outside the PDR device): search and navigation, location resolution, content provision, content creation and access.

In this model the Search and selection can be realized by using the specialized "Web-EPG company" or "TV-portal company". The same parties can be responsible by location resolution. This process can assume the users awareness of remote functionality or can be fully transparent for the user. Such solution can be treated as cloud computing concept adopted onto the digital television domain.

11.2.3 Content Referencing and Location Resolution

The very important capability of TV-Anytime system is that user can select the content regardless of its location or time of availability. Just to illustrate this concept better let us imagine that the user sees some movie advertisement and PDR receiver allows user to record the content for later viewing. At the moment of recoding request the exact time and location of transmission for such movie can be unknown to PDR receiver. Moreover, even a broadcaster may have not it yet in the schedule. Anyway, the TV-Anytime system should ensure that user can request such movie at that time and do not miss it once this content became available on any broadcast channel or even on Internet file server (if PDR offers such feature).

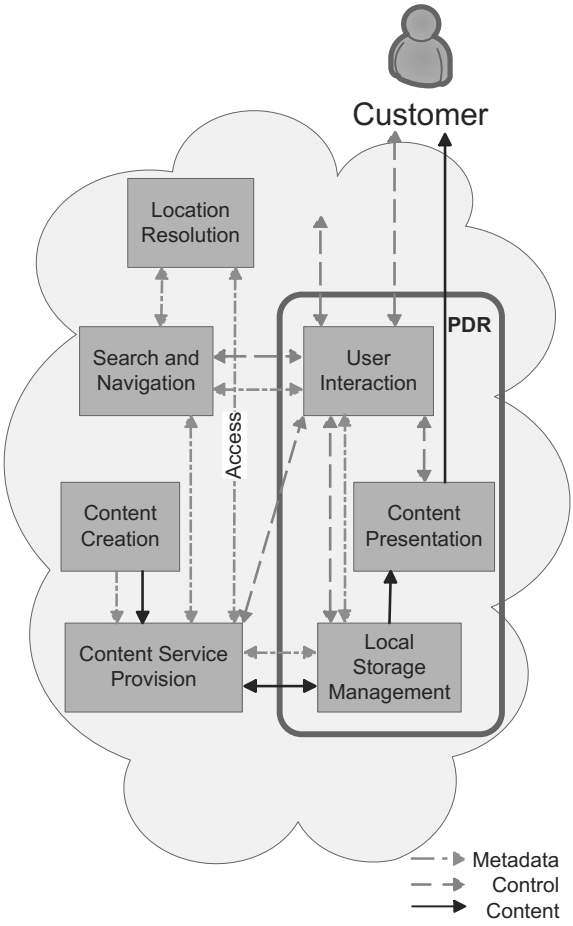

Fig. 11.2 Fully interactive model of TV-Anytime system

The user can request the recording also the whole series of episodes. In this case the PDR should obtain the time and location for each particular episode of the series and acquire them once available. For that reason the content referencing tool must be flexible enough to point single content and collection of contents.

The main concept of content referencing defined by TV-Anytime is the separation of reference to content from specific information which is necessary to physically acquire the content. It allows to indicate content before the final location and time of content transmission is available (as only unique reference to content is necessary at that time). Additionally such approach allows to map the single content reference to many physical locations and improves the efficiency of the system (alternative location can be used for the same content obtained with the same content reference).

To provide the separation of two elements of content referencing mentioned above there were distinguished:

- **CRID** used as reference to the content
  The general syntax of CRID is :
  CRID://<authority>/<data>
  where:
  - <**authority**> is registered Internet domain (e.g. *www.football-authority.net*);
  - <**data**> is unique content identifier in scope of given authority (e.g. */football/match10*).

  The full example for specific football match event can be:
  CRID://www.football-authority.net/football/match10.
- **Locator** defines the physical location of content
  The general syntax of locator is :
  <**transport-mechanism**>:<**specific-data**>
  where:
  - <**transport-mechanism**> is a string of characters unique for transmission mechanism (e.g. transport stream, HTTP, local storage file);
  - <**specific-data**> is unambiguous within the scope of specific transport mechanism.

  The example of locator can be:
  dvb://123.5ac.3be;3e45 20131207T120000Z–PT02H10M
  where the content is identified by *3e45*, transmitted in DVB network (DVB is European standard for digital television transmission) on channel identified by *123.5ac.3be* (network identifier: 123, transport stream identifier: *5ac*, service identifier:*3be*). According to DVB standard the channel is referenced by three parameters: network identifier, service identifier, service identifier. These three parameters are enough to tune PDR receiver to specified channel in DVB network. The planned date of content transmission is 7^{th} of December 2013 at 12:00 am.The duration of content is 2 hours and 10 minutes.

The content identifier CRID is created at the time of content creation and should stay constant and unique for particular content for ever. The location resolution process converts the CRID into the locator or other CRID-s (in case of series) as illustrated on Fig. 11.3.

The CRID itself is not enough for PDR receiver to resolve the location (and find the locator as a result). Therefore additional data must be delivered to the PDR [9, 10]. These data are provided as two well defined XML data structures called "tables" (in digital television the data structures sent together with the content in the same carrier are usually called "tables"):

- **RAR Table** (Resolving Authority Record) It maps the authority that issued the CRID to resolution service provider.
- **Content Referrencing Table** It is the actual resolution table which maps the CRID to final locator or another CRID-s (for series).

The RAR Table contains one or more resolution service providers for each authority that submits CRID. The example of one entry RAR Table is shown on

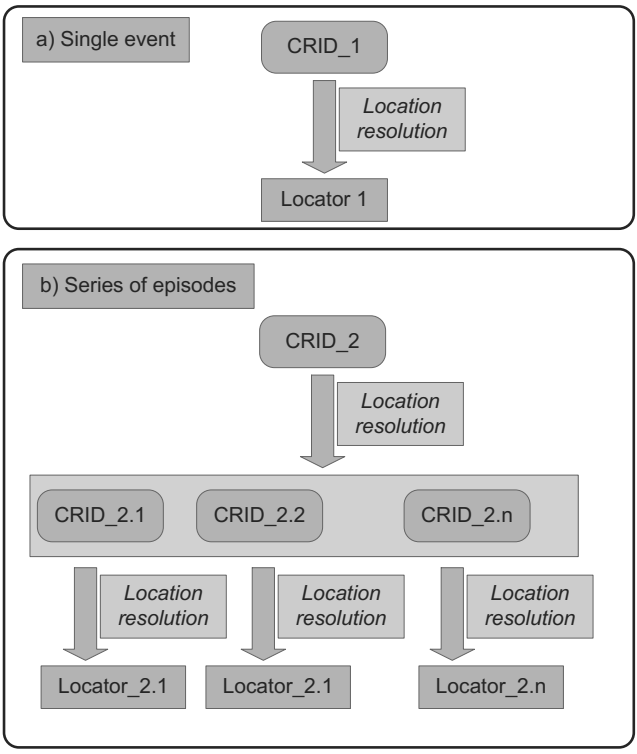

Fig. 11.3 Location resolution process for (a) single event (e.g. one movie) and (b) for series of episode (that can be transmitted at different time and location)

Fig. 11.4. For previously mentioned authority *www.football-authority.net* the resolution service provider is footballresloc.net and the Internet address to that provider can be *http://footballresloc.net/resloc*.

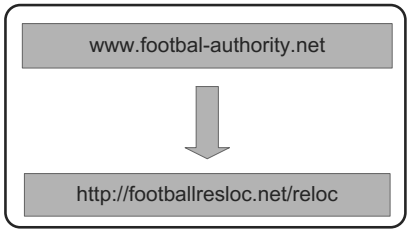

Fig. 11.4 Example of mapping the authority to the resolution service provider in RAR Table

According to this mapping the PDR receiver knows that it can find the resolution information on above address. Using this address the Content Referencing Table can be downloaded to PDR receiver and final locator(-s) or further CRID(-s) can be obtained. The example of one entry of Content Referencing Table is shown on Fig. 11.5.

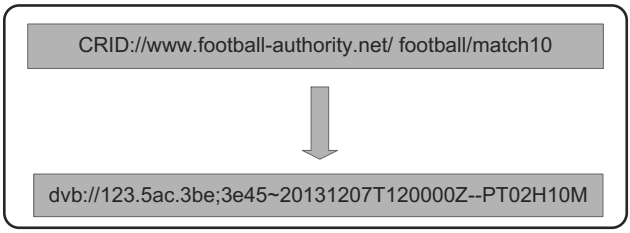

Fig. 11.5 Example of mapping the CRID to the locator in Content Referencing Table

Finally we can identify the place of particular elements of location resolution in the general sequence of actions that user is able to perform on TV-Anytime system (described in previous sections), namely:

- CRID is defined in **Search** and **Selection** actions;
- Locator is defined in **Locate** action, using CRID, RAR Table and Content Referencing Table.

11.2.4 Metadata

Before selecting the particular content the user needs to have some descriptive information on that content to make decision. The user is usually interested in title, gender (e.g. drama or comedy), actors or plot description. Only basing on this the user can select content so that PDR could obtain specific CRID. On the other hand the content creators and broadcasters use such information to attract the user for their content. The tool for providing this descriptive information is concept of content-related metadata.

The process of metadata creation for particular content may involve many organizations during the content creation, distribution and delivery to the user phase. After delivery to the user the metadata must be readable on different devices and software technologies. For that reason there is a need of defining common metadata framework to ensure high level of interoperability on different usage phases and on different technologies. The metadata format adopted by TV-Anytime standard is XML that ensures extensibility, being agnostic of application technology and wide usage around different domains and technologies [8].

There are following basic kinds of metadata:

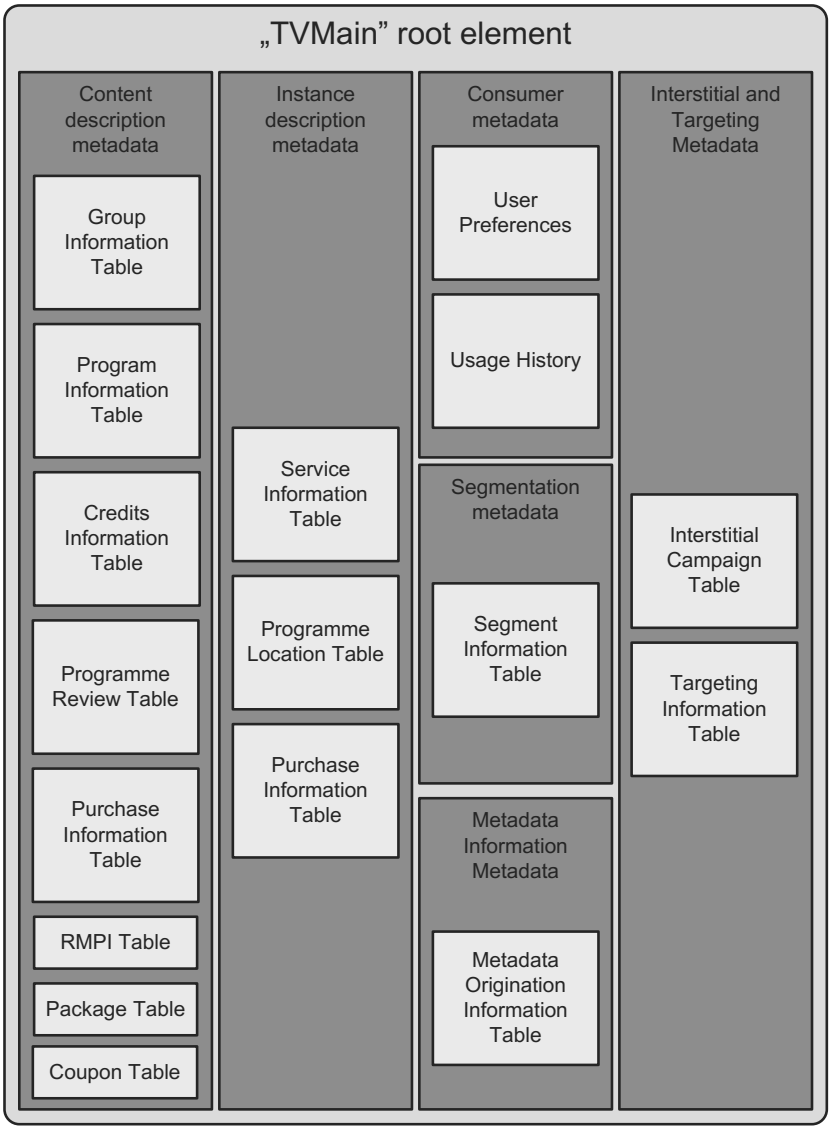

Fig. 11.6 TV-Anytime documents with "TVA Main" as a root element

- **Content description metadata** This kind of metadata is divided into four areas (each area is delivered in specific structure called "Table"):
  - **Program Information Table:** description of elements belonging to the content it can include a title of content, gender, keywords etc. These data can be used for search content by user.

  - **Group Information Table:** description of the groups of elements belonging to the content (e.g. all episodes of particular series).
  - **Purchase Information Table:** used for content that can be purchased by user.
  - **Program Review Table:** contains critical reviews for available for content.

- **Instance Description Metadata** This kind of metadata is divided into two areas (also delivered in tables):

  - **Program Location Table:** contains the schedule start time and duration (and some other parameters related to time of transmission e.g. repetition). It should be noted that these data are not used for determining content location (for that purpose the CRID resolution is used described in previous sections).
  - **Service Information Table:** description of services (e.g. channels) available in the system.

- **Consumer metadata** This kind of metadata is divided into following areas:

  - **User Preferences:** contains a profile for the user which can be used for more efficient searching, filtering, selecting and consuming the content.
  - **Usage History:** contains usage history of set of actions done by user (e.g. click tracking which registers the actions performed by user with use of remote control). This data can be later use for defining user preferences.

- **Segmentation metadata** These data are provided in **Segment Information Table:** contains description of Highlights or Events (e.g. the goals in football match content).
- **Metadata origination information metadata** These data are provided in **Origination Information Table:** contains information about the origination of the content (e.g. cinema originated content).
- **Interstitial and targeting metadata** These data are provided in both **Targeting Information Table** and **Interstitial Targeting Table:** contains description of conditions that must be satisfy on the target PDR device to properly obtain the content (like dedicated hardware or parental control set to some value) [7].
- **RMPI metadata** These data are delivered in **RMPI Table:** contains information about the rights associated to the content that user can be familiar with before he decided to the purchase this content [12].

The general schema of TV-Anytime metadata is illustrated in figure 6. There are some elements not described above (like Package Table or Coupon Table). These additional elements will be mentioned later in this chapter in description of additional features supported by TV-Anytime metadata.

Generally the main goal of metadata is to provide the user with tool for content selection as well as to provide the service provider (content creator or broadcaster) the tool for attracting the user. Apart from that the TV-Anytime standard defines some additional features that metadata must supported to keep the most recent trends in digital television like describing user profiles, search preferences or event facilitating the filtering and acquisition of content in behalf of user by auto-

matic agents. The list of features that metadata must support to make above tasks feasible is presented below:

- New content types;
- Packaging;
- Targeting;
- Interstitial content;
- Sharing;
- Remote programming;
- Coupons.

11.2.5 Additional Features Supported by Metadata

In this section the additional features supported by TV-Anytime metadata are described.

New Content Types

The metadata should support other content than standard audio-video content. The examples of such content are: graphics files, music files, web-pages, video-games or even interactive applications.

Packaging

Metadata should enable the combination of different content types as audio-video, games, applications or images. All components of the package are intended to be consumed together. The example of packaging can be the additional soccer game combined together with the football match content plus some additional still images of particular players attending the game. Package description metadata may provide also the options (information which package components should be consumed if not all) and time synchronization between them. The example can be the multi-camera feature for sport events.

Targeting

Metadata enable automatic matching the relevant content to profiled customers. There are two types of targeting:

- **Push targeting:** broadcaster delivers content that can be consumed depending on the user profile;
- **Pull targeting:** intelligent agent selects the content depending on user profile and stores it on users PDR receiver.

Generally targeting uses the user preferences and usage history that can be stored locally on PDR receiver or on remote server.

Interstitial Content

Metadata enable interruption mechanism to replace the currently being played back content with another one. The example of such interrupting content is advertisement spot transmitted during the playback of movie.

Sharing

Metadata enable users to notify other users about interesting content. Additionally it provides the mean to manage the configuration of alternative PDR device according to users profile. Also the sending content to other devices or to other users is considered by such kind of metadata.

Remote Programming

Metadata enable users to program the recording of content from other device that actually records the content. The example of this feature is requesting the recording on home PDR receiver from mobile phone being physically outside home (e.g. in the office).

Coupons

Coupons metadata provides the concept of electronic value that can complement or replace the money during content purchase operation. The examples of coupons are discounts, "two products instead of one" promotion or "buy two get three" promotion.

11.2.6 Template of TV-Anytime Usage

Having all tools for location resolution defined we can now define the general template of TV-Anytime usage realizing the sequence of actions defined above (see Fig. 11.7).

Publish

The service provider (content creator or broadcaster) generates the CRID and metadata for content that will be available for the user.

Search

User searches the content using some kind of EPG tool (Electronic Program Guide) embedded in PDR receiver or remote Web EPG tool. Each kind of EPG tool (embedded or remote) provides the descriptive information about available content extracted from content-related metadata.

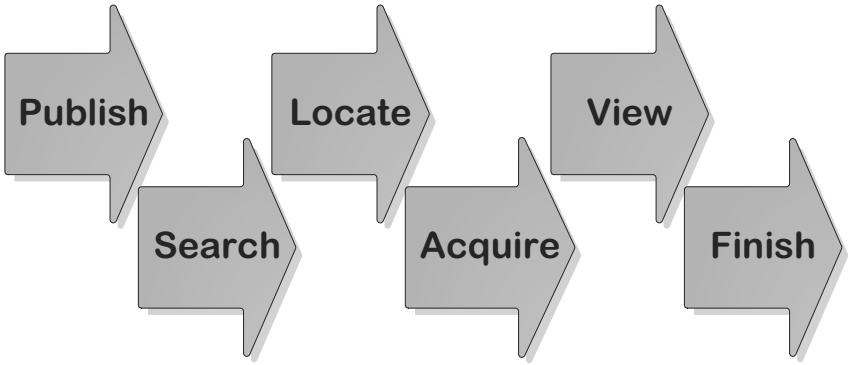

Fig. 11.7 Sequence of consecutive actions in TV-Anytime system usage

Select

User selects the content and content CRID is identified.

Locate

PDR receiver performs location resolution:

- It uses RAR Table to identify the resolution service provider (using authority from CRID);
- It obtains the locator using Content Referencing Table provided by resolution service provider.

Acquire

The content is downloaded according to the locator and stored on PDRs local storage once it is available.

View

Content is ready for users consumption.

Finish

After consumption of content by user the usage history can be stored on the local storage of PDR receiver or can be sent to the server. Using this data the user preferences can be defined and used later for enhancement of the user experience during his searching the content next time.

11.3 TV-Anytime Practical Example

In this chapter there is an example how the TV-Anytime system can work. The consecutive steps (actions) are compatible with the general TV-Anytime usage template defined in the previous chapter.

11.3.1 Publish

The content creator or broadcaster generates new CRID after production of the content football match from Champions League 2013. The same or another company creates the metadata that describes this football event as well as location resolution data with information on the time and location of content transmission.

The constructed metadata describing the content (Program Information Table) may look like XML snippet below:

```
<ProgramDescription>
 <ProgramInformationTable>
   <ProgramInformation programId="crid://sport-authority.com
       /football/match10">
     <BasicDescription>
       <Title type="main">Dortmund Vs Bayern</Title>
       <Synopsis length="short">Semi-final of Champions
           League belongs to Germany
       </Synopsis>
     </BasicDescription>
   </ProgramInformation>
 </ProgramInformationTable>
 <ProgramLocationTable>
   <BroadcastEvent serviceIDRef="hbc10022311">
     <Program crid="crid://␣sport-authority.com␣/football/
         match10" />
     <ProgramURL>dvb://1.4ee2.3f4/</ProgramURL>
     <PublishedStartTime>2013-05-25T18:00:00.00+01:00Z</
         PublishedStartTime>
     <PublishedDuration>PT6H</PublishedDuration>
   </BroadcastEvent>
 </ProgramLocationTable>
</ProgramDescription>
```

11.3.2 Search

User is searching the content for watching using EPG embedded on the PDR receiver. The PDR uses Program Information Table and Program Location Table to render the EPG. Using the EPG the user can navigate and search the interesting

```
<UserDescription>}
 <UserPreferences>
   <mpeg7:UserIdentifier protected="true">
    <mpeg7:Name xml:lang="en">John Simpson</mpeg7:Name>
   </mpeg7:UserIdentifier>
   <mpeg7:FilteringAndSearchPreferences>
    <mpeg7:ClassificationPreferences preferenceValue="12">
     <mpeg7:Language>en</mpeg7:Language>
     <mpeg7:Genre href="urn:tva:metadata:cs:
      FormatCS:2007:3.2.3.12"/>
     <mpeg7:Subject>Football</mpeg7:Subject>
    </mpeg7:ClassificationPreferences>
   </mpeg7:FilteringAndSearchPreferences>
 </UserPreferences>
</UserDescription>
```

contents. One of the ways of searching can be that user types 'champions league' as a keyword in EPG. As a result the EPG can examine the title and synopsis fields of all available contents and offers the user the one that matches the requested keyword: Dortmund Vs Bayern: Semi-final of Champions League belongs to Germany

If the user used to watch many football games before, the EPG can suggest the selection of above event to him without typing the keyword by user. In this case the following metadata describing user preferences can be delivered to PDR:

11.3.3 Select

Once user made a selection the system can start to realize his request. At this time the usage history can be updated and stored on PDR local storage or send it to remote server managing user profiles. From now on the system will be tracking the availability of content and acquire it once available.

11.3.4 Locate

After selection of the content the location must be resolved. The CRID is extracted from Program Information Table and use for defining the locator using Content Referencing Table.

The Content Referencing Table for above football match can look like a metadata snippet below:

```
<ContentReferencingTable>
<!-- CRID resolution to locators -->
 <Result CRID="crid://sport.com/football/match10"
 status="resolved" complete="true" acquire="all">
  <LocationsResult>
   <Locator>dvb://1.4ee2.3f4;4f5~2013-05-25T18
       :00:00.00+01:00/PT01H30M
   </Locator>
  </LocationsResult>
 </Result>
</ContentReferencingTable>
```

For requested football match the only one DVB locator is defined. Also the exact time and duration is known at the moment of content resolution.

There can be also different scenario when exact time of content transmission is not known yet and Content Referencing Table snippet can look like this:

```
<ContentReferencingTable>
<!-- CRID resolution to locators -->
 <Result CRID="crid://sport.com/football/match10"
 status="cannot␣yet␣resolve" complete="true"
 acquire="all" reresolveDate="2013-05-20T12:00:00.00+01:00"
     ></Result>
</ContentReferencingTable>
```

11.3.5 Acquire

Once the start time of content (if the location is already resolved) will be reached the PDR receiver will tune to the specified channel and start recording of content. When recording is complete the content is announced to be available for viewing by PDR receiver. In case when location cannot be resolved the acquiring process must be postponed till the location resolution is possible.

11.3.6 View

User can view the recorded content on PDR receiver once the recording is complete. Depending on the system available on PDR the user can send critical review of the content back to the broadcaster, recommend the content to his friends or send it to

them. It is possible to also send the content to other devices (like tablets or smart phones) if PDR system offers such functionality.

11.3.7 Finish

After consumption of content the usage history can be updated for that user. For example the recording operation itself can be add to the usage history and following metadata can be generated and store in local storage or send back to the broadcaster:

```
<UserDescription>
 <UsageHistory id="usage-history-001" allowCollection="true"
     >
<mpeg7:UserIdentifier protected="true">
 <mpeg7:Name xml:lang="en">John Simpson</mpeg7:Name>
</mpeg7:UserIdentifier>
<mpeg7:UserActionHistory id="useraction-history-001"
    protected="false">
 <mpeg7:ObservationPeriod>
  <mpeg7:TimePoint>2013-05-25T6:00-23:00</mpeg7:TimePoint>
 </mpeg7:ObservationPeriod>
 <mpeg7:UserActionList id="ua-list-001" numOfInstances="1"
  totalDuration="PT1H30M">
  <mpeg7:ActionType href="urn:tva:metadata:cs:ActionTypeCS
      :2004:1.3">
  <mpeg7:Name>Record</mpeg7:Name>
  </mpeg7:ActionType>
  <mpeg7:UserAction>
   <mpeg7:ActionTime>
    <mpeg7:MediaTime>
    <mpeg7:MediaTimePoint>2013-05-25T18:00:00</mpeg7:
        MediaTimePoint>
     <mpeg7:MediaDuration>PT1H30M</mpeg7:MediaDuration>
    </mpeg7:MediaTime>
   </mpeg7:ActionTime>
   <mpeg7:ProgramIdentifier organization="TVAF"
   type="CRID">://sport.com/football/match10
   </mpeg7:ProgramIdentifier>
  </mpeg7:UserAction>
 </mpeg7:UserActionList>
</mpeg7:UserActionHistory>
</UsageHistory>
</UserDescription>
```

11.4 Summary

The TV-Anytime standard seems to be good solution for introducing the unification method which can make the global distributed system for TV consumers that can select and acquire TV content from the global cloud system. The TVA standard is

developed and supported by many significant organizations acting on DTV domain which is a huge advantage in adaptation it to TV market process. Although its proven right direction and support by key TV market players the full adaptation of the TVA standard globally is not easy task. There are too many of existing legacy solutions that are not prepared for adjusting all standard requirements. For that reason most TV service providers use still their own proprietary solutions for TV anytime and TV anywhere features and introducing one global standard seems to be long way process. In this document we describe only the principles of TV-Anytime standard and simple examples to get the reader familiar with general picture of TVA. To go into more detailed specification or to use the standard in practice the reader should study the references indicated in this document especially [6, 7, 8, 9, 10, 11, 12].

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