TV-Anytime Phase 1: A decisive milestone in open standardisation for personal video recorders

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Abstract

Personal Video Recorders may soon fundamentally change the media delivery industry. Projections of development rely on horizontal service and consumer electronics retail markets in which standardisation has a key role to play. The world has reached an important milestone with the publication of the TV-Anytime Phase 1 specifications for unidirectional broadcast and metadata services over bi-directional networks. TV-Anytime is a worldwide pre-standardisation body, and the authors respectively chairs the metadata sub-group of the Forum and coordinates the editing of Part B of the specification. The paper gives an overview of the main features of the TV-Anytime's metadata specification. TV-Anytime has been among others adopted by ARIB (Japan), ATSC (USA) and DVB (Europe), which activities are briefly presented here. The next task is the introduction of these tools in the production and play-out centres and their adoption by creators to produce richer content. The EBU is committed to this important challenge. The TV-Anytime specifications will soon be published as ETSI Technical Specifications and Reports.

Introduction

Digital Television is rapidly penetrating the market. There is now a growing demand for digital PDRs (Personal Digital Recorder) to be connected to digital iDTVs (Integrated Digital Television) and STBs (Set-Top-Boxes). Personal Video Recorders may soon fundamentally change the media delivery industry.

Though there are several proprietary PDR systems already on some markets selling moderately, TV-Anytime has developed open specifications for the next generation of products to be retailed on a horizontal market of equipment and services.

Continuing on DAVIC's vision, TV-Anytime has specified a set of tools that will allow establishing richer relationships between content producers, service providers and consumers. The first objective is to ensure that users have access to personalised content (i.e. of their specific interest) from the largest possible variety of sources that will themselves benefit from these exchanges. The second objective is to add value by allowing consumption of this content when and where users want in respect to access and usage rules associated to this content.

With Phase 1, the TV-Anytime Forum has developed a set of open specifications enabling the interoperable searching, selection, acquisition and management of content independently to the means of delivery. It addresses unidirectional broadcast associated to bi-directional ancillary information/metadata services. This is made possible using the tools proposed by TV-Anytime that cover content and user related description metadata, content identification and location, access to metadata services and associated security mechanisms.

ARIB (Japan), ATSC (USA), DVB (Europe) and others are working on the adaptation of TV-Anytime in their respective environments. This process is supported through cross-membership.

Liaisons have been established with EBU, MPEG and Pro-MPEG to continue the on-going harmonisation effort on profiling and introduction of TV-Anytime in the production facilities.

This paper focuses on the key features of the TV-Anytime metadata specifications 'SP003v13 [Metadata]' and 'SP006v10 [Metadata Services over a Bi-directional Network]'. The TV-Anytime Phase 1 specification also includes four other documents known as 'SP001v12 [Phase 1 Benchmark Features]', 'SP002v13 [System Description], 'SP004v12 [Content Referencing]' and 'SP007 [Bi-directional Metadata Delivery Protection]'. Documentation is accessible from the Forum's website: http://www.tv-anytime.org/

TV-Anytime metadata: what is in the specification?

In TV-Anytime, metadata is descriptive information about content. It is generically qualified as *attractors* as this data is used to attract the user towards content of his interest.

With Phase 1, the TV-Anytime Forum has defined a set of specification that targets PDRs-based applications in unidirectional broadcast environments. This was complemented with methods for accessing ancillary metadata services using bandwidth-limited bi-directional networks.

The TV-Anytime metadata specification (SP003v13) contains:

- ***Part A***: The TV-Anytime Forum has adopted the XML-based (W3C [XMLSchema]) MPEG-7 Description Definition Language (DDL) [ISO/IEC 15938-2] as its representation format for metadata. XML is now widely used and offers many advantages like extensibility and the faculty of separating data from the application. PART A specifies the format of metadata to be exchanged e.g. between content/information/metadata providers and consumers, including service, content and user description schemas and classification schemes.
- ***Part B***: It contains a recommended binary format (MPEG-7 BiM [ISO/IEC 15938-1]), a fragmentation model, a mode of encapsulation of these fragments and an indexing method.
- The specification provides the TV-Anytime XML files including the XML and MPEG-7 stubs.

TV-Anytime is transport agnostic and can be adapted to different environments such as in ARIB, ATSC and DVB. The manner in which metadata is stored, accessed and used on the PDR is not covered by the TV-Anytime specifications.

SP006v10 defines the tools for accessing ancillary metadata services over a bi-directional network.

Part A: the schemas

TV-Anytime has defined a unique document structure to aggregate programmes descriptions (programme, services, etc), user descriptions, or classification schemes (e.g. ContentCS/genre, ActionTypeCS, ContentCommercialCS, HowRelatedCS, TVARoleCS) as shown on Figure 1.

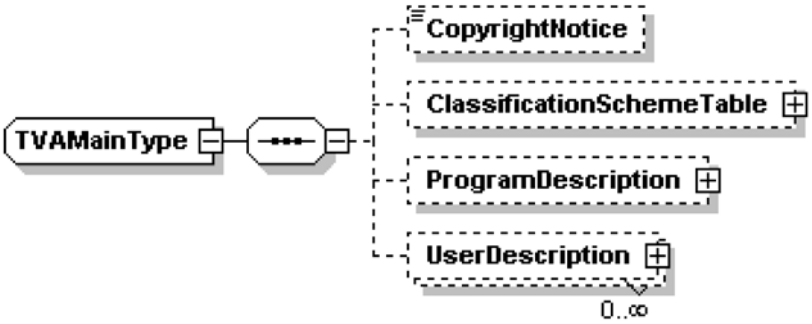

Figure 1: TVAMainType: Main document type

In order to help developing attractive services, TV-Anytime has defined the following minimum interoperability restrictions:

- A valid description of a programme shall always at least contain a Title.
- All other TV-Anytime metadata is optional. However, TV-Anytime recommends to thoroughly documenting the synopsis, genre (intended audience, content origination, content intention, and atmosphere), language, member of, and credits list (director, provider, key talent, key character, writer) elements and attributes of a programme description.

The TV-Anytime identifiers and their role

As shown in Figure 2, the TV-Anytime schemas form different clusters:

- The programme information and segment information schemas are related to a programme and inter-related via the Content Referencing IDentifier, so-called CRID.
- The programme location information is also linked to a programme via the CRID in particular through the instance description of a broadcast, schedule or on-demand event.
- The service information is related to the programme location information via the Service Identifier.
- User information is connected through the User Identifier. Programme specifc information is identified by the CRID.

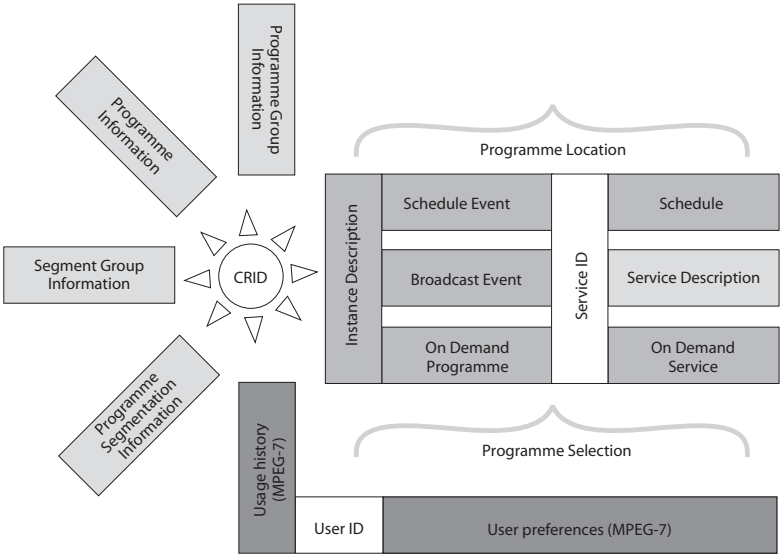

Figure 2: Inter-relationships and TV-Anytime identifiers

Programme description

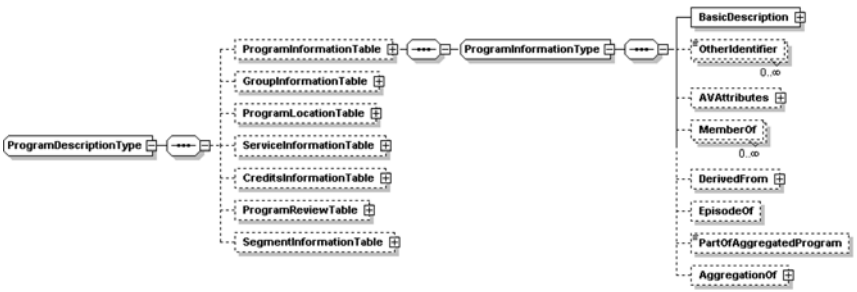

Figure 3: TV-Anytime ProgrammeDescriptionType

As reflected in the structure of ProgramDescription (Figure 3) the TV-Anytime model has been designed to describe the following content concepts (and more...):

1 Simple programmes using ProgramInformation descriptions (e.g. TV on on-demand programmes).

2 Programme versions (e.g. different edits) differentiated using BasicDescription (Title, genre, synopsis, languages, etc).

3 Commercials (e.g. programme trailers) e.g. using the PromotionalInformation in a BasicDescription.

4 Groups of related programmes with ProgramInformation (using MemberOf and EpisodeOf) and GroupInformation (using the appropriate GroupType) e.g. to describe a programme being broadcast in two parts, or a series (ordered or unordered), or related programmes sharing common concepts, etc.

5 A programme that is a concatenation/group of sequences of other programmes (ProgramInformation/PartOfAggretatedProgram), identified as an aggregated programme (ProgramInformation/AggretationOf).

6 A publication of a programme that may have publication dependent attributes (e.g. a film showing as tribute to a recently deceased actor which would have a different description) using a ScheduleEvent's or BroadcastEvent's or OnDemandProgram's InstanceDescription.

In this context, the TV-Anytime Content Referencing Identifier (CRID) links the descriptions to content referenced by this CRID.

Programme location

The same programme may be found in one or more locations according to the results of the location resolution process.

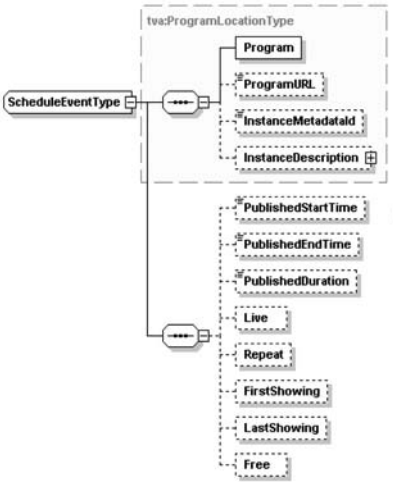

Figure 4: Schedule event

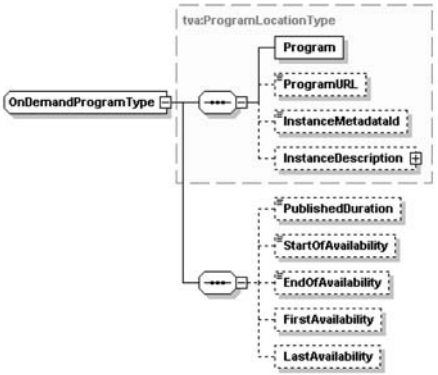

Figure 5: On-demand programme

TV-Anytime supports the definition of schedules using the ScheduleEventType (Figure 4) that will bind programmes (using the CRID as the link) to a service. The link to a service is established using the service ID that also links to the corresponding ServiceInformation description.

It is also possible to define a broadcast event using the BroadcastEventType (not represented here). It is an extension of the ScheduleEvenType as it is not required to reference a service in this case.

TV-Anytime allows defining on-demand services that propose a collection of on-demand programmes described using the OnDemandProgramType shown in Figure 5.

Segment information

Segmentation metadata is an important innovative feature of the TV-Anytime specification. It will allow creating richer content. It is believed that its simplicity, in comparison to the MPEG-7 segmentation tools, better responds to the physical and operational limitations of broadcasting.

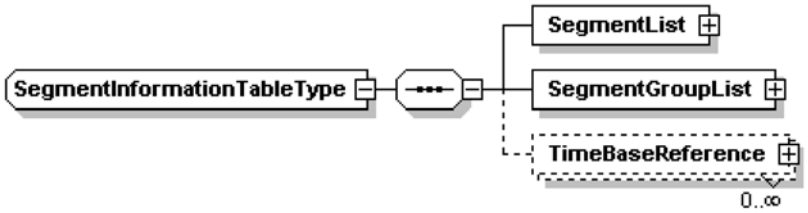

Figure 6: TV-Anytime simple segment information structure

Segmentation refers to the ability to define, access and manipulate temporal intervals (i.e. segments) within an Audio-Visual (AV) stream. It is possible to restructure and re-purpose an AV stream to generate alternative consumption and navigation modes (e.g. a summary of the content with highlights, or a set of bookmarks, repurposing of content for educational purposes) by associating metadata to segments and segment groups.

The description model is very similar to the generic 'content' and 'content group' description models developed by TV-Anytime. However, segmentation requires additional precise segment timing and location information.

User description

TV-Anytime uses the MPEG-7's 'user preference' and 'usage history' tools [ISO/IEC 15938-5] currently grouped in a draft MPEG7 'User Description profile', which has the support of TV-Anytime. TV-Anytime decided to select a common set of user description metadata in an adequate interchangeable format in order to support different scenarios such as, but not limited to:

- Selecting content matching user viewing habits using e.g. software agents.
- Tracking and monitoring content viewing habits for commercial purposes

Usage history (Figure 7) allows tracking and monitoring user actions while consuming content e.g. record, pause, fast-forward, etc. This can be done to develop a user profile that will be used to select content of user's personal interest. This information can also be shared with a service provider as a means to better design content and target programme offers. Different users accessing the same content at different times can be identified separately if required by one of the possible applications having access to this information.

User preferences (Figure 8) are used to filter content from a large variety of sources according to a rich combination of criteria such as genre, time, date, channel, etc. This operation may require user interaction to confirm a selection. It is also possible for software agents to accurately map user preferences to media descriptions. It is possible to personalise a profile or a set of preferences by weighting the different selection criteria.

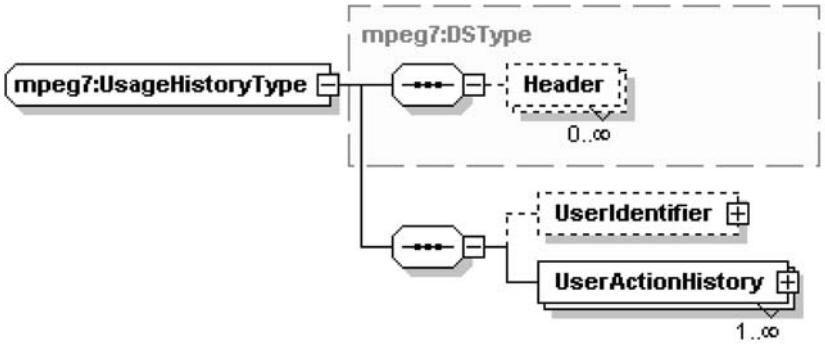

Figure 7: TV-Anytime and MPEG-7 common UsageHistoryType

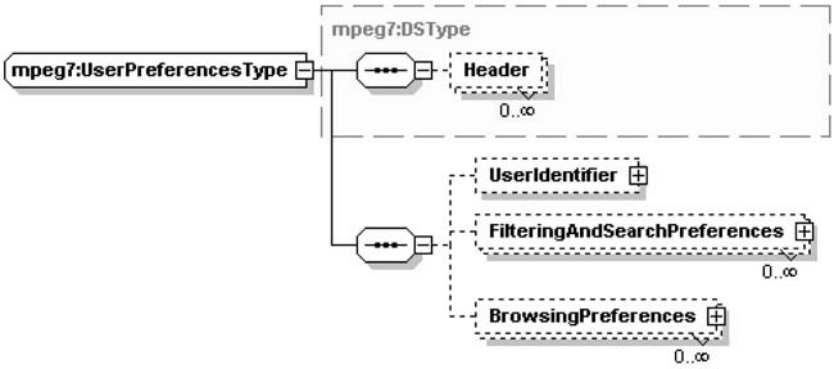

Figure 8: TV-Anytime and MPEG-7 common UserPreferencesType

The protection of user privacy has been duly taken into account. TV-Anytime PHASE 1 scenarios do not support unauthorised access to private data. Particular attention has been paid to control that the exchange of user description data shall remain anonymous. This is possible e.g. by using the appropriate protection flags in the MPEG-7 schemas appropriately set 'on' to 'anonymous' by default. However, it is envisaged that future phases of TV-Anytime will need to address a wider range of business models where user-authorised (e.g. contractual agreement) and user-controlled access to more user data will be possible.

Part B: System aspects in a unidirectional environment

Part B defines a set of mechanisms to enable and optimise TV-Anytime delivery (Figure 9). The main technical requirements can be summarised as follows:

- Bandwidth efficiency.
- Capacity for this data to be delivered asynchronously using a carousel.

- Modularisation of the carried information so as to allow partial and targeted updates, and to enable a certain prioritisation in the way the information is cyclically transmitted.
- Improved navigability within this information so as to provide, when needed, an efficient way to retrieve pieces of priority access.

The principal object to be transmitted is a '*TV-Anytime metadata description*'. It is the actual XML document instantiating the schema (PART A) and containing all the metadata provided by the same entity, which has to be delivered to a TV-Anytime terminal at a given time.

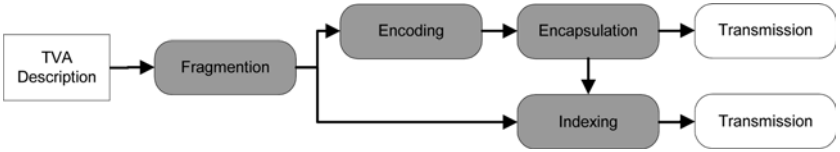

Figure 9: Processing of a TVA metadata description for its delivery over a unidirectional link

Fragmentation is the generic decomposition mechanism of a TV-Anytime metadata description into self-consistent units of data, called *TVA fragments*. A fragment is the ultimate atomic part of a metadata description that can be transmitted independently to a terminal. A fragment is self-consistent in the sense that it is capable of being updated independently from other fragments. The way it is processed and accessed is independent from the order in which it is transmitted relative to other fragments.

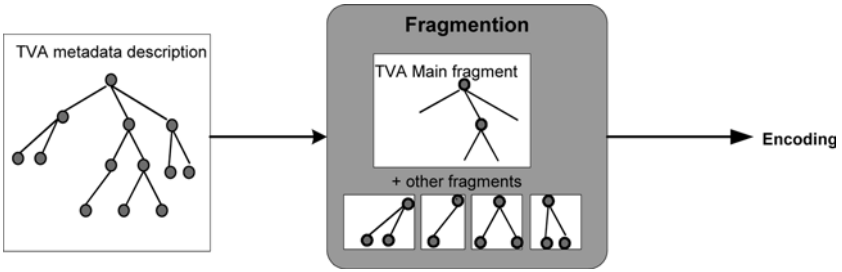

Figure 10: Illustration of the mechanism of fragmentation of a TVA metadata description

The decoding of a fragment by a terminal and its addition to the *partial description* shall eventually provide a TV-Anytime schema-valid description. A partial description is the document rebuilt from, at least, the fragment delivering the root element (the *TVA Main* fragment on the Figure 10) plus, possibly, other previously decoded fragments.

TV-Anytime has specified a set of standard TVA fragments such as:

- A fragment containing the description of a program, the review of a single content or descriptive about a given content group.
- A fragment bringing the description of an instance of a given content either on-demand or broadcast.
- A fragment carrying information about a broadcast or an on-demand service.

- A schedule fragment for the description of a sequence of broadcast events on a given service.
- A SegmentInformation fragment and/or SegmentGroupInformation fragment carrying segmentation information for a given content.

Each of these fragments can be acquired and processed independently of the others. A possible scenario is when fragments carrying information about content are broadcast along with this content so as to provide the viewer with more information about what he is watching (for example, for the promotion of a related material like a web page or a link to the content group to which this content belongs to e.g. an episode of a series).

As seen on Figure 10 for bandwidth efficiency, TVA metadata fragments must be *encoded* (e.g. binarised) for transport and delivery. For that purpose, TV-Anytime recommends using MPEG-7 BiM in association to ZLib compression for textual data (e.g. a programme synopsis or review). BiM encoding is based on the tokenisation of the structure of each fragment with respect to a state diagram produced from the TV-Anytime schema.

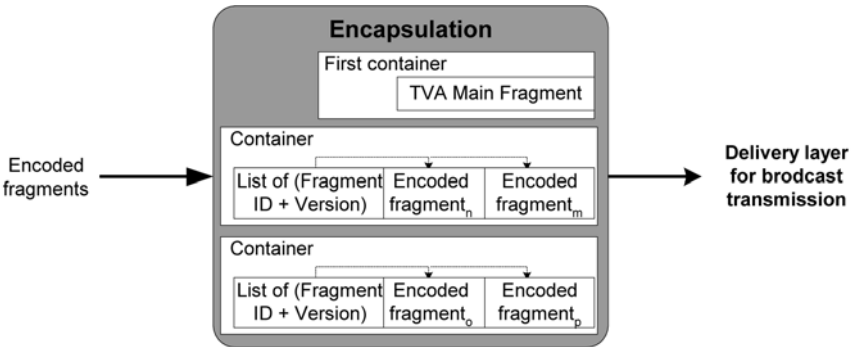

Figure 11: Mechanism of encapsulation of a TVA metadata description

Encapsulation is the process that enables grouping encoded fragments in 'containers' ready for transmission (Figure 11). It associates further information to these fragments like a unique identifier and a version number that enable the monitoring and management of updates.

Indexing is an optional mechanism (Figure 12) to deliver TV-Anytime metadata to receivers with limited processing and storage capabilities. It provides a mechanism for locating information from within a fragment stream forming a TVA metadata description. Indexing structures accompanying a fragment stream provide direct access to each fragment by listing the values of a particular node and describing where the matching fragment(s) can be found within the delivery layer.

TV-Anytime does not define the exact way in which containers and indexing structures should be carried as TV-Anytime wishes to remain transport agnostic. This is left to standard bodies adopting the TV-Anytime solution (e.g. ARIB, ATSC and DVB).

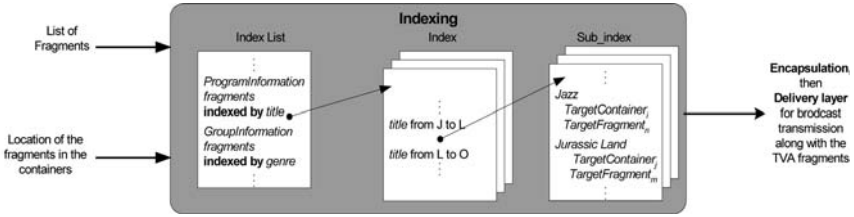

Figure 12: Abstract representation of indexing of a TVA metadata description

Metadata access via bi-directional networks

The methods and protocols specified in TV-Anytime PHASE 1's SP006v10 [5] allow a richer set of ancillary metadata to be exchanged between TV-Anytime clients and metadata servers over a bi-directional network in complement to unidirectional services. It also allows service providers to access anonymous consumer profile/ preference information.

Metadata service discovery occurs either using the mechanisms defined by TV-Anytime to provide appropriate URLs through a unidirectional stream, or using other generic mechanisms (e.g. W3C standards) for web service discovery (UDDI and WS-Inspection). The purpose is to allow the client to retrieve location information about servers from which TV-Anytime metadata can be retrieved.

SP006v10 describes a client-initiated means for requesting metadata from, and submitting user-centric data to, IP based web services:

- The get_Data operation allows a client to query a server in order to retrieve TV-Anytime data like for a set of programs or program groups (e.g. a list of CRID related resolving data, additional programme description data). A get_Data operation can, in principle, support complex queries using XPath expressions.
- The submit_Data operation is much simpler and limits the data that can be submitted to a defined set of *anonymous profile data* that has been created via manual input or intelligent agents based on usage of services and content.

It also defines mechanisms for describing such metadata services.

SP006v10 completely specifies the transport and network layer protocols (TCP/IP) necessary for end-to-end interoperability. SOAP and HTTP are used for delivering TV-Anytime XML data over the IP networks, since this combination is very well suited to the point-to-point, request-response nature of the TV-Anytime operations.

Developments in ARIB, ATSC and DVB

ARIB has now published 'ARIB-STD B38: Coding, Transmission and Storage Specification for Broadcasting System Based on Home Servers' based on the TV-Anytime Phase 1 specifications. This is an official standard for broadcasting in Japan since February 6th, 2003. The ARIB's Metadata Task Group is now actively working on implementation guidelines scheduled for publication in April 2003 by the Ministry of Posts and Telecommunications. There are several on-going projects like the 'Large-scale Content Distribution Experiment' funded by the Ministry of

Posts and Telecommunications (NHK, TBS, NTT, etc), and mobile digital terrestrial broadcasting experiments like the 'Tokyo Pilot' (TBS, Hakuhodo, NTT Data, NTT DoCoMo, Mitsubishi, etc) and the 'Operation CRID Akasaka' (TBS, Hakuhodo, NTT Data, NTT Labs, Expway and Waseda University).

The TV-Anytime metadata specification has been selected by ATSC to develop a T3/S8's draft AdvEPG (advanced EPG) specification. T3/S8 has decided to base the AdvEPG on the TV-Anytime metadata model using at least ProgramInformation, ProgramLocation, GroupInformation, ServiceInformation, and likely SegmentInformation and SegmentGroupInformation. ATSC will not use the TV-Anytime classification schemes, which are optional, to maintain compatibility with the PSIP categories. T3/S8 will not use TV-Anytime content referencing and is defining alternative methods to link metadata to content and channels. Interest was expressed in using MPEG-7 BiM (binary encoding format) as recommended by TV-Anytime.

DVB has now agreed a set of PDR-related commercial requirements. These requirements cover the carriage of TV-Anytime data over DVB networks and the broadcast of PDR-related DVB-MHP applications using this data. DVB GBS is the DVB technical group now looking at a solution addressing these requirements. DVB GBS is making rapid progress in specifying mechanisms for the transport and delivery of TV-Anytime data (content referencing and metadata) over DVB streams. This work, still in progress, should be completed by the end of 2003.

There are many other initiatives. For example, the TV-Anytime members from Korea have demonstrated very interesting developments and more is certainly to be seen at the TV-Anytime implementers' workshop to be organised in June 2003 in Seoul.

ETSI publication

The TV-Anytime specifications are in the final stage of ETSI publication as Technical Specifications (ETSI TS 102 822 series) and Technical Reports.

Future challenges

There is a general need for continuing the harmonisation effort on the dictionaries. TV-Anytime and MPEG-7 already share a large proportion of common terms. However, the TV-Anytime classification schemes have been further extended since the MPEG-7 standard was frozen.

SMPTE allows for reference to external dictionaries and a pointer to TV-Anytime should be considered.

The EBU P/META has developed a metadata exchange scheme that shares a significant amount of common elements and attributes with TV-Anytime. This means that most TV-Anytime data can be used as a P/META criteria for business-to-business search and exchange of content for developing TV-Anytime services. Work is still needed to ensure that these mechanisms are implemented in the production arena and used by content creators and programme makers.

TV-Anytime and ProMPEG are in the process of formalising liaison to discuss the possible support of TV-Anytime by MXF (Media Exchange Format). It can be foreseen that the following issues will be addressed:

- Harmonisation of metadata, including elements, attributes, classification schemes and enumerated values and mapping to DMS1.
- Harmonisation to further support the already well-covered TVA-Anytime programme groups and segment concepts.
- Adaptation of TV-Anytime for metadata encoding using SMPTE's Key-Length-Value (KLV) codes as currently specified in the MXF specification, and/or investigate the possible insertion of TV-Anytime XML descriptions (textual or binary encoded) in MXF streams.

Acknowledgement

The following TV-Anytime members have particularly contributed to the completion and success of PHASE 1: BBC, BskyB, CANAL+ Technologies, European Broadcasting Union, ETRI, Expway, France-Telecom R&D, NDS, NHK, NOB, NTT, OnTV, Philips, Samsung, Sharp Labs of America, Sony and Thomson Multimedia. The authors would like to express their gratitude to their representatives for their commitment and help during the last 3 years.