Master Thesis

Personalized ESG for converged digital broadcast and 3G mobile services

Student:

Xu Zhang (s050881)

Supervisors:

Reza Tadayoni and Michael Petersen

CICT • Technical University of Denmark

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Technical University of Denmark
Informatics and Mathematical Modeling
Center for Information and Communication Technologies
Building 372, DK-2800 Kongens Lyngby, Denmark

Abstract

The current designs of conventional Electronic Service Guides (ESGs) are an increasingly inefficient way for users to discover and select something to watch from the large amounts of digital broadcast content for Mobile TV available on handsets. One of the options to improve the design involves personalizing media selection from the existing Electronic Service Guide. The opportunity to deliver personalization has been made easier by the rapid pace of convergence. The overall aim of the project is to explore how to realize personalized ESG based on shifting contexts in converged digital broadcast and 3G environments. This report covers a review of various aspects influencing ESG design, an analysis of the stakeholders involved in mobile TV, and the planning, implementation and analysis of a case study based on a broadcaster. On this basis, an ESG design is proposed and preliminary work has been done on a prototype. The report concludes with a brief discussion of ESGs for Mobile TV and suggestions for future work.

Preface

This project is the last step of my master's education in Telecommunications Engineering at the Technical University of Denmark (DTU). The thesis work was carried out at Center for Information and Communication Technologies the period from June 2007 to January 2008 with a workload of 35 ECTS points.

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Finally I would like to thank my family for their endless love and support and my boyfriend for his support and understandings.

Table of Content

List of Figures

List of Tables

List of Acronyms

3G	Third Generation
3GPP	3rd Generation Partnership Project
3GPP2	3rd Generation Partnership Project 2
API	Application Programming Interface
ARPU	Average Revenue Per User
BBC	British Broadcasting Corporation
BNO	Broadcast Network Operator
BSO	Broadcast Service Operator
CDMA	Code Division Multiple Access
CS	Classification Scheme
DAB	Digital Audio Broadcast
DB	Database
DJ	Disc Jockey
DLNA	Digital Living Network Alliance
DMB	Digital Multimedia Broadcast
DOM	Document Object Model
DR	Danmarks Radio
DRM	Digital Right Management

DTT	Digital Terrestrial Television
DVB-H	Digital Video Broadcasting - Handheld
DVB-T	Digital Video Broadcasting - Terrestrial
EDGE	Enhanced Data Rates for GSM Evolution
EIT	Event Information Table
EPG	Electronic Program Guide
ESG	Electronic Service Guide
ETSI	European Telecommunications Standards Institute
FEC	Forward Error Correction
FLO	Forward Link Only
FM	Frequency Modulation
GPRS	General Packet Radio Service
GSM	Global System for Mobile communication
HSDPA	High Speed Downlink Packet Access
HTML	Hypertext Markup Language
HTTP	HyperText Transfer Protocol
IEC	International Electrotechnical Commission
IP	Internet Protocol
IPDC	IP Datacast
ISO	International Standardization Organization
ITU	International Telecommunications Union
JSP	JavaServer Pages
KR	Knowledge Representation
LAC	Location Area Code
MBMS	Multimedia Broadcast Multicast Service
MCC	Mobile Country Code
MNC	Mobile Network Code
MNO	Mobile Network Operators
MPE	Multiprotocol Encapsulation
MPEG	Motion Picture Experts Group
OFDM	Orthogonal Frequency Division Multiplexing
OMA	Open Mobile Alliance
RDF	Resource Description Framework
RDS	Radio Data System
RSS	RDF Site Summary
S60	Series 60
S-DMB	Satellite DMB
SFN	Single Frequency Network
SI	Service Information

SQL	Structured Query Language
T-DMB	Terrestrial DMB
UI	User Interface
UML	Unified Modeling Language
VHF	Very High Frequency
W3C	World Wide Web Consortium
XML	Extensible Markup Language
XPath	XML Path Language
XSD	XML Schema Definition
XSL	Extensible Stylesheet Language
XSLT	XSL Transformations

1 Introduction

1.1 Motivation

Over the last decades, convergence and digitalization have not only had an impact on media but also on the networks and devices used to access them. The latest official figures from the ITU (International Telecommunications Union) indicate that more than 2 billion people in the world own mobile handhelds. Meanwhile, there is a rapid growth in the personal consumption of media. Mobile TV is considered as one of the most promising services.

The mobile TV market is estimated to reach between € 7 billion and € 20 billion by 2011, having between 200 million and 500 million customers worldwide although there are considerable uncertainties about the kind of service needed and the amount of time that customers will use. [1] In order to seize this huge opportunity, mobile network operators, broadcast network operators and content providers need to implement, evaluate and release new services.

The rapid emergence of convergence brings not only opportunities but also great challenges to the stakeholders in the Mobile TV market. The consumers' usage pattern for Mobile TV

changes noticeably compared to traditional TV consumption. What it is needed is a new programming paradigm, in particular one based on personalization and interactive experiences. However, the currently designed Electronic Service Guide (ESG) is a one-to-all broadcast mass market service. Including personalization in the design of ESG could be realized by involving cellular networks (eg. 3G networks). The basic idea is illustrated in Figure 1-1.

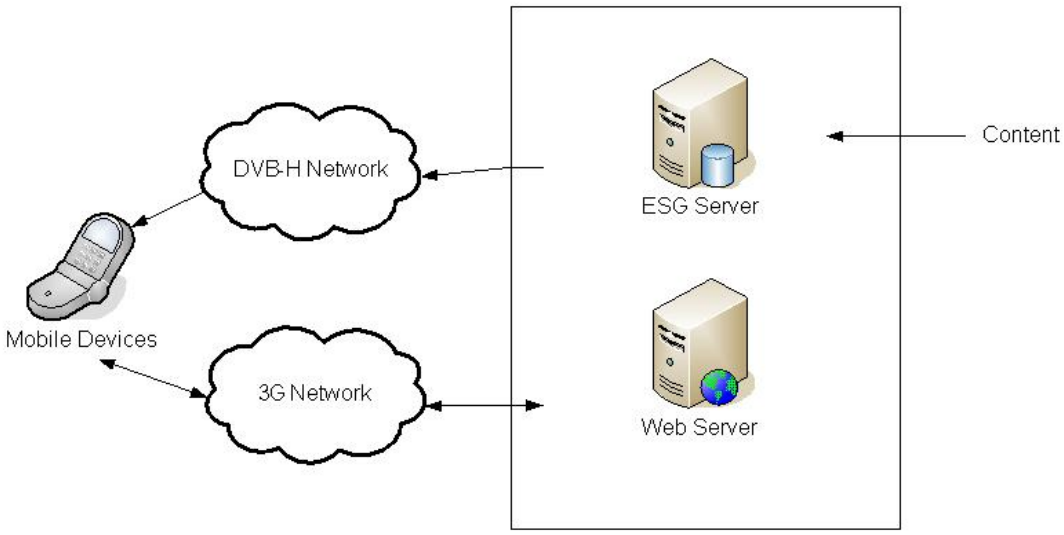


Figure 1-1 Including personalization in ESG design by involving cellular networks.

1.2 Problem Definition

The increase in the amount of digital broadcast content raises a problem: users may have difficulties to make choices about what to watch when using the Electronic Service Guide (ESG). Not only is the screen smaller and therefore a bigger challenge in terms of usability. Potentially there are other kinds of content apart from television channels and programs that need to be accessed through the ESG. This problem encourages the service provider to launch personalized service to address the problem of conventional ESGs in order to build up a one-to-one relationship with individual subscriber and furthermore preserve the subscriber's loyalty. If all of these are successful, this leads to higher Average Revenue Per User (ARPU).

The major objective of the thesis is to investigate how to realize personalized Electronic Service Guide in converged digital broadcast (IP Datacast) and 3G networks. The specific questions that the thesis aims to explore are:

1. What are the functionalities of the current ESG and how could we extend and

optimize them?

2. What are the requirements for personalized ESG service in relation to mobile phone?
3. What are the new functionalities that follow from these requirements and how can they be realized?

1.3 Methodology

The focus of the project will be the design of a personalized end-to-end Electronic Service Guide solution based on the usage contexts within converged digital broadcast and 3G environments. The work starts by reviewing a variety of standardization documentations, scientific articles and web pages within the areas addressed in this thesis. The thesis will give a comprehensive review and summary of the previous research and studies based on the literature study.

Before proposing the design, several tasks will be carried out with specific reference to the Danish market:

- A stakeholder analysis in the value chain in terms of metadata delivery for Mobile TV will be conducted.
- User requirements will be collected in parallel with analyzing Mobile TV consumption patterns, mainly based on the previous European research and pilots.
- Technical or theoretical requirements will be explored with a special focus on mobile personalization and context awareness.
- A case study with a special focus on DR/Danish Broadcasting Corporation will be carried out based on interviews with key members of staff.

After the above work, a general system framework will be proposed along with the detailed modeling of each component. The functional requirements will be addressed by modeling use cases using UML. The user preferences will be addressed and the usage contexts will be described using mobile network cell ID location information associated with time. The content description will be based on TV-Anytime metadata system architecture. The XML result sets are filtered using XSLT (eXtensible Stylesheet Language Transformations) transformation for matching and selecting elements and attributes using template constructs combined with XPath (XML Path Language) conditional predicate expressions, based on semantically structured metadata, user preferences and contextual Cell ID information using

the TV-Anytime data models.

1.4 Thesis Structure

The thesis is composed of 11 chapters together with appendixes. Each chapter will be introduced with an enclosed short description in this section.

Chapter 1 briefly introduces the area of ESG for Mobile TV, its major challenges and finally the motivation for this project. Problem definition and methodology applied in this project are addressed as well in this chapter.

Chapter 2 provides the background information of the current Mobile TV services and general issues influencing the design and implementation of an electronic service guide, including the current standards and their limitations.

Chapter 3 offers a stakeholder analysis in Mobile TV and the content delivery value chain will be addressed in the end.

Chapter 4 analyses the user requirements of designing electronic service guide by examining mobile TV consumption patterns in different usage contexts

Chapter 5 focuses on how to personalize and automatically adapt the electronic service guide in relation to the changing usage contexts from the theoretically angle.

Chapter 6 illustrates a case study on DR, with a particular perspective of broadcaster. The existing services of DR and their EPG deployment status are reviewed.

Chapter 7 outlines the summary of the requirement specifications before going further to the design and implementation.

Chapter 8 focuses on the design. The overview framework is introduced first. Both server and client are given out as follows.

Chapter 9 presents the prototypes implemented in this project.

Chapter 10 provides with discussing proposes feasible adoption plan of the previous design addresses recommendable future work to the intended readers.

Chapter 11 draws the conclusion of the whole project.

2 Overview of Mobile TV services

A short time ago, the inspiration of bringing TV to mobile devices with small screens seemed implausible. However, the interest and attention on mobile TV has grown dramatically since 2005. Nowadays, many operators have already released their mobile TV services on a commercial basis around the world.

While mobile TV generates considerable interest, it is still not clear what users actually want to see and how much they wish to pay. As the capital costs of providing an IP-datacast transmission network with gap fillers to ensure indoor reception is considerably higher than the cost of a conventional digital terrestrial television network [34], there are still questions about how mobile TV can become a sustainable business.

This chapter will offer an overview of current development status of Mobile TV enabling technologies and addresses their future trends. Additionally, introductive knowledge of current available ESG standards and their functionalities will be examined.

2.1 Available Mobile TV Technologies

There are various technical alternatives to offer mobile TV services, which can be classified to two main kinds according to distribution methods:

- Streaming and/or downloading content via mobile networks
- Broadcasting content via a broadcast network

There is no universally accepted Mobile TV standard. In fact, different regions across the world have different choices among the available standards for deployments or trails, especially for broadcasting standards.

2.1.1 Via Mobile networks

Mobile networks, mainly 3G cellular networks are able to provide video streaming and downloading of unicast services (to one subscriber) or multicast services (to many subscribers simultaneously).

2.1.1.1 Unicast

Unicast means one-to-one relationship, via which the programs can be transferred to a certain user on demand: [35]

- 2G/2.5G/2.75G networks: Theoretically, the data transfer speed using GPRS technology is up to 115kbps, while with EDGE it is up to 384kbps. Instead the users experienced data throughputs of 20 kbps on average on the GPRS networks and 40–50 kbps on the EDGE networks.
- 3G networks: For UMTS, the current low 3G network speeds of 150 to 220 Kbps but even with steady increases in transmission speeds to the 3G maximum speed of around 384 Kbps, it is still insufficient. The evolution to High Speed Downlink Packet Access (HSDPA) technology can bring increasing bandwidth provided to the users with a theoretical downlink speed of 14.4Mbps.

Unicast video streaming has the following advantages:

- across different mobile standards, GPRS/EDGE, UMTS and HSDPA
- no limitations for the number of the content channels

- bidirectional transmission makes interaction possible

However, it also has disadvantages. The popularity of mobile TV over cellular networks means a great number of users simultaneously, which will bring the congestion problem. Therefore, unicast via mobile networks will not be the ideal solution when serving the same live content for numerous consumers. Furthermore, the congestion problem increases as a function of the bandwidth used for the streams. It is important to establish the subjective quality threshold for watching TV on a small screen. As screens get better, QVGA may well be insufficient.

2.1.1.2 Multicast

The content can be delivered to a group of users by means of *multicast*. Paradigm is Multimedia Broadcast Multicast Service (MBMS) provided via existing 3G networks, which is being standardized by 3GPP. Products based on this standard are estimated to be commercialized at the end of 2007.

The limitation of MBMS is the number of content channels. From the consumers' perspective, MBMS is not required to purchase new devices with separate antennas. For the mobile operators who have already invested 3G networks, MBMS might seems to be a natural choice since it allows carriers to use their existing infrastructures and the spectrum is available as well. [35]

2.1.2 Via Dedicated broadcast networks

Besides unicast, another approach is using separate networks to broadcast mobile content using technologies such as DVB-H, DMB, ISDB-T and MediaFLO.

The issue of standards is both political and technical as there are big commercial interests involved. Which broadcast TV standards are likely to predominate in which countries is a complex matter and the claims made about competing solutions need to be analyzed with care.

Integrated Services Digital Broadcasting - Terrestrial (ISDB-T) were commercially deployed in Japan in 2006, who is also delivering its digital television services based on this standard. Brazil is also considering employing ISDB-T. MediaFlo is a proprietary broadcasting standard developed by Qualcomm in the U.S on the basis of the Forward Link Only (FLO) technology. Although the Japanese operator KDDI has planed to join the venture with Qualcomm and a

British operator BskyB also conducted tests with MediaFlo in 2006, MediaFLO is still considered to be mainly used in the U.S. [38]

Europe is currently facing a risk of fragmentation in the internal market as there are several Mobile TV technologies for different platforms. Among the trials and commercial launches based on terrestrial digital technologies, DVB-H is the most widespread and widely considered as an open and robust standard. The other major trials and commercial launches are using T-DMB (and S-DMB). [1]

Since most European courtiers are more concerned about the DV-H and DMB, they will be examined with more details as follows:

- **DVB-H**

The research work on enabling mobile receptions of Digital Video Broadcasting - Terrestrial (DVB-T) signals in Digital Video Broadcasting (DVB) project could be traced back as early as 1998, which leads to the result that Digital Video Broadcasting - Handheld (DVB-H) specifications were published as European Telecommunications Standards Institute (ETSI) Standard EN 302 304 in November 2004. [36]

DVB-H overcomes some limitations of delivering television on mobile devices by introducing new important elements in the link layer. The first is a mandatory element called time slicing, which reduces the handheld's battery power consumption (up to about 90%–95%) and ensures more seamless handovers. The second is Multiprotocol Encapsulation - Forward Error Correction (FEC) coding for improving the reception performance in the difficult reception environments of both indoor and outdoor portable use. The third is a new 4k mode for Orthogonal Frequency Division Multiplexing (OFDM) while DVB-T just has 2k and 8k modes. Adding an optional 4k mode in DVB-H trades off the mobility and single-frequency network (SFN) cell size, allowing single-antenna reception in medium SFNs at very high speeds.[36]

The coding and compression issues for video and audio signals are also identified by DVB-H, which can be carried through the DVB-T networks, as well as the IP datacasting standard, so that all mobiles can work across the various DVB-H stations in a uniform manner. [35] The transmission of IP packets is realized by Multiprotocol Encapsulation (MPE). Figure 2-1 presents an example of transmitting IP-based services using DVB-H. It is noted that the multiplex in this figure is shared by both MPEG-2 services and time-sliced DVB services. [36]

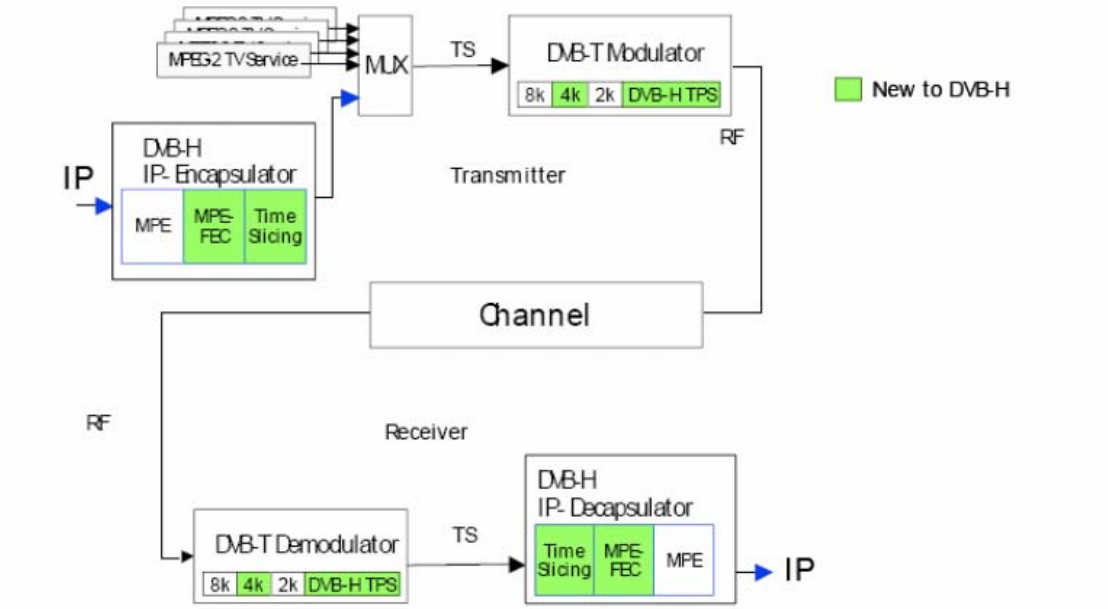


Figure 2-1 A conceptual description of using a DVB-H system (sharing a MUX with MPEG-2 services) [36]

For the channel capacity issue, a single DVB-H carrier of 8 MHz in a typical operating environment can carry between 20 and 40 channels (depending on the bit rates). [35]

The DVB-H standard has the political support of the European Commission and has been used in mobile TV pilot projects in many countries and regions, including Finland, Germany, Italy Australia, Malaysia, South Africa, Taiwan, the UK, and the USA. DVB-H is forecast to be accessible by approximately 350 million mobile users by 2008. [37]

- **DMB**

Digital Multimedia Broadcast (DMB) is another evolved standard developed as a result of modification of the Digital Audio Broadcasting (DAB) standard. The Asia Pacific region has actively facilitated the development of this technology. DMB services can be divided into two headline technologies by transmission methods: via satellite (S-DMB) or terrestrial (T-DMB). Table 2-1 summarizes the characteristics of S-DMB and T-DMB.

Table 2-1 S-DMB and T-DMB Characteristics [35]

	S-DMB	T-DMB
Transmission	Satellite with gap fillers	Terrestrial transmitters
Coverage	Countrywide	One city with SFN
Frequency band S	S-band (2630–2655MHz)	VHF band (Korea) L-band (Europe)

Modulation standard	System E (CDMA)	Korea System A, OFDM
Channel capacity	In 25MHz: 15 video channels 30 audio channels up to 5 data channels	In 6MHz: 6-9 video channels 12-15 stereo audio(AAC) channels up to 8 data channels

South Korea launched commercial S-DMB and T-DMB services respectively in May 2005 and December 2005. Germany, France, and the United Kingdom also launched Mobile TV services using the DMB and DAB-IP technology. [35]

2.1.3 Comparison

Table 2-2 shows the comparison of different technologies. In the table, most of the data is directly extracted from the result of Tele-Economic study for Mobile TV in Sweden [7]. The parameters of T-DMB are filled according to the study of comparison of T-DMB and DVB-H [51].

In European countries, DVB-H and T-DMB have been gained more attentions compared to other standards. Particularly, DVB-H has been favored by the European Union. [53]

Table 2-2 Comparisons among different Mobile TV standards [7]

Technology:	**Broadcast**			**Unicast**			**Multicast**
	DVB-H	**S-DMB**	**T-DMB**	**2G (GPRS)**	**3G (UMTS)**	**HSDPA**	**MBMS**
Maximum Data Rate (per connection)	11 Mbit/s	2 Mbit/s	1.06-2.03 Mbit/s	115 kbit/s	384 kbit/s	14 Mbit/s	Operator allocated
Typical realistic data rate for video streams	as above	as above	1.06 Mbit/s	30 kbit/s	30-300 kbit/s	550-1100 kbit/s	as above
Common data rate for video streams	128-384 kbit/s	128 kbit/s	128-400+ kbit/s	30 kbit/s	72-128 kbit/s	128-384 kbit/s	as above

Perceived quality of video	very high	high	high to very high	medium	medium high	very high	high
Investment costs	high	medium	low to medium	low	low	low	low
Efficiency of mobile TV delivery	high	high	high	low	low	low	medium

2.2 Trends - Convergence

Convergence is definitely a buzzword when people are talking about Mobile TV. The term of "convergence" can own various definitions. It could refer to the increasing blur of the boundaries among the involved industries or the integration of all the moving parts networks, devices, content and services. In this thesis, it is seen as the convergence of broadcast and 3G based mobile services.

Since the popular 3G-based delivery reveals its limitation on sustaining a large amount of users, deploying broadcasting technologies for Mobile TV seems to be essential. As depicted in Figure 2-2, the tendency is anticipated as combining the strengths of broadcast and mobile communication. However, integrating a one way broadcast technology into a two-way communication environment will bring challenges for all market players to solve.

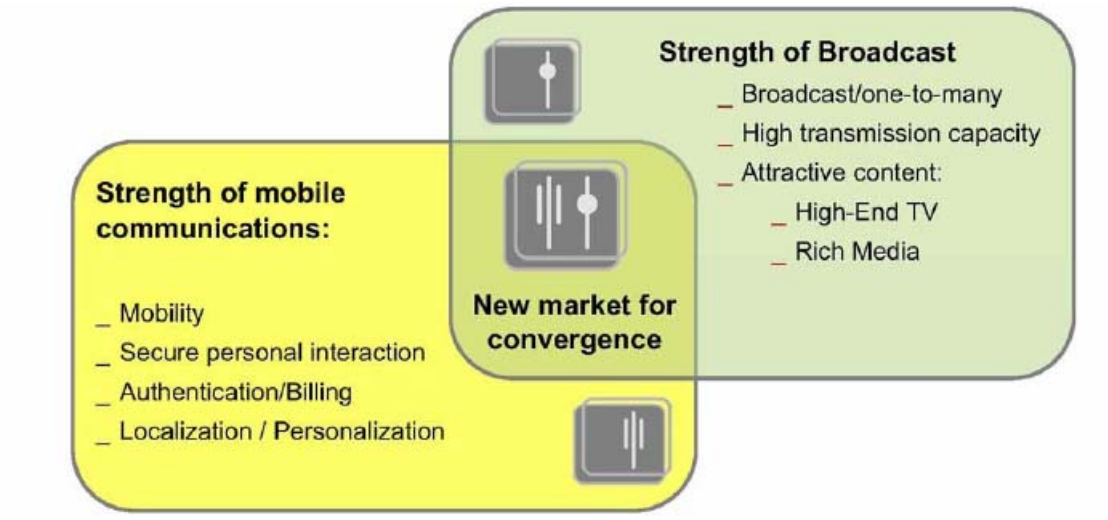


Figure 2-2 Convergence of broadcast and mobile communication [17]

2.3 General issues of Electronic Service Guide

2.3.1 Migration from EPG to ESG

Electronic Program Guide (EPG) – also known as IPG, Interactive Programming Guide - is typically referred to as an on-screen program schedule. Digital EPG is usually broadcast alongside digital television or radio signals. These signals may arrive in band via cable TV, satellite TV, cable radio, satellite radio, or via over-the-air terrestrial broadcast stations. In other cases, the metadata is delivered out of band on an IP-network. The metadata driving the EPG is consolidated and delivered through the IP connection.

The term Electronic Service Guide (ESG) is attributed to the Mobile TV world, whose features are quite similar to its antecedent EPG. The descriptive information of the available services are delivered and presented on the interface of ESG, allowing the users to select the service they wish to consume. Additionally, ESG also serves signaling data for management and configuration of the client terminals.

2.3.2 Standards Comparison

Currently, there are two major ESG standards: DVB IPDC (IP Datacast) and OMA BCAST.

DVB IPDC
DVB IPDC ESG is defined by one of the DVB specifications for IP datacasting published as formal ETSI standards called “IP Datacast over DVB-H: Electronic Service Guide”. DVB IPDC is also known as DVB CBMS. The document elucidates the data model, the representation format, the encapsulation and the transport of the ESG of DVB-H.

Basic ESG operations in DVB IPDC standard are comprised of three parts: ESG bootstrap, ESG acquisition and ESG update.

The available IPDC services are described by the ESG Instance based on the data model using XML Schema. The standard allows partitioning the ESG Instance into ESG XML Fragments. Shown in the protocol stack of the IPDC DVB-H system (see Figure 2-3), ESG XML fragments (ESG metadata) are encapsulated into containers and then transported by FLUTE to enable the optimal delivery of containers as files.

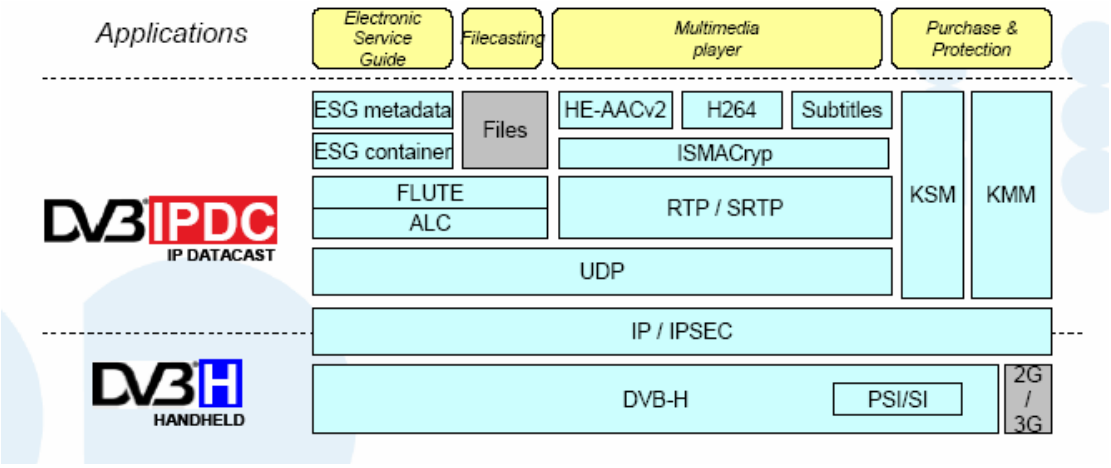


Figure 2-3 Protocol Stack of IPDC DVB-H system [18]

The overall representation is graphically depicted in Figure 2.4, where each ESG XML fragment and the references between the fragments are presented as well. Generally, ESG consists of two essential types of information: user attraction information and acquisition information. User attraction information describes services and their contents while the acquisition information contains information for service acquisition. [51]

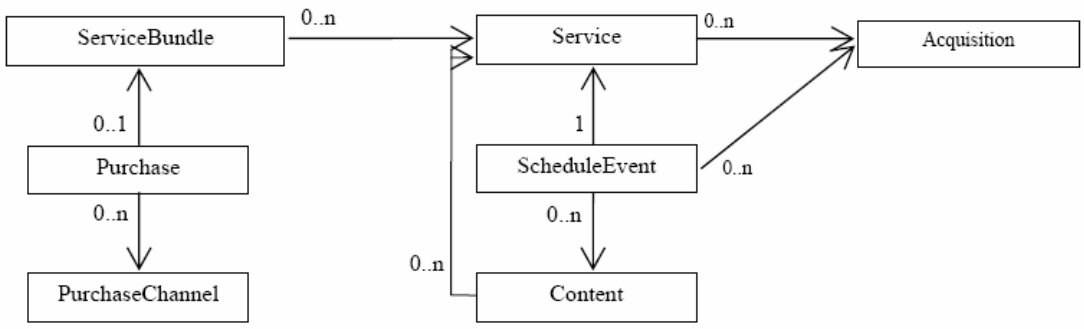


Figure 2-4 Block diagram of ESG Data Model [51]

Presently, the DVB-IPDC version 2 is in process. Work includes issues such as the delivery of the ESG via a bi-directional network.

OMA BCAST

OMA BCAST is an open global specification for mobile TV and can be adapted to any IP-based mobile content delivery technology. The standard is initiated by a standards body called Open Mobile Alliance (OMA), who is focusing on developing open standards for the

mobile phone industry.

A variety of features were specified in OMA BCAST 1.0 including ESG, file and delivery, service and content protection using the smart card or DRM profiles, terminal and service provisioning, interactivity and notifications. Meanwhile, OMA BCAST is designed to support broadcast technologies such as DVB-H, 3GPP MBMS, 3GPP2 BCMCS and mobile unicast streaming systems as well. Figure 2-5 gives an overview of the OMA BCAST functions and protocol stack.

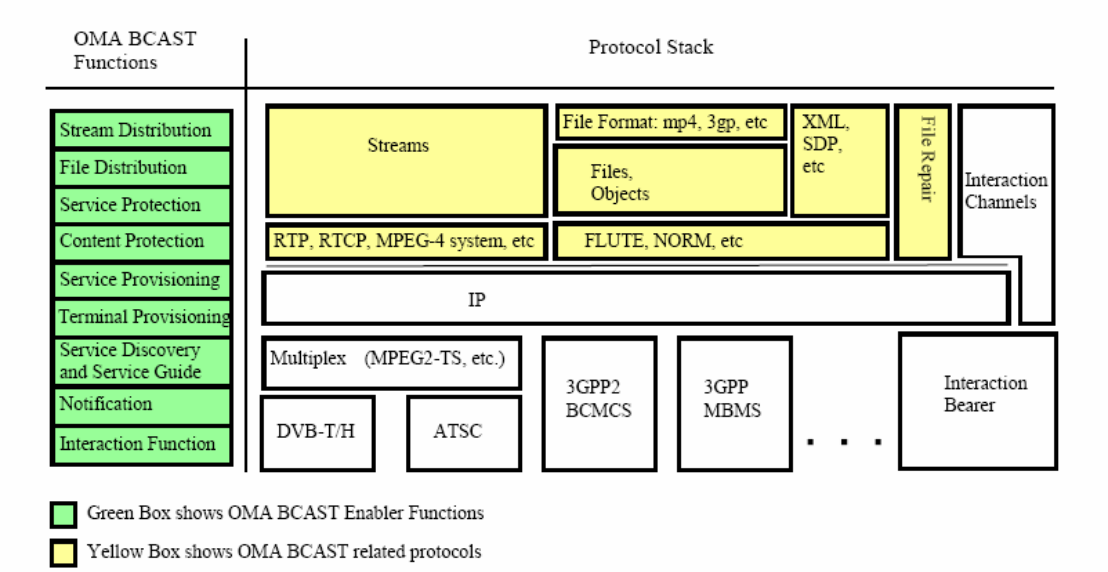


Figure 2-5 OMA BCAST Functions and Protocol Stack [48]

ESG is called as Service Guide in OMA BCAST. Figure 2-6 shows the data model of Service Guide supported by OMA BCAST.

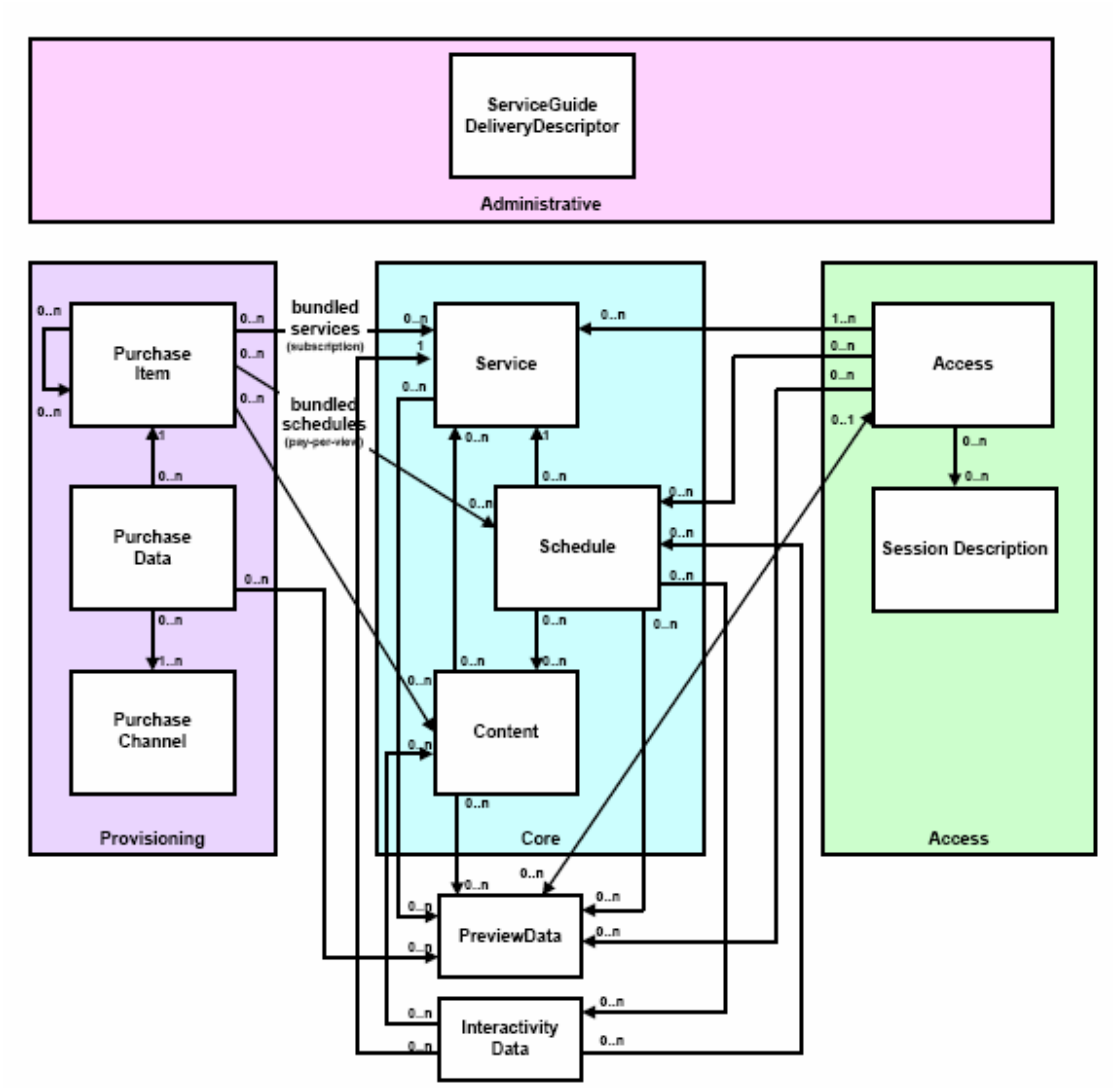


Figure 2-6 OMA CAST Data Model[49]

Comparison

Generally speaking, DVB IPDC and OMA BCAST attempts to fulfill similar market needs but with different emphases. Integrating deeply with mobile network infrastructures is the main aspect focused by OMA BCAST. While DVB-IPDC is built consistent with broadcast operator and content provider infrastructures while adopting tools developed by the mobile community.

Previous study have dived into the details of the specifications and made comparisons between OMA BCAST and DVB IPDC standard as illustrated in Figure 2-7, where the ESG part is highlighted.

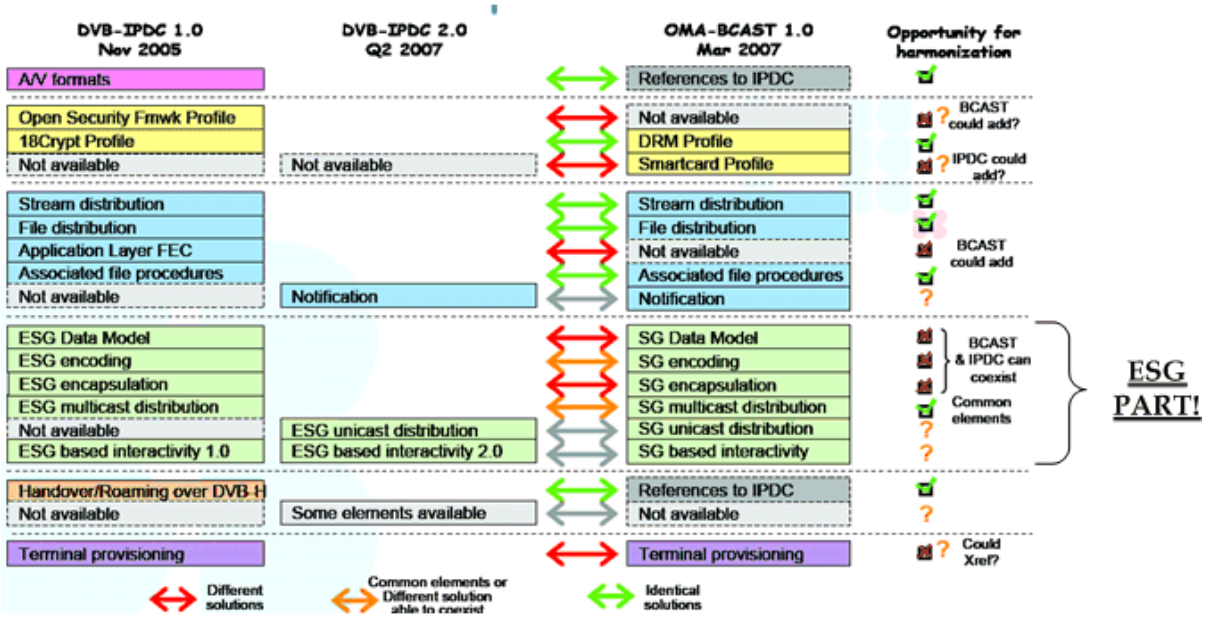


Figure 2-7 Comparisons between DVB IPDC [18]

Along with what have been compared in Figure 2-7 and some other issues regarding comparisons, the following aspects need to be pointed out:

- A single OMA BCAST Service Guide transport supports the marketing messages of several service operators. In the IPDC alternative, a separate ESG is needed for each operator.
- Dynamic interactivity changes are supported by the OMA BCAST Service Guide.
- OMA BCAST allows the OMA BCAST Smartcard security method to be used in addition to the OMA BCAST DRM profile.
- OSF-based proprietary conditional access systems are not standardized in OMA BCAST.

Most industrial players, including Siemens, Thomson, Alcatel, Expway, S3, TI, BenQ, Motorola, Samsung, LG., have committed to the DVB-IPDC path. Nokia has also committed to DVB-IPDC so far, not only their proprietary solution. For ESG, Nokia supports both DVB-IPDC and OMA-BCAST versions. [54]

2.3.3 Current ESG Functionalities and Limitations

Based on the discussion before and implemented solution across industry, it is known that current available ESG standards basically can provide the consumers with rich, up-to-date information about the services. In addition, ESG could support the mobile terminal middleware with signaling data to enable service look-up from the stream and playback with the correct client software and codecs. Automatically discovery of all the service platforms and services available in the usage area and even purchases prompts could be enabled by current ESG as well.

However, the current ESGs are mainly broadcast to the end users, even though OMA BCAST is trying to put effort on interactively. The issue of enabling highly personalized ESG delivery has not been addressed so far.

3 Stakeholder Analysis in Content Delivery Value Chain for Mobile TV

Before going further into analyzing the requirements of ideal features for ESG, a stakeholder analysis in content delivery value chain for Mobile TV will be presented in this chapter.

Figure 3-1 shows the simplified broadcast content delivery flow. The term “content” here include both the content essence and metadata. The flow starts from content rights acquisition, via content production and channel aggregation, service aggregation and distribution and finally makes the service accessible to the end users by their user devices. The stakeholders involved into the value chain may be responsible for one or more steps in the chain. Their roles may also alter in terms of different business models. The following discussions will address these issues in more details.

Figure 3-1 Basic Broadcast Content Delivery Value Chain (Inspired by [31])

Reviewing the stakeholders in the traditional TV value chain will assist the assessment in the world of Mobile TV. Figure 3-2 illustrates how the information and revenue flow across different stakeholders for traditional TV delivery.

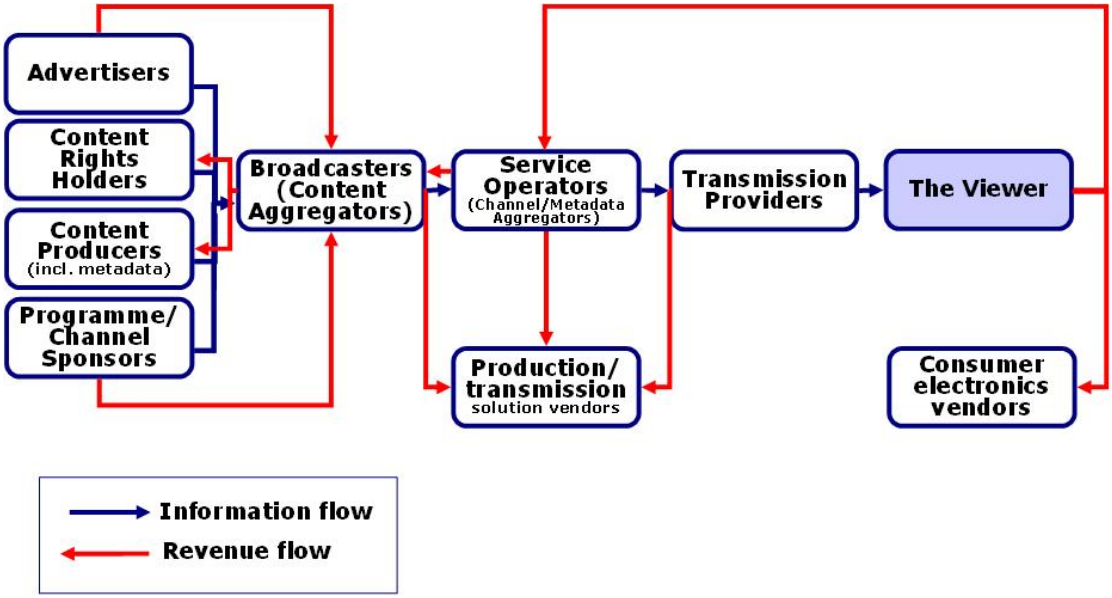


Figure 3-2 Stakeholders in the traditional TV Value Chain [40]

Compared to traditional TV, delivering content in the converged broadcast and 3G environments brings new players such as mobile operators, which increases the complexity in building up the business models. To identify the adequate business model, the interests, strengths and weakness of different stakeholders involved within the mobile broadcast content value chain are analyzed in Table 3-1 Stakeholder Analysis within Mobile Broadcast Content Value.

Table 3-1 Stakeholder Analysis within Mobile Broadcast Content Value

Stakeholders	Interests	Issues
Content Rights holders	• Want to maximize the return on their investment	*Strengths:* • Some kinds of rights (sports, news) have strong appeal to some market segments *Weaknesses:* • Doubts about earnings on mobile rights and potential danger to existing agreements on DTT (Digital

		Terrestrial Television), pay-TV etc.
Broadcasters	• Repurpose the existing content for a new revenue source • Attract incremental audiences, especially re-attain the group of youngsters	*Strengths:* • Have experience in providing attractive broadcast services and advertising financed offerings *Weakness:* • Have no direct access to the end users unless it is free-to-air broadcasting and the broadcaster also owns the transmission company. In all other cases, the broadcaster has to cooperate with a mobile network operator.
Broadcast Service Operators (BSO)	• Reuse existing content aggregated for mobile use (if the rights are available)	*Strengths:* • Cost savings by negotiating bigger rights deals for both DTT and mobile TV use • Experience in aggregating and selling channels *Weaknesses:* • Without cooperation with a 3G operator, need to sell free-to-air services funded by advertising or offer public channels pay for by a license fee.
Broadcast Network Operator (BNO)	• Reuse existing infrastructures, for example, the deployment of DVB-H can be built up base on the DVB-T facilities	*Strengths:* • Operate the backbone and access networks *Weakness:* • Limited market for free-to-air services, so collaboration is needed with 3G operator
Mobile Network Operators	• Get return from the large investments for 3G licenses • Offer complementary service in	*Strengths:* • Have experience in controlling the mobile networks which directly

(MNO)	order to enhance customer relationship	access to the end users *Weakness:* • Have limited access to the content • Expect higher share of revenue than the broadcasters and service aggregators to pay the investment in a transmission network risky.
Mobile Device Manufacturers	• Develop new types of handhelds with the receivers for Mobile TV, which brings new opportunities to dominate the market	*Strengths:* • Can build hybrid handsets which are more flexible than either 3G or DVB-H alone *Weaknesses:* • There is the risk of fragmentation and national standards, not only for the services themselves but also for things like Conditional Access. Manufacturers would prefer a GSM scenario with global standards.
Advertisers and other sponsors	• Can access to the mass popularity of their ads. • Can target their ad spend to specific audiences	*Strengths:* • Greater accountability *Weaknesses:* • In some countries this kind of service is more highly regulated because there is a direct link between the device and the user
End Users	• Greater freedom of movement both indoors and outdoors when consuming media	*Strengths:* • Integrates all of the personal media in one device • More reliable picture and audio quality than 3G/HSPA for popular content viewed when broadcast *Weaknesses:* • Convenience comes at a higher price

The complexity of Mobile TV causes numerous possible business models, which are under

discussion at the moment. Meanwhile, the revenue sharing model is not clear as well. However, no matter who is taking the role as the leading actor in the business model, there is a general consensus that the close collaboration among different parties will be an indispensable factor to success.

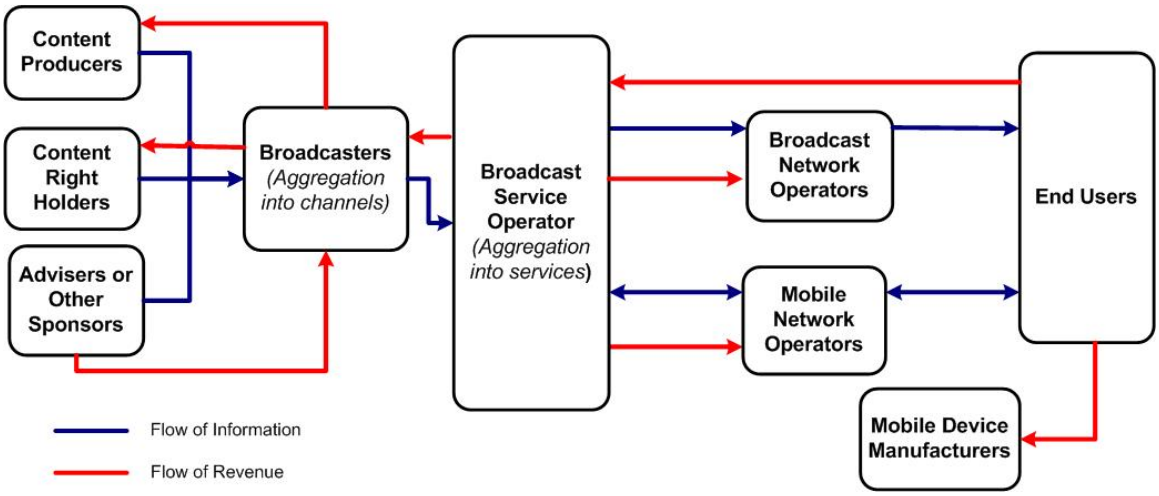


Figure 3-3 Mobile TV Business Model

Since this project is mainly focused on the broadcaster's interests, the proposed Mobile TV business model drawn in Figure 3-3 is broadcaster-driven, where the broadcasters are playing an indispensable role to provide the content (both essence and metadata). This potential business model is on the premise that BNO adopts DVB-H on the top of existing DVB-T infrastructures while MNO utilizes 3G networks. The blue lines show the information flow while the red lines suggest the revenue sharing. It is also noticeable that multiple roles can be taken by one party in reality.

Within this model, content sources are similar to the traditional TV model. TV channels are distributed through the BSO and the BSN. Other kinds of rich media that require downloads can also be distributed through the MNO. The BSO also plays a key role as it has a service agreement with the end users. The BSO will aggregate the channels bought from the broadcasters into services and transmit them via broadcast networks direct to the end users. BSO can make deal with MNO for a return path. Alternatively, the MNOs with the experience with delivering broadcast TV channels over 3G has the ability to come to terms with the new role of BSO. Nevertheless, in reality, providing a full range of broadcast and on demand services is normally something outside the experience of many MNOs. Normally, it is rare for broadcasters to take the role of broadcast service operator, partially because broadcasters own a limited number of channels.

For revenue sharing model, content producers and content right holders will get payment from broadcasters. One source of income for broadcasters is from BSO by selling channels to them and the other is from advertisers and other sponsors if mass adoption is occurred. BSO will profit from end users' pay-TV subscription fees. Meanwhile, BSO needs to pay BNO and MNO for network use. Mobile device manufacturers sell devices enabling the Mobile TV reception to the end users.

The opportunities and challenges of this business model are:

- Broadcast solution brings the delivery efficiency and scalability, making it possible to broadcast content simultaneously to mass audiences within a large area.
- Broadcast Mobile TV ensures the quality of the media, which will enhance the overall user experience.
- DVB-H based Mobile TV services require investment for frequency spectrum, and a transmission network with gap fillers that in a small flat country like Denmark probably costs 4-8 times more than the DVB-T network.
- By adding return channel using mobile networks, BSO can use Conditional Access to run "Pay TV" services on DVB-H. This return path also enables realizing personalized and interactive electronic service guide, although it is possible to implement personalization without a centrally-held profile as will be discussed later.

4 Understanding how people consume Mobile TV

ESG is the direct portal reaching the end users. The design of the ESG becomes quite essential to let the user experience to be adequately compelling to encourage people to become paying subscribers and furthermore stick to the service.

To understand the content and service requirements of designing ESG, the user behaviors and expectations need to be thoroughly examined.

Although an increasing number of mobile TV user studies have emerged recently, the user proposition still requires further clarification.

Key questions to explore include:

- How are users likely to consume mobile TV, for what purposes and in what contexts?
- How do the contexts influence the user's choices of content?

4.1 Drivers of using Mobile TV

In order to fully understand the user requirements for ESG, the question of "What are the drivers for the end users to use Mobile TV services?"

By reviewing studies and pilots, the prominent reasons influencing the end users' willingness to adopt Mobile TV services can be summarized as:

- **Flexibility and independence**

People wants easily to stay up to date without the constraint of location, including following the breaking news and participating popular events. Some people hate to miss their "must-see" programs, even though they are not at home. [10]

Mobile devices allow for media consumption on the move and while moving around indoors, so people can have access to media almost anytime anywhere. This flexibility is one of the major reasons people are likely to watch mobile TV. Users consider the independence from the television set as one of the key benefits of mobile TV. [22]

- **Personal and intimate viewing experience**

Traditional TV was mainly used to be a communal experience primarily in families. However, mobile phones are usually kept as private belongings. Watching Mobile TV tends to become more individualized and intimate experience. [22]

- **Kill time**

It is natural that Mobile TV is intended to use to kill boredom in spare time, for example, while waiting in queues or traveling on busses, trains and airplanes, waiting friends in the bars etc. Killing time was claimed to be the dominant reason for using mobile TV by the participants in the Finnish pilot. [12]

- **Novelty**

People tend to have a desire to be the first. Whilst novelty can draw people to try Mobile TV services, in particular among the youngsters. However, novelty usually wears off so it may also become the same reason for those users to discard the services later on. [12]

4.2 Target user group

Recent research conducted in Sweden identified the early adopters as people who are 15-49 years of age, men, with some type of subscription, a high income and high interest in

technology. [23] Earlier Finnish pilot indicated men aged between 30 and 40 are expected to be the early adopters. [12]

Other study concludes the primary groups of Mobile TV users in general terms. [22]

- The young aged 18-34
- Teens and children
- Business People

4.3 Usage contexts

4.3.1 What is Context?

Mobile devices are used in a highly dynamic, mobile and personalized context that provides an abundance of information. Mobile devices can access and use this information in order to adapt themselves to it.

Although there is no universally acknowledged notion of “context”, researches indicate that the most common and operational context definition was proposed by Dey and Abowd:

“Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.” [8]

Furthermore, the major entities of mobile context information are:

- Spatial / location information: e.g. GSM cellID
- Temporal information: e.g. Time
- Environmental information: e.g. weather
- Presence and related status: e.g. online, offline, available, busy, etc.
- Handset status and capabilities: e.g. capabilities of the handheld
- Personal context: e.g. User preferences, user mood.
- Social context

The characteristics of context are: [3]

- dynamic and alter frequently
- the relevance of contextual information depends on the application and situation at hand
- sometimes maybe incomplete or even incorrect

4.3.2 Mobile TV Usage Contexts

The usage contexts of Mobile TV have been evaluated by many studies worldwide, since they change dramatically in contrast with conventional television consumptions. The term “usage context” refers to when and where people are likely to consume Mobile TV. The following study is basically based on summarizing the previous research by Chipchase [10] and Shani Orgad [22].

Where?

Unlike stationary spot of traditional television service, the places to consume Mobile TV shift due to the mobility trait of mobile devices. This frequent place-shifting causes unplanned viewing. According the previous studies, the primary locations of Mobile TV are: at home; on the move and at work/school.

1. Home

Recent pilots show that home is the most prevalent location for Mobile TV watching and about a third (and in some studies almost half) of the users watched mobile TV at home. It is somewhat surprising given the alternative forms of entertainment that were available in the home. It may either because the main television is occupied by other family members or roommates or because they are frustrated with traditional television offerings and have access to more channels on their device than their own TV. People may also watch mobile TV to relax before going to sleep, when they do not have a television set in their bedroom. Mobile TV in the home has to compete with similar media such as video on I-Pods and video streamed to a lap-top over the wireless LAN connection in the home. The reasons for consumers choosing to watch mobile TV rather than make use of such alternatives are not well understood.

2. On the move

Another popular complement to home TV watching is watching mobile TV on the move. It is natural that people tend to watch mobile TV when they are traveling on public transport.

Meanwhile, people are likely to use mobile TV fill the idle times as well, making waiting at the stations evolved as well. Pilots conducted in China showed that mobile TV has proven to be an invaluable source of information for people waiting in queues for a bus and at the airport.

3. At work/school

Recent studies reveal that students and homemakers are likely to view mobile TV during breaks from classes or housework, while minding children or when spending time with friends. Mobile TV can also give office workers a chance to have short bursts of 10 to 20 minutes of news or entertainment during breaks and lunchtimes. The session lengths are reported to be shorter for mobile TV than similar content on I-Pods. It is thought that uncertainties about the price of the service keep session lengths to 3-6 minutes, whereas they are considerably longer where the services is either funded by advertising (Korea) or has a known price (I-Pod).

When?

New prime time emerges as well when compared to traditional TV consumption. (see Figure 4-1)

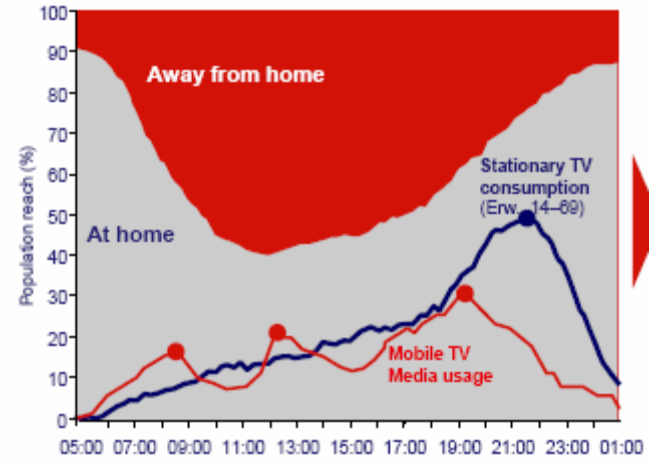


Figure 4-1 Mobile TV Prime Time [20]

Viewers are expected to watch mobile TV at the following popular slots:

- Early evenings: several European studies show that the highest percent of viewing took place after 18.00, with the heaviest usage between 18.00 and 20.00

- Early mornings: the second largest slot of mobile television viewers in those studies was 06:00-09.00
- Lunchtime: UK pilot results reveal a lunchtime peak higher than normal television viewing, suggesting that people are watching it while on their lunch break

The popularity of viewing during early evenings and early mornings corresponds with commuters looking either for something to unwind after a day at work, or to 'kill' the time or keep up to date with the news, during the commute to work. Mobile TV offers a portable and potent source of entertainment and an alternative to books and newspapers in the tight quarters of buses and trains. These are termed "macrobreaks" by Chipchase[12]

The empirical data mentioned above raises a number of issues about the generalizations we can make concerning user behaviors:

- Cultural differences: in northern Europe, work starts and finishes earlier than in southern Europe, as there is a short lunch break. Viewing figures need to take these differences into account
- Killing time in connection with commuting on public transport: There are big differences within Europe that are related to the size of the cities and the average journey time for people commuting.

Based on the above discussion, typical user situations for Mobile TV services can be anchored by location and time dimensions (see Table 4-1)

Table 4-1 Typical user situations for Mobile TV services

User Situation	**Location**	**Time**
Have breakfast and prepare to work	At home	Morning during weekdays Mon-Fri
Relax after work		Evening during weekdays Mon-Thu
Enjoy the weekends with family or alone		Weekends Fri evening to Sun evening
Commuting	On the move	Random
Waiting at the station, bus stop, airport etc.		Random
Lunch time break	At work/school	Around noon during weekdays
Coffee break		Other time

4.4 Mobile TV consumption patterns

Many empirical research and pilot studies have been emphasized on the dominant consumption patterns on mobile handhelds.

Most pilots and commercial launches during 2004-2006 used simulcasting of existing television channels, which were claimed to be what the viewers want. [41] For radio services, the Oxford poll indicates 7 out of 10 participants in the trial would like to have digital radio channels included in a commercial service. [39] Besides the synchronous consumptions, asynchronous content (e.g. the on-demand) should also not be overlooked.

There is another general agreement saying that the Mobile TV viewing time is transient, which is usually less than 10 minutes[10][11]. The Oxford pilot show that 33% of participants indicated that they are looking for something made for mobile programming, and even some long-form content (e.g. movies) is proving suitable for watching on mobile handsets. [39]The BT Wholesale/Virgin trial attempted to deliver short form and long form content but the results are not conclusive as the project seems to have had difficulties clearing copyright for the content that was to be repurposed into short-form modules. This would seem to be an important area where more research is needed. In Denmark, anecdotal evidence on the use of short –form satire from DR on the Web (the Christmas calendar Yallerup Færgeby) has 20% of its total viewers. This supports figures quoted by DR from earlier productions such as the Angora Brothers which was made available in short form on the Web and on mobiles.

General findings point out that the most popular genres on Mobile TV are quite similar as traditional TV: News, Sports, Music and Entertainment. The Finnish pilot reveals that the users consume different content types in different locations [12]. Other pilot also mentions about this issue, for example, Oxford pilot demonstrates a lunchtime viewing peak higher than the normal TV pattern, suggesting that viewers are enjoying news, sports and their favorite daytime soaps while on their lunch break.

However, there are no conclusive summaries on the subject of how and to what extent does the user consumption pattern affected by the shifting contexts. Table 4-2 attempts to summarize how viewers' preferred genres change in different scenarios.

Table 4-2 The relationship between the people's preferred genres and scenarios

Scenarios(Situations)	**Popular Services**
Have breakfast and prepare for work	Traffic, Weather, News
Relax after work	Entertainment

Enjoy the weekends with family or alone	Entertainment, Educational
Commuting (may depend on whether you are on public transport or driving, riding a bike/scooter/motorcycle)	Radio, Music
Waiting at the station, bus stop, ect.	Events and Entertainment
Lunch time break/Coffee break	News, Sports
Working	Background, Entertainment

Another usability issue related to consumption pattern is how the people will actually use the ESG on mobile devices. As it is known that since the screen is rather small, the interface of ESG will be particularly important. The interface should be simple because too many manipulations before actually finding out desired programs would be quite annoying. Thus, the end users will not expect extremely complex and difficult manipulations from their side.

4.5 User Requirements Implications

The above discussions implicate that the user requirements of ESG could be summarized as:

- The content of the service package should include existing channels and other popular content. The short form of content tailored as less than 10 min is highly demanded by the end users.
- Highly personalized ESG is required since mobile TV is mostly considered as personal viewing.
- Suitable content should be delivered for different mobile viewing conditions, requiring the ESG to be tailored based on the user preferences along with the current contexts. By providing the content that is personalized, end users will be given what they really want.
- The ESG should be simple and intuitive. There is a requirement that the delivery of personalized content mentioned above should minimize the end user’s manipulation, reducing the complexity from the user’s side.

5 Customizing ESG based on mobile contexts

Following up the features of ESG required by end users summarized by previous chapter, this chapter will mainly focus on how to approach these features technically and their enabling components.

There are two key elements for being able to customize ESG based on mobile contexts. The first is well-defined digital metadata. The other issue is the technique for handling the mobile contexts and realizing automatic service adaptation that matches the user's requirements and needs. Both elements will be studied respectively in this chapter.

5.1 Content Description using Metadata

5.1.1 Reviewing Existing Metadata Standards

Metadata is technically defined as "data about data". Metadata can be considered as control and descriptive elements associated with media content or essence. Adding metadata into

broadcast stream will allow for delivery of personalized interactive service.

DVB-SI

In Europe, the DVB series of standards is the integral basis of the digitalization of cable, satellite and terrestrial television networks, within which there is the ETSI EN 300 468 standard for metadata defining Service Information (SI). The Event Information Table (EIT) in DVB-SI can be utilized to supply program related information. Basic information includes title, start time, duration and synopsis etc. It also has the possibility to implement a two-level genre description list (the top level consisting of ten broad program categories - movie/drama, news/current affairs, show/game show etc. - within each of which there are from 7 to 18 sub-categories) by using "Content Descriptors" [25]. In practice, programs in Denmark normally only have the obligatory DVB-SI information nevertheless, without the classified genre description. (See Appendix A2)

TV-Anytime

TV-Anytime is an open standard containing a set of specifications defined by TV-Anytime Forum published as formal ETSI standard. For metadata, TV-Anytime formally defines the audio-visual content. It is also to be found in other DVB standards, as part of the OpenEPG initiative in the USA to provide a metadata mechanism using RSS (RDF Site Summary) feeds for Video On Demand and in the Digital Living Network Alliance DLNA v1.5 standard for interoperability of consumer electronic devices in the home.[50]

The following features are mainly addressed by TV-Anytime metadata specification:

- Content-related metadata includes both semantic and low-level (audio and video) description
- Segmentation metadata refers to the ability to create, access and manipulate temporal intervals of a particular audiovisual stream (for example metadata about the content of news items in a television news program).
- Consumer metadata uses the MPEG-7 user preference" and "usage history" tools [ISO/IEC 15938-5], which enhances the feasibility of personalization. [43]

In reality, TV-Anytime has been adopted by BBC, which is one of the leading broadcasters in the world and which is at the forefront of deploying digital metadata and its application to new services and by Red Bee (formerly BBC Broadcast) which is currently Europe's largest aggregator of program listings metadata. Red Bee supplies metadata for more than 1,200 European TV channels and is present in overseas markets including Australia and China.[47] Taking bandwidth limitations on broadcast networks into consideration, the BBC implements a subset of TV-Anytime data models to describe its digital TV and radio programs. Normally,

each program has title, synopsis, keywords and genre descriptions. [30]

For the genre descriptions, the most frequent dimensions used to describe BBC programs are listed as follows:

- IntentionCS e.g. entertainment, enrichment, education etc.
- FormatCS e.g. documentary, cartoon, play, chat, quiz, DJ etc.
- ContentCS e.g. news, finance, soap, fascism, poetry, grunge etc
- AtmosphereCS e.g. crazy, exciting, sad, stylish, heart rending etc.

The data structures of these dimensions are not the same. For ContentCS, FormatCS and IntentionCS, their hierarchical structure provides top-down taxonomies narrowing classification down to a certain category. However, the AtmosphereCS's open spatial structure will capture feelings and emotional responses.

5.1.2 Discussion

The feasibility of realizing highly personalized ESG service rely on the degree of the semantic richness of content description.

TV-Anytime metadata particularly includes a comprehensive hierarchical multidimensional genre scheme. This semantically meaningful genre scheme enhances the flexibility of describing the nature of content [29] and makes much easier to allocate a particular item due to the multi-dimensions. Meanwhile, the possibility of realizing personalization is enabled by the Usage History DS and User Preference DS in TV-Anytime. In real implementation, to what extent the TV-Anytime can be implemented will rely on the carrier bandwidth.

Compared to TV-Anytime, DVB-SI lacks of the ability in personalization and semantic content description. However, it is widely deployed in the current European digital services. SI information can be re-used as fundamental description of the content by splitting it from the original signal when repurposing existing services.

Meanwhile, interoperability is also considered as a significant issue when talking about metadata. An open and unified metadata framework will greatly facilitate the vision that the end users can utilize their desired content any time and anywhere. Contrarily, the lack of interoperability will hinder the mass adoption of the service.

5.2 Context awareness for ESG

The definition of context and the primary usage contexts and scenarios of Mobile TV have been discussed in Section 3.3. In this section, the author is going to explore the mechanism for gathering and disposing these contexts. Since the research area of context awareness is rather vast, the knowledge addressed in this section is to give an introductive representation within this area.

Context awareness refers to the enabling technology for creation and deployment of context aware services. As discussed before, the term “context” in this thesis represents the user situation. Within the context of this project, “context awareness” could be interpreted as automated ESG adaptation for individuals according to current context.

Theoretically, a typical context-aware system would consist of the following blocks (see Figure 5-1):

- **Context Gathering**
- **Context Interpretation**
- **Adaptation Inference**

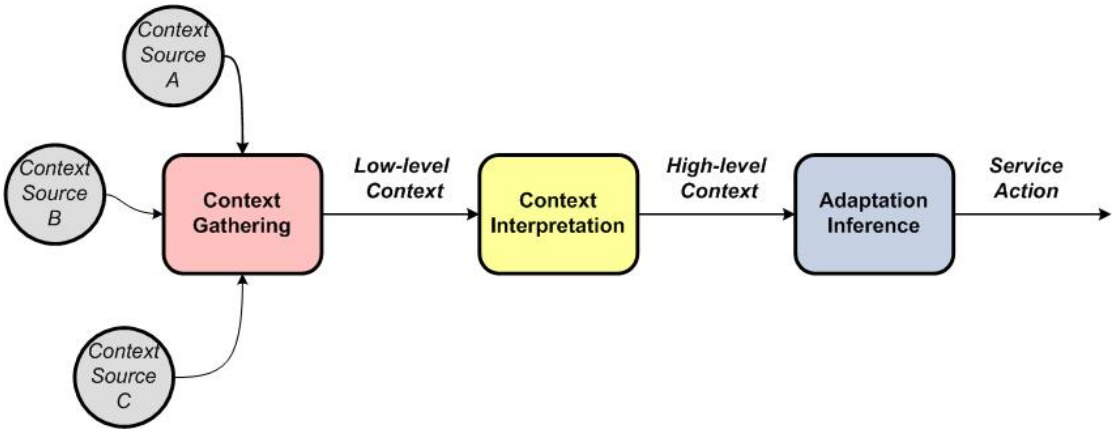


Figure 5-1 Basic Context Awareness Process

5.2.1 Context Gathering

Context gathering refers to gathering raw contextual data from different context sources, which are either the end user’s devices or network elements. The gathering approach can be

via sensors, user input and system processing. Examples of context gathering approach are listed in Table 5-1.

Table 5-1 Examples of context gathering approach

Type of context	Gathering approach
location	cell ID, GPS coordinates
time	system synchronization
user preference	user input or system inference based historical record
user mood	user input
weather	system reasoning based on specific location information

Sensor data may be vague or incorrect so that it can not be applied without any adjustment.

5.2.2 Context Interpretation

Context interpretation means derive higher-level conceptual context from the gathered low-level contextual data. The aim of this interpretation process is to supply the application or service layer with a fully fledged context representation. Table 5-2 shows the relationship between low-level and high-level context for spatial and temporal contexts.

Table 5-2 Relationship between low-level and high-level context

	Spatial	Temporal
Low Level	Cell id	Date and time
High Level	Conceptional location (eg.at home)	Conceptional period of time (eg. mornings on weekend)

A situation is described by a context, which is an instance of the contextual information available . Thus, the context model here is to represent the current usage situation. In view of the electronic service guide service, correlative contextual information could include spatial context, temporal context and personal context.…

For example, if a situation is that a sports fan would like to watch mobile TV while she is waiting for the bus in the morning, the corresponding context descriptions can be:

- location: commuting
- time: 8:30
- userpreference: sports

5.2.3 Adaptation Inference

Adaptation inference is reasoning potentially useful service adaptations from the higher-level context obtained from the interpretation process.

Usually, reasoning paradigms are deployed in this inference process, which could be roughly divided into two major parts: Knowledge representation (KR) methods and predictive models. [21][46]

The KR methods normally cover:

- Traditional expert systems like rule-based reasoning (e.g. rule-based inference engines)
- Logic-based systems (e.g. ontology-based inference)

Predictive models include:

- Probabilistic reasoning such as statistical machine learning techniques (e.g. rule induction, neural networks, and Bayesian networks)
- Machine learning by model-based reasoning, e.g. models for the automatic classification and/or prediction of context patterns

In reality, most work related to context-dependent adaptation inference has been focused on KR methods. From technical point of view, KR methods are relatively simpler to realize compared their counterparts—predictive models. For instance, one common approach using static rules is usually handcrafted and provided by the application designer. However, major drawbacks of KR methods were summarized by researchers: the first is the techniques are lack of ability to successfully manage uncertainty and the second is KR methods usually find difficulties in generalizing their performance, such as to cope with previously unseen situations. [46]

5.3 Technical Requirements Implications

The above discussions implicate that the technical requirements of ESG could be summarized as:

- A unified standardized metadata schema for describing content and user profiles is

required. The metadata should also consider semantic richness of content description in order to achieve personalization.

- For context description, different entities should share the common context representation, inference and reasoning mechanisms.
- Intelligent context-aware techniques could be employed for realizing context-aware media selection

6 A case study of DR - from broadcaster's perspective

This chapter is based on information gained from interviews with Peter Looms and Peter Mølsted from DR and supplemented with internal DR documents provided by them. The interviews were recorded and selectively transcribed as inputs for this chapter.

The key purpose of this case study is to understand the broadcaster's needs and constraints in terms of the ESG delivery for Mobile TV.

6.1 Introduction to DR

Danmarks Radio (DR), founded in 1925, is the largest public service broadcaster in Denmark. With the aim of informing, educating and entertaining the public, DR's services cover about 92-93% of the Danish population. It runs two television channels, which are DR1 and DR2. For radio, DR has four nationwide FM radio stations, 14 Digital Audio Broadcast (DAB) stations and 13 additional web radio stations. It also has an extensive website called dr.dk and a version of which is accessible via mobile phone, which accounts for about 20% of mobile

content service in Denmark.

DR is funded by a “media license”, whose former counterpart was a “television and radio license” until then end of 2005. DR’s vision has moved from radio and TV to general public service media and services in any form and on any platforms, as long as it complies with the public service contract with the Ministry of Culture. Thus, a proper provision of content on mobile platform certainly accords with DR’s public service remit.

6.2 Metadata Deployment for Current Services

Several information services operated by DR and their metadata deployment status will be inspected with details separately:

DTT
At the moment, the delivery of program listings information on Digital Terrestrial Television (DTT) is via Master EPG, which is a central database updated from different sources and accessible from a standard gateway. Basic DVB-SI metadata including EIT, present and following and 7-day schedule are delivered. Currently, no DVB-SI genre information has been implemented in the transport stream due to the difficulty of defining the genres by those who currently input the metadata. In some cases, where this is done further down the value chain, there are mistakes when it is necessary to distinguish the programs for different age groups of children.

DAB and net radio
Since Danish survey results indicate that the radio audiences do not need program listing information for radio on the DAB radio receiver itself. Audiences say they just need information about what is being broadcast. As a result, there is no actual EPG available for radio apart from the one available on DR’s website www.dr.dk. The current runtime playlist information for DAB radio and net radio is automatically generated from the radio playout system, called DRLE. The playlist information will not be given out before the moment that the corresponding content is being broadcast. The PTY codes, the content categories for classifying radio channels originally developed for FM radio as part of the RDS (Radio Data System), have the potential for being reused as genres.

DR Ekstra
DR Ekstra is considered as the second generation of Tekst TV (Teletext). It contains program information both for TV and radio, international and national news headlines, weather information and sport information. About 700k of the transport stream is allocated to the

application, which is far away from cheap.

dr.dk

dr.dk is the content portal providing various services, for example, traffic advisories. It is offered in each of the radio regions that correspond broadly to political regions whose XML feeds describes buses, trains, metro, flights, road repairs and traffic accidents. The feeds are from Ritzau.

DR update

DR update is an internet TV channel, which is also broadcast on satellite. On the web, it provides the news loop and allow user to choose their desired items from the archive function. The RSS feeds associated with DR update programs consist of the title and synopsis information, which is created by manual inputs at the moment. In fact, DR is working with a system capable of coordinated and automated metadata generation, where an existing news management and editorial system can be used as a source. However, the current metadata for DR update does not contain any specific genre information.

Table 6-1 shows the summary of EPG metadata on at DR's different platforms.

Table 6-1 Metadata of program information on DR's own platforms

Service	EPG Metadata
DTT	Master EPG program information from "What's On" with live updates from AVS
DAB Radio	Playlist information
Tekst TV	"What's On"/Ritzau and manual editing
DR Ekstra	Same sources as Tekst TV
dr.dk	Ritzau
DR update	RSS feeds

6.3 Forecasting Mobile TV Services

Until now, DR has been actively involved into the DVB-H pilot projects cooperating closely with Technical University of Denmark and expected to be a major player in the newly emerging Mobile TV platform. In principle, the target audience group will cover the whole population in Denmark, with a special focus on the young audiences.

In terms of the services for use on mobile devices, DR's possible strategy will start by

building on its existing content brands at the early stage for economic reasons. To what extent will DR reuse the existing services has not yet been decided. To start with, the service package may contain two existing TV channels and several selected radio channels. DR update will definitely appear as candidates. An interesting but unclear area is user-generated content, which is considered to attract the 18-25 year old users as well. Other existing digital services like the traffic advisories and DR Ekstra are also interesting to be looked at.

For metadata, DR is making efforts to get it as standardized as possible to make it easier to repurpose content and metadata to power new services on the mobile delivery platform amongst others. TV-Anytime is likely to be the chosen standard, including the implementation of the TV-Anytime genres and descriptors such as intention and atmospherics. Although there are already genres in use internally, primarily in connection with checking DR's compliance with the public service agreement, there are arguments in favor of using the TV Anytime taxonomy for end-user related information services. The barriers include conservatism among editors and production staff, and the need to be able to comply with the contractual requirements mentioned earlier.

The adoption of the second phase of TV-Anytime standard being discussed by TV-Anytime Forum will introduce a range of advanced features, nevertheless, it will require changes of the network equipment and the updates for receivers. Thus, DR will be very cautious regarding a decision on phase two unless the commercial imperative for doing so is persuasive enough.

6.4 Practical Constraints from Broadcaster's Side

This case study obviously shows DR's enormous desire in delivering content to the mobile devices, which will definitely drive the wave of broadcast Mobile TV. Another finding of the case study is the broadcasters like DR are confronted with several inherent challenges before realizing the opportunity. These inherent challenges will also have a significant impact on the design of an ESG solution, especially under the circumstance that the chief part of the service package is broadcast content sourced from current broadcasters.

The provision of DR's existing two television channels is undoubted when selecting content for service packages. Other services may be also quite demanding on mobile TV platform but obtain more constraints compared to television services. For instance, according the author's opinion, traffic advisories in dr.dk would be a promising service on mobile devices. However, the information DR's delivering is from external traffic companies and only has region-related information without a direct location link. Advanced location-based features will rely on more detailed geographic verifying information, which is beyond DR's responsibility. Therefore,

consultations with other stakeholders in traffic information are essential.

It is known that interoperability is an important issue for designing ESG solution. However, there are barriers like the inherent bifurcation among staffs from different departments and regulatory issues slowing down the pace of the development of the interoperability. For example, when it comes to metadata, both interviewees from DR identified with the opinion that an open and unified standard is indispensably required, however, the reality is the current deployment of metadata of different DR's digital services are lack of uniformity, making it difficult to directly extract related information out from the stream when repurposing on mobile TV platform. The current metadata description of DR's digital services is also devoid of advanced richness despite basic information. Thus, it indeed takes a while for adopting a standard-based metadata framework, particularly in the sense of offering personalized services.

7 Summary of requirement specifications

The main objective of an ESG system is to provide the user with the most relevant content anytime based on his/her preferences as well as contexts to maximize the user's satisfaction and user experience.

The discussions in above chapters attempt to understand the user and technical requirements for designing an ideal ESG system. However, not all the fancy desired features could be implemented due to the practical barriers. There is always a trade-off during the real design work.

The following summary of requirement specifications is leveraged between the ideal features and the practical constraints:

- The ESG should be allow the end users to previously set their location information and user preferences. The location and preferences information should be stored on the server side to minimize the storage on the client.
- The end users should be able to retrieve context-aware program listings by implicitly sending out their current context.
- All the disposal of the context information should be conducted on the server side in

order to minimize the manipulation on the mobile devices.

- The server side of the ESG should be able to interpret the current context to high-level context and infer the corresponding adjustment of genre preferences value.
- The server side should be able to support efficient and accurate content filtering and return the result to the user.
- All the context related information should share a common context model, which enables describing both low level and high level context.
- The content description for programs should be TV-Anytime standard-based.
- The function of converting SI information extracted out of the current digital stream to TV-anytime compliant is required due to the needs of simulcasting existing digital channels.
- The genre dimensions for content description should be able to semantically rich enough in order to support efficient and accurate content filtering, meanwhile only a set of genre dimensions should be included considering the particle issues such as the broadcast bandwidth to consume.

It is noted that the design work in the subsequent chapter is based on the summary requirement specifications.

8 Design

8.1 System Overview

The proposed solution provides a unified framework enabling customized ESG delivery within converged digital broadcast and 3G environments. In principle, every service provider, metadata aggregator, network operator or even mobile device manufacturer can implement their own ESG, which will be confusing to the end users. Since multiple sources of services and content will emerge in the future mobile TV services, it would be better that the ESG system is operated by the service provider to avoid divergence and overlapping. Therefore, the ESG solution proposed is on the premise that service provider will provide the ESG.

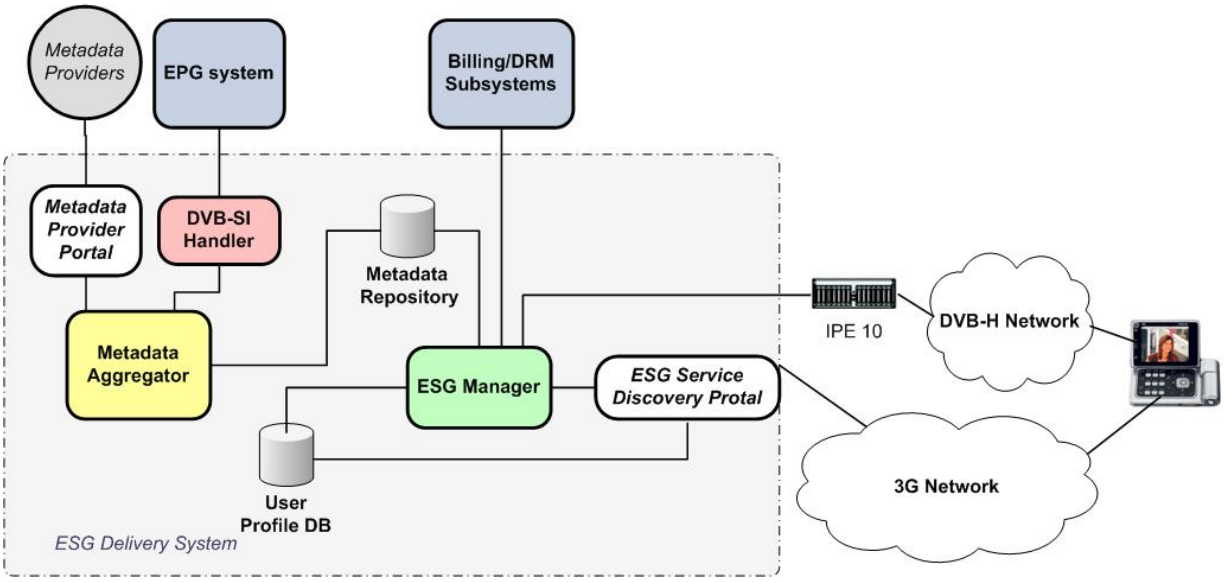


Figure 8-1 Overall Architecture

Figure 8-1 illustrates the overall architecture of the ESG delivery system proposed in this project. Generally speaking, the functionalities facilitated by the proposed solution can be split into three parts: metadata management, user profile management, ESG discovery and delivery, which will be clarified in the following sections with details of their essence and supporting components.

8.2 Metadata Management

Metadata Management enables gathering the real-time feeds of live EPG information by *DVB-SI Handler* as well as uploaded feeds from external metadata providers via *Metadata Provider Portal*. It also enables metadata aggregation and validation based on standardized data models by *Metadata Aggregator* and metadata storage in *Metadata Repository*.

Details of each component within the metadata managements are:

- *Metadata Provider Portal* facilitates metadata submission from the external metadata providers. The portal provides a simple web-based interface, via which metadata providers can upload, update or delete the metadata.
- *DVB-SI handler* retrieves the DVB-SI information from the connected EPG system and transforms it to XML-based data for further processing.
- *Metadata Aggregator* aggregates the metadata from different sources. All ingested

sources will be transformed into standard-based DVB IPDC ESG formats, in which TV Anytime will be adopted for content description due to its semantic richness. Slight modifications on the metadata may also occur if it is not based on the schema. After final validation, it will upload the metadata to *metadata repository.*

- *Metadata Repository* stores the ESG metadata generated by *Metadata Aggregator.*

8.3 User Profile Management

User Profile Management enables storage of user information including user preferences and user contexts log in *User Profile DB.*

User Profile DB connects with *ESG Manager* to support user-related information for personalizing ESG services. This user-related information is gathered from the end-user by linking to *ESG Service Discovery Portal* via 3G network.

8.4 ESG Discovery and Delivery

The ESG can be pulled by *ESG Discovery Portal* via 3G networks. It should also integrate the function of broadcasting ESG using the FLUTE IP carousel via DVB-H network. The design in this project will mainly address the issue of pulling ESG via 3G networks since personalization is the major focus.

- ESG Discovery Portal provides the end users with access to ESG services via 3G networks.
- ESG Manager acts as a key component in the ESG delivery system responsible of generating and delivering the ESG containing the program listing for general broadcasting purpose as well as the tailored version according to the user preferences and contexts. For creating the personalized version, it gets the ESG metadata by connecting with Metadata Repository and retrieves user profiles from User Profile DB. ESG Manager also attaches to the billing or DRM subsystem to acquire necessary user subscription and digital right information.

8.4.1 Personalized ESG Generation Flow

Concerning personalized ESG delivery via 3G networks, the key functionality of *ESG*

Manager is to filter content based on user preferences and context. Figure 8-2 shows the basic flows of how to personalize ESG. The steps of the flow can be summarized as:

1. The *ESG manager* gets the request message for retrieving program listing from the mobile client and fetches the user's current cell id inside the message.
2. The *ESG manger* decides the user's current conceptional location by comparing the current cell id with the user's pre-stored cell id records in User Profile DB. Meanwhile, the *ESG manger* gets the use's pre-stored genre preferences information as well.
3. The *ESG manger* infers the current situation according to current conceptional location and system time.
4. The *ESG manager* adjusts the genre preference value.
5. The *ESG manager* filters the recommended program listing based on an algorithm, which will be stated later.

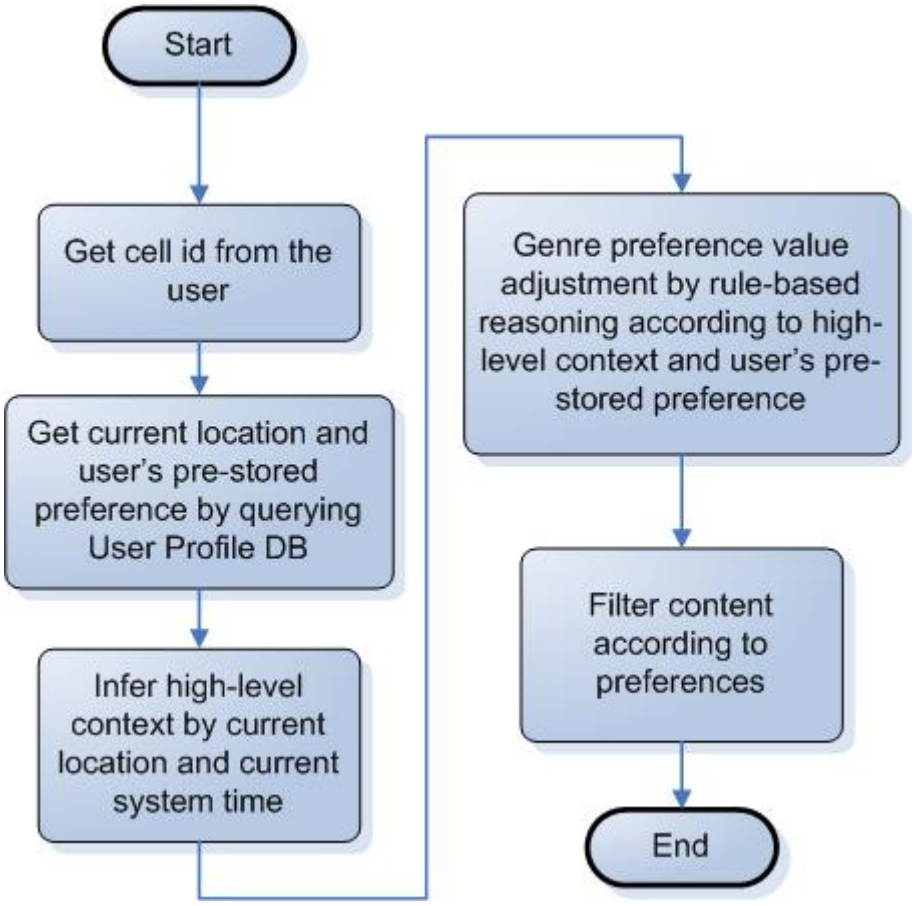


Figure 8-2 Basic Flow of Personalizing ESG

8.4.2 Context Data Model

An open context model needs to be in place for describing the contextual information. Figure 8-3 demonstrates a top-level taxonomy for context. All user generated contextual information (location and user preference) along with the system generated context (time) are required to be described based on the proposed context hierarchy.

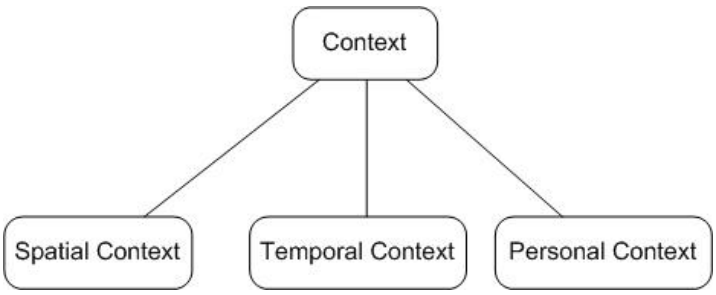


Figure 8-3 Top-level taxonomy for context (inspired by [45])

8.4.3 Rule-based Reasoning

Static rule-based reasoning is applied here to decide how to leverage the user preference and the current context. Rule-based reasoning is a particular type of reasoning which uses “if-then-else statements”. The "if" means "when the condition is true," the "then" means "take action A" and the "else" means "when the condition is not true take action B."

Referring to this project, the “rule” could be if a certain high-level context is true, then the value of its corresponding TV-Anytime genres will be raised up.

The static rules deployed in this design are based on the summary in Chapter 4 (see Table 4-1 and Table 4-2) after analyzing the end users’ requirements. From the design’s perspective, the summary should be translated into technical mappings between high-level context and TV-Anytime Genres are listed in Table 8-1. In this table, the genre names formatted TV-Anytime and their Classification Schemes (CS) accord with TV-Anytime Metadata specification.

Table 8-1 Mapping between high-level context and TV-Anytime genre names

High-level Context		Genre Name in TV-anytime Format	Genre Dimension CS
Time	**Location**		
Morning during weekdays Mon-Fri	Home	Weather forecasts	ContentCS
		Daily news	ContentCS
		Bulletin	FormatCS
Evening during weekdays Mon-Thu	Home	ENTERTAIN	IntentionCS
Weekends Fri evening to Sun evening	Home	ENTERTAIN	IntentionCS
		EDUCATE	FormatCS
Random	On the move	Radio	ContentCS
		Music	ContentCS
Random	On the move	Event	FormatCS
		ENTERTAIN	IntentionCS
Noon during weekdays	At work/ School	Daily news	ContentCS
		Bulletin	ContentCS
		SPORTS or Sports	ContentCS
Other time except noon during weekdays	At work/ School	Background music	ContentCS
		ENTERTAIN	IntentionCS

8.4.4 Content Filtering

The purpose of content filtering is to tailor the desired content based on the genre preference after adjustment by rule-based reasoning. Specifically, the aim of the content filtering algorithm is to filter programs whose genre descriptions have the higher similarity to the genre model in the user preference.

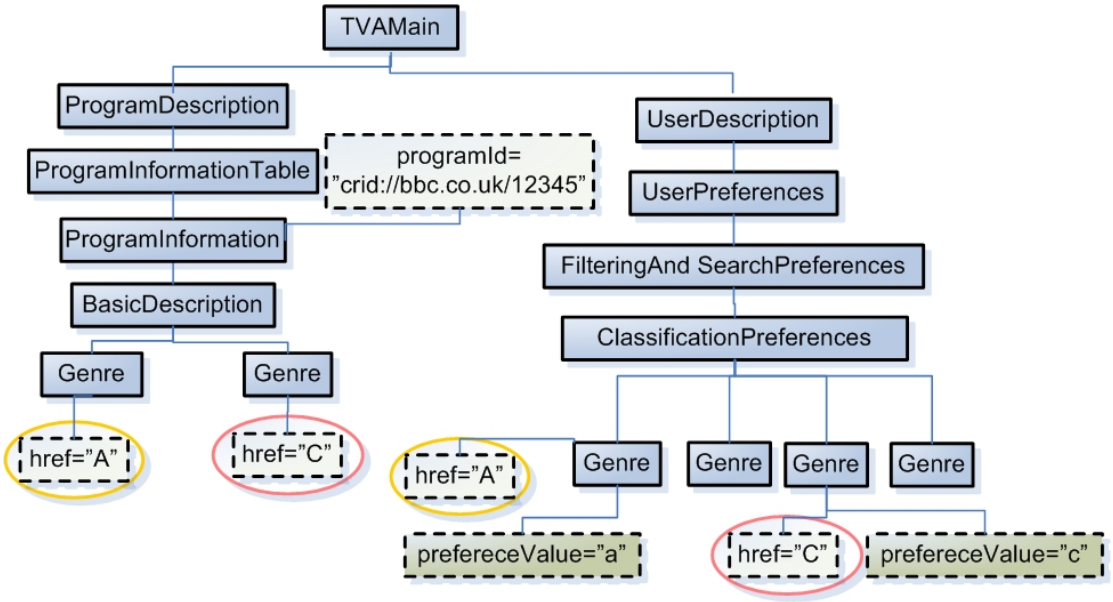
The content and user genre preferences should follow TV-Anytime Phase 1 standard. Multiple genre dimensions can be utilized for content description. Not all genre dimensions will be distributed among describing content. Dimension set could include ContentCS, IntentionCS, FormatsCS and AtmosphereCS.

Content filtering could be done by using XSLT transformation for matching and selecting elements and attributes using template constructs combined with XPath conditional predicate expressions. Within XSLT systlesheet, a certain inherent algorithm will be applied. The basis of the proposed algorithm is to filter programs whose genre descriptions have the higher

similarity to the genre model in the user preference.

The algorithm is interpreted in the following two steps:

- The first step is to calculate the score of each program in database according to the genre mapping between the content description and user preference. Figure 8-4 explains the fundamental basis of how to calculate the score of a certain program. The calculation process is to count a Genre's **preferenceValue** in **UserPreferences** into the total score only if this Genre is also used to describe the **ProgramInfomation**.
- The second step of the algorithm is to sort the programs by their scores in order to filter the desired recommendable programs.



The score of the program which programId="crid://bbc.co.uk/12345" should be "a+c"

Figure 8-4 Basic theory of how to calculate the score of a program

8.5 UML Modeling

The purpose of this section is to explain how the proposed system works by modeling use cases and system sequence diagrams. Use cases and system sequence diagrams are included in functional requirements. The term of "functional requirements" is to understand what the system performs. More specifically, they describe the inputs and outputs, and how it is that specific inputs are converted to specific outputs at various times. [33] The functional

requirements for the design in this thesis are explained in concordance with the UML diagramming standard as defined by Rumbaugh, Jacobson and Booch (1997).

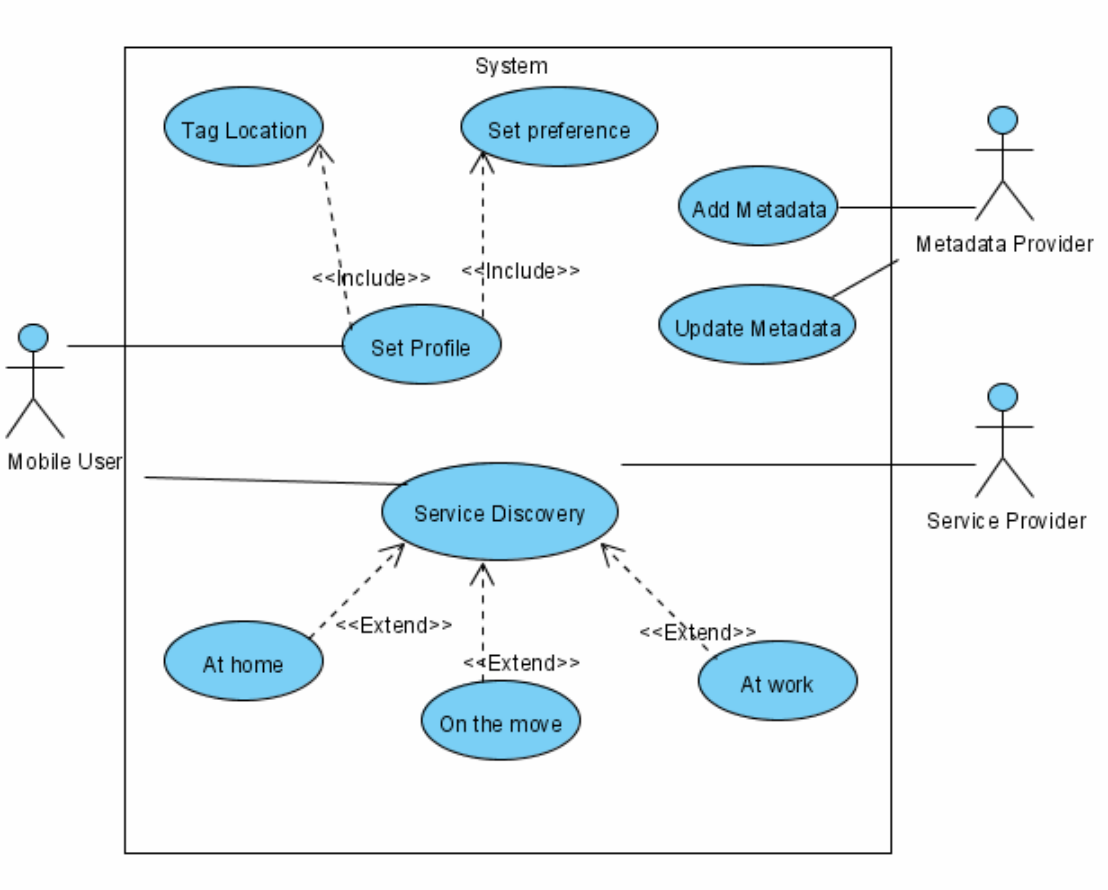


Figure 8-5 Use Cases Diagram

Utilizing the technique of modeling use cases assists to capture a set of typical scenarios of using the system. Each well-refined use case explicitly describes how the actor interacts with the system to achieve a specific goal. The use case diagram of the proposed ESG delivery system for this project is portrayed in Figure 8-5.

Since the design in this project emphasizes on the part of how to realize personalizing ESG based on contexts and preferences, the detailed descriptions and sequence diagrams of use cases of “Set Profile” and “Service Discovery” are documented in the subsections. The purpose of drawing sequence diagrams is to illustrate how objects interact via messages.

8.5.1 Tag Location and Set Preference

The use case called "Set Profile" consists of two scenarios: "Tag Location" and "Set Preference". The detailed information of these scenarios is given out in Table 8-2 and Table 8-3. Following the use case description, sequence diagrams are provided in Figure 8-6 and Figure 8-7.

Table 8-2 Tag Location Use case

Use case name	Tag Location
Actor	Mobile User
Brief Description	This use case prescribes the way in which the mobile user can tag their current location
Flow of Events	(1) The mobile user chooses "Profiles" category (2) The mobile user enters the "Tag location" (3) The system promotes a list with several choices of location names to the mobile user (4) The mobile user select one location name from the list and press "OK" (5) The system sends successful notifications
Alternative Flow of Events	At any time during the flow, the mobile user can press "Exit" to terminate the action and go back to the main menu
Pre-Conditions	The client application running on the mobile user's handheld must be initialized
Post-Conditions	The current cell ID bound with the location name selected by the mobile user and his/her user id are saved by the system

Table 8-3 Set Preference Use case

Use case name	Set Preference
Actor	Mobile User
Brief Description	This use case prescribes the way in which the mobile user sets preference of the genre of the services.
Flow of Events	(1) The mobile user chooses "Profiles" category. (2) The mobile user enters the "Set Preference". (3) The system promotes a list of service genres for the mobile user to choose from. (4) The mobile user selects one or multiple choices and press "Update". (5) The system sends successful notifications.

Alternative Flow of Events	At any time during the flow, the mobile user can press “Exit” to terminate the action and go back to the main menu.
Pre-Conditions	The client application running on the mobile user’s handheld must be initialized.
Post-Conditions	The selected user preferences bound with the mobile user’s user id are saved by the system.

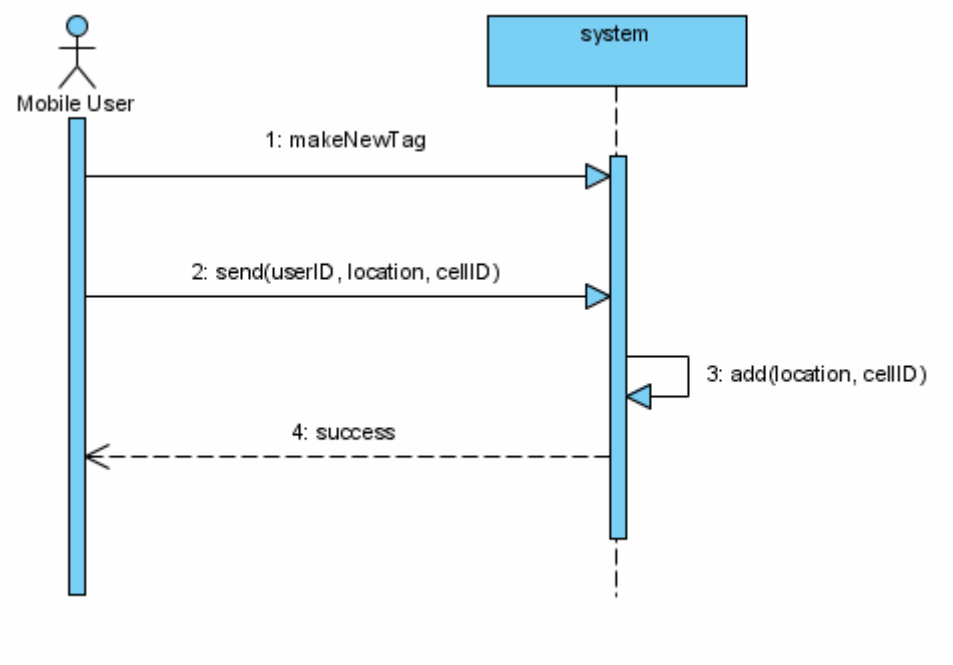


Figure 8-6 System sequence diagram of setting new location

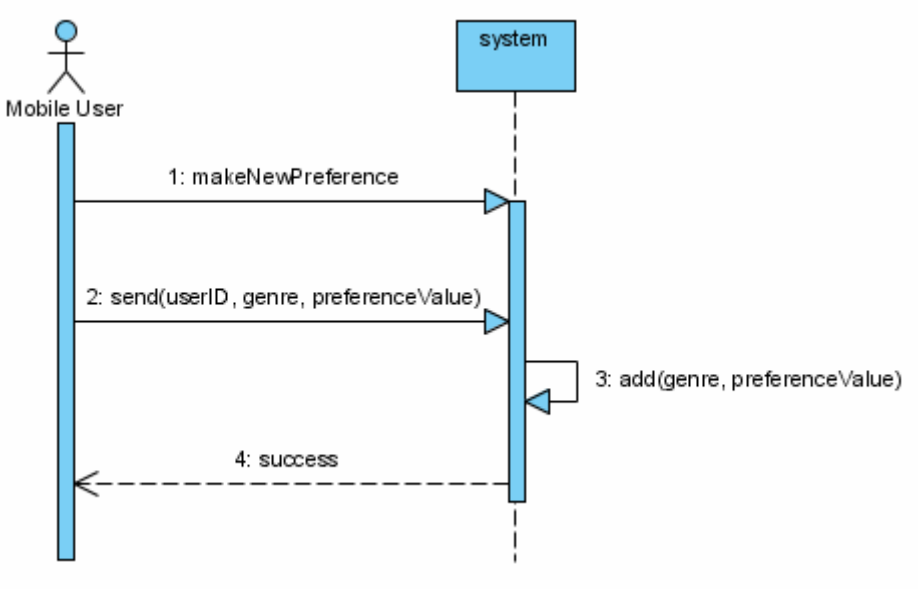


Figure 8-7 System sequence diagram of setting genre preference

8.5.2 Service Discovery

"Service Discovery" is a major use case that the user automatically discovers the ESG service. Details are described in Table 8-4. The sequence diagram of service discovery is provided in Figure 8-8.

Table 8-4 Service Discovery Use case

Use case name	Service Discovery
Actor	Mobile User and Service provider
Brief Description	This use case prescribes the way in which the mobile user automatically discovery the personalized program listing based on their current cell id and time.
Flow of Events	(1) The mobile user chooses "ESG" category. (2) The mobile user selects the "Retrieve myESG" option. (3) The client sends the mobile user's current cell id to the system. (4) The system decides the user's current high-level context according to the cell id and system time (5) The system adjusts genre preferences based on the high-level context.

	(6) The system generates the program listing based on the new genre preferences value. (7) The system delivers the program listing to the client application. (8) The client application parses the program listing and displays it on screen.
Alternative Flow of Events	At any time during the flow, the mobile user can press “Exit” to terminate the action and go back to the main menu.
Pre-Conditions	The client application running on the mobile user’s handheld must be initialized.
Post-Conditions	The mobile user will navigate the program listing and choose the program he/she wants.

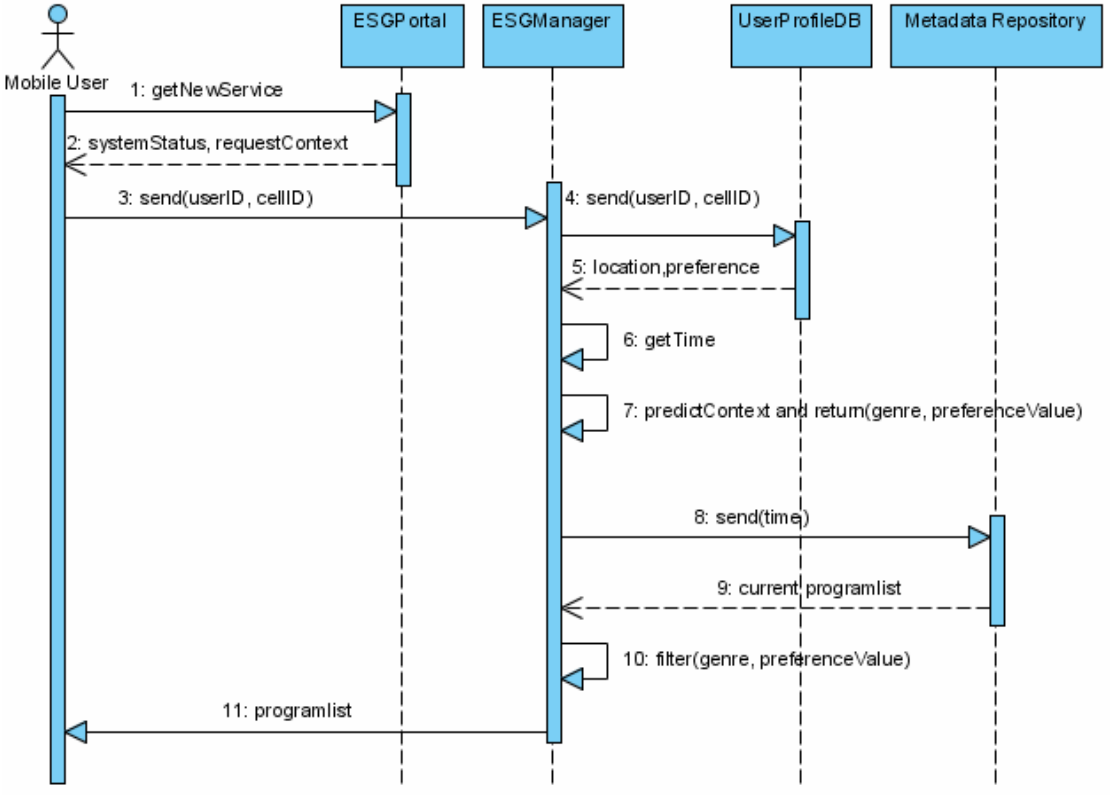


Figure 8-8 System sequence diagram of ESG Service discovery

9 Prototype Implementation

The prototypes implemented in this project were based on the proposed design in Chapter 8. The architecture of the prototype is shown in Figure 9-1.

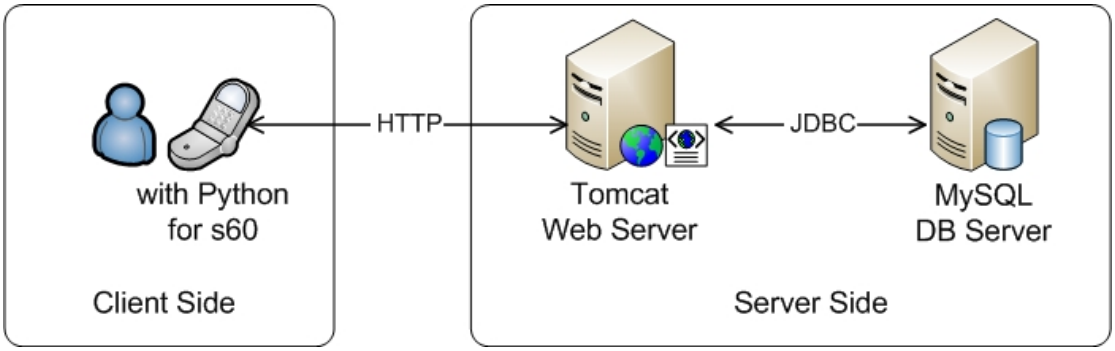


Figure 9-1 Architecture of the prototype

Not all in the design proposal have been implemented. Following is a brief summary of what parts have been implemented during the project and details will be provided in each subsection in this chapter:

- Mobile client has been prototyped using Python for S60. Functions realized include

interface, setting location and genre preferences, automatic program listing retrieval.

- User profile DB has been implemented using MySQL.
- A JSP web application has been deployed on the Apache Tomcat server
- The context data model has been produced by creating XSD Schema.
- Content Filtering has been partially prototyped by designing XSLT stylesheet.

9.1 Mobile Client

The client is based on Symbian OS platform for current 3rd edition device-Nokia N92. Python for S60 is chosen for implementing the client side due to its predominance in rapid prototype development.

9.1.1 Interface

In this project, the high level UI components in the built-in “appuifw” module are used to develop the user interface.

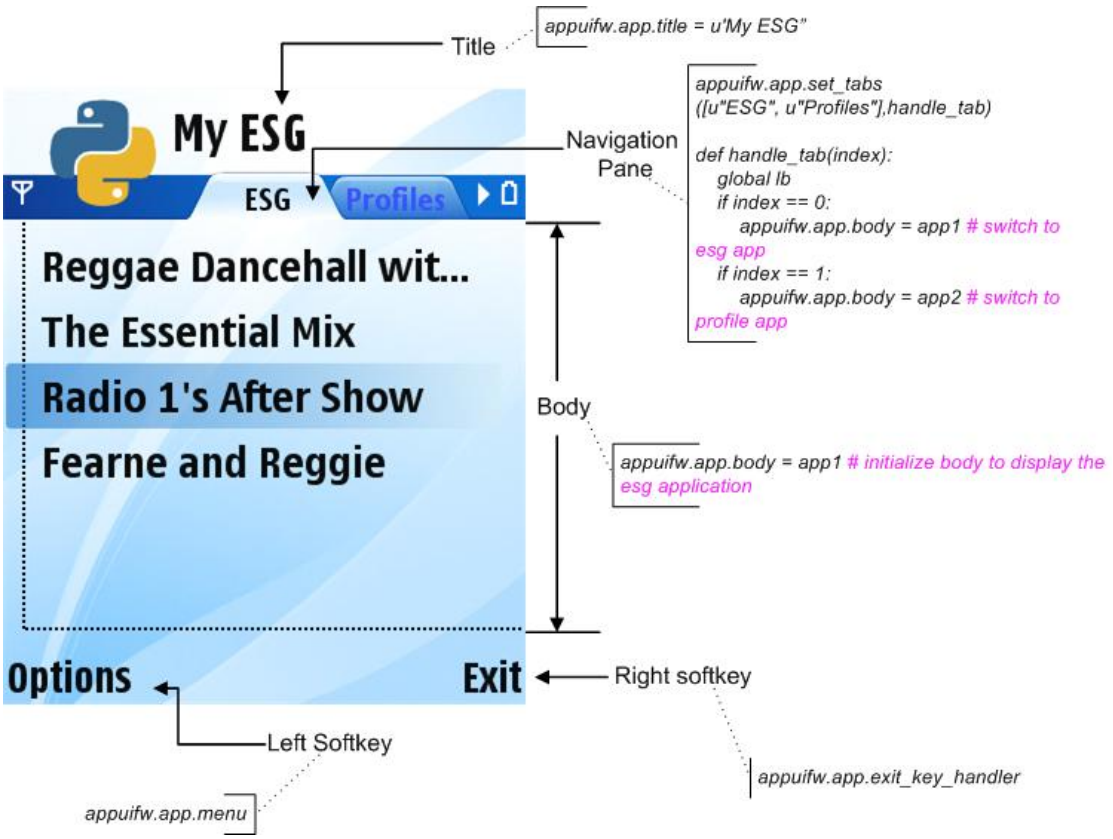


Figure 9-2 Overview of Interface

An overview of the client interface and its supporting models is presented in Figure 9-2. The tab bar is activated for switching between the applications, which are retrieving programming listing (called ”ESG”) and setting user profile (called “Profiles”). Each time when the user loads the application, the body area will initialize the “ESG” application.

9.1.2 Setting for user profile

9.1.2.1Context Data Model based on XSD Schema

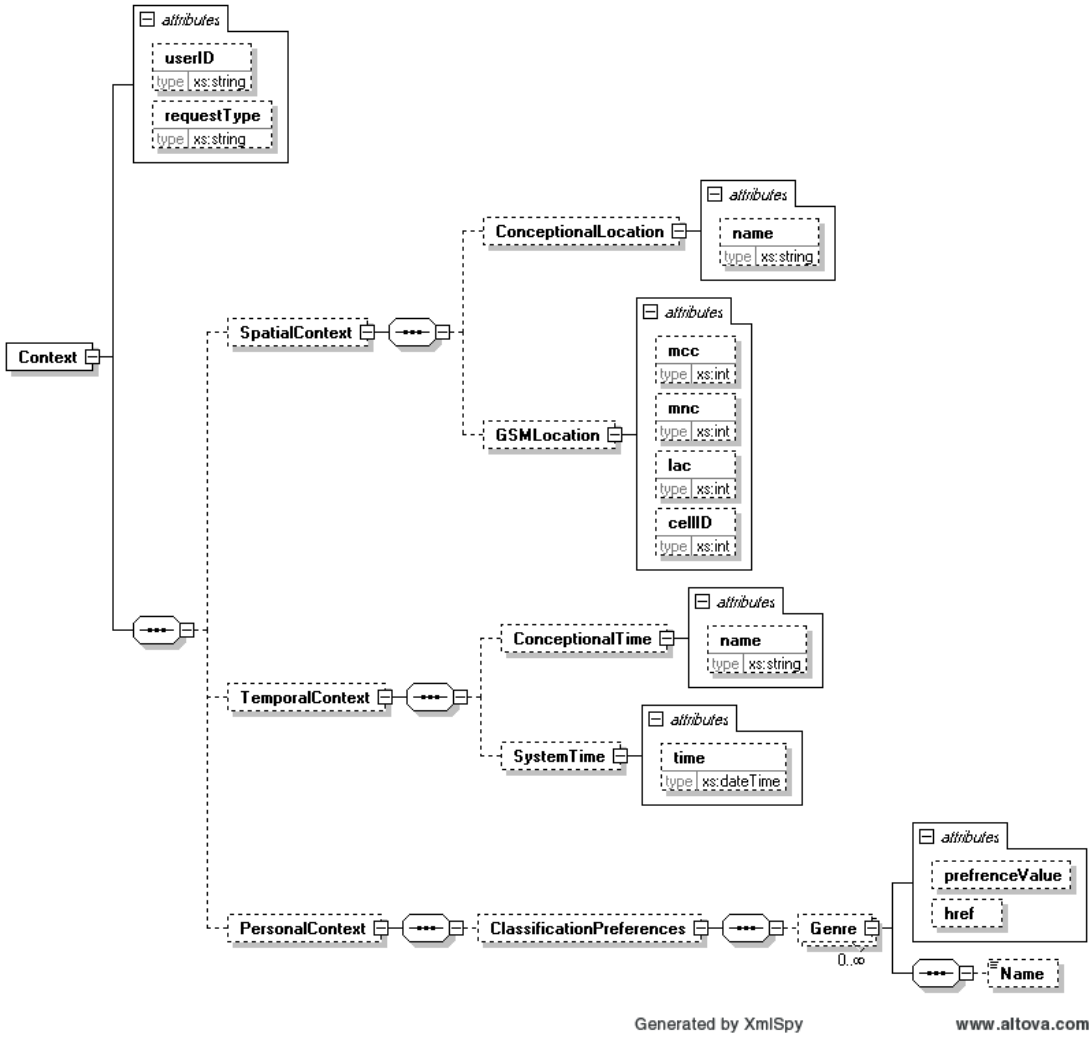


Figure 9-3 Context Data Model

The XSD schema is implemented using Altova's XmlSpy tool based on the context hierarchy proposed in Section 8.1.3. The tree diagram is presented in Figure 9-3. **Context** elements have three children, which are **SpatialContext**, **TemporalContext** and **PersonalContext.** Both **SpatialContext** and **TemporalContext** are interpreted by low-level and high level descriptions. For instance, **GSMLocation**, who is the child of **SpatialContext**, has MCC (Mobile Country Code), MNC (Mobile Network Code), LAC (Location Area Code), and

cellid (Cell ID) for indicating the low level location context. Another child of **SpatialContext** called **ConceptionalLocation** is to present high level location, whose attribute ***name*** will be assigned as “Home”, “Office” or “On the move”.

It is noticeable that the **ClassificationPreferences** in TV-Anytime is imported for the purpose of describing **PersonalContext**, which enables the end user to set the genre preferences.

9.1.2.2GSM Location Retrieval Function

The GSM location can be retrieved by importing the location model. This function is realized by the following codes.

```
import location
def get_current_location():
    #mcc = Mobile Country Code
    #mnc = Mobile Network Code
    #lac = Location Area Code
    #cellid = Cell Id
    mcc, mnc, lac, cellid = location.gsm_location()
    return mcc, mnc, lac, cellid
```

Sample location information gathered during the project is: MCC: 238, MNC: 2, LAC: 94, Cell id: 13211.

9.1.2.3XML creation

The user location and preference information from the user will be stored in XML format and then delivered to the server for further processing.

The modules of xml.dom and xml.dom.minidom (from xml.dom.minidom import Document) are imported for the purpose of generating XML files. Document Object Model (DOM), a standard tree representation for XML data, is a cross-language API from the World Wide Web Consortium (W3C) for accessing and modifying XML documents. The “Document”, an object in DOM, represents an entire XML document, including its constituent elements, attributes, and comments etc. In addition, the toprettyxml() method in xml.dom.minidom facilitates the exporting of XML document to file.

```
def create_loction_xml(loc):
    global doc
    doc = Document()
    #create root element context
    global context
    context = doc.createElement(u"Context")
    doc.appendChild(context)
    context.setAttribute(“requestType”,u”tagLocation”)
    #create element "Spatial Context"
    spatial_context = doc.createElement(u"SpatialContext")
    context.appendChild(spatial_context)
    #high-level location
    current_location = doc.createElement(u"CurrentLocation")
    spatial_context.appendChild(current_location)
    current_location.setAttribute("name",loc)

    #get current location and write to xml
    mcc1, mnc1, lac1, cellid1 = get_current_location()
    gsm_location = doc.createElement(u"GSMLocation")
    gsm_location.setAttribute("mcc",unicode(mcc1))
    gsm_location.setAttribute("mnc",unicode(mnc1))
    gsm_location.setAttribute("lac",unicode(lac1))
    gsm_location.setAttribute("cellID",unicode(cellid1))
    spatial_context.appendChild(gsm_location)
    test1 = doc.toprettyxml()
    xmlname = u"e:\\python\\cellid.xml"
    file_object = open(xmlname, "w")
    file_object.write(test1)
    file_object.close
```

9.1.3 Automatic Program Listing Retrieval

The following steps on the client side concerning automatic program listing retrieval have been fulfilled:

1. Generate XML file containing current cell id upon request.

The creation of XML files is similar to what has been discussed in Section 9.1.2.3. Iterative explanation is not provided here.

2. Parse the XML file containing program information returned from the server.
The XML parsing is realized by using DOM API as well.

```
xmlname1 = u"c:\\python\\content.xml"
xmldoc =  minidom.parse(xmlname1)
```

3. Get program information from the XML file and display the title on screen.

```
L1 = []

def handler_L1():
    index = app1.current()
    print index
    print L1[index]

for number in range(4):
    title1 = get_program_title(number)
    synopsis1 = get_program_synopsis(number)
    crid = get_program_id(number)
    print title1
    L1.append(title1)

app1 = appuifw.Listbox(L1, handler_L1)
```

9.2 Server side

Due to the time limitation, only a small part of server side was implemented.

9.2.1 User profile database

A MySQL database named *MyESG* is built to keep the information of user profile and genre preference. There are two separated tables in *MyESG* database. One table is called *userprofile*

whose structure is shown in Table 9-1. It stored the user identity and location data, which can be used together to determine whether the user is at home/work or not. The mapping of location data onto each user is not unique and it can be added or changed by executing an INSERT or an UPDATE SQL statement to the database server. *User_id* is indexed to help the query run faster.

Table 9-1 The MySQL table definition of *userprofile* table

Database: myesg Table: myesg.userprofile			
Field Name	**Type**	**Length**	**Description**
user_id	unsigned int not null	4 bytes	user ID
home_lac	unsigned int	4 bytes	location area code for home
home_cell	unsigned int	4 bytes	cell ID for home
office_lac	unsigned int	4 bytes	location area code for the office
office_cell	unsigned int	4 bytes	cell ID for the office
Index Column = `user_id` Index Type: BTree Engine = MyISAM Default Charset = latin1			

Another table in *MyESG* is *genre*, which is structured as Table 9-2. It stores the user identity and the user preference for eight kinds of genres. The user preference is measured in a quite simple way; it can only be interested or uninterested, like a Boolean value. *User_id* is defined as a primary key to secure that *user_id* is unique in the table.

Table 9-2 The MySQL table definition of *genre* table

Database: myesg Table: myesg.genre			
Field Name	**Type**	**Length**	**Description**
user_id	unsigned int not null	4 bytes	user ID
news	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
entertainment	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
sports	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
weather	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
music	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
radio	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
series	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
educate	unsigned tinyint	1 byte	genre; 0: uninterested, others: interested
Index Column = `user_id`(Primary Key) Index Type: BTree Engine = MyISAM Default Charset = latin1			

Appendix B.1 provides with more detailed SQL Statement.

9.2.2 Web Server

A JSP web application has been deployed on the Apache Tomcat server. The web server can receive HTTP request from the client, then it may query the MySQL database via JDBC connection, after that the client will get the query result in HTML format. The JSP web application also has the capability to run XLST to transform XML documents into other desired XML documents. However, this task is not accomplished in the project due to time limitations.

9.2.3 XLST stylesheet

As mentioned in Section 8.4.4, by using XSLT, desirable content can be filtered according to profiles by selecting matching XML nodes from the TV-Anytime content and user branches which are output as personalized result trees.

Due to the limitation of time, this project only attempts to design a simple XLST stylesheet, which just gives an idea of how to filter the content according to user preferences. The broadcast metadata testing file is from BBC Backstage and user preference is manually created by the author. The XLST stylesheet is intended to filter **title** and **synopsis** in **ProgramInformation** matching the genre preference stored in the **UserPreference.** The full XSLT stylesheet could be found in Appendix B2.

10 Discussion and Future Work

The chapter contains two sub-chapters. The discussion part will provide a reflection of some important issues considered throughout the previous design work and furthermore give out a proposal of what should be done at different adoption phases.

10.1 Discussion

There is no doubt that Mobile TV will be accessible in the near future. Although a dazzling vision of personalizing ESG for Mobile TV service is foreseen in this thesis, challenges are still ahead.

The previous chapters have reviewed different factors affecting the design of the ESG solution. During the design phase, there are two main trade-offs to be taken into account. The first trade- off is between requirements and business risks. For The second trade-off between user expectations and technological feasibility, that is, user demands sometimes make demands beyond what is technically realistic at the present time. On the other hand, not everything that is technologically feasible needs to be realized, especially at the starting period.

When the solution moves beyond the conceptual phase, the two trade-offs are required to be leveraged as well. The ultimate goal of MyESG solution is to bring rich media to the end users and let them discover it. However, to achieve an optimal balance, some of the issues could be introduced in phases when actual adoption is planned.

In the author's opinion, the adoption of MyESG solution should be done in two different phases: the initial and later phase. Aspects to be looked at include:

(1) In general what content the consumer will embrace?
(2) What TV-anytime genre dimensions should be implemented?
(3) How complex should the context model be?
(4) What content filtering technique should be applied?

Table 10-1 shows what should be done in the various phases. Basically, the initial phase will try to stick to the "need-to-have" features. At the starting period, a majority of users will not find all the services attractive, with high turnover rates and highly complex applications. [15] The earlier adoption with simple but necessary features will be a good introductive paradigm for the end users to start with, allowing them to "learn" about the service progressively. Later on, more advanced application with higher complexity could be provided to achieve higher enhancement of their Mobile TV experience. This step-by-step approach has been done most successfully in digital television by Sky in the UK market, according to Looms and Mølsted.

Table 10-1 Adoption suggestions at different phases

		Phases	
		Initial	**Later**
Aspects	**Content Packages**	Simulcasting existing TV channels and several popular radio service along with weather and traffic related services will be an initial package	More content or services tailored especially for Mobile TV can be added into the existing content package.
	Genre Dimension Set	IntentionCS, ContentCS and FormatCS	AtmosphereCS will be added
	Context Model	The context model implemented in Section 9.1.2.1	The context of "mood" will be added into the context model

	Content Filtering Technique	Simple technique will be implemented for fast content filtering.	More advanced technique could be applied in order to enhance the accuracy of the content filtering.

10.2 Future Work

The whole area is vast and obviously a lot of work remains to be done in the future.

Possible areas for future work are provided in the following listing:

- Conducting more in-depth analysis of user requirements. Taking culture influences into consideration, the service provider should carry out a detailed end users analysis with a more precise focus on the regional users. Thus, Regional quantitative user surveys could be conducted.
- The area of user generated content could be are very interesting area to be looked at, which has recently become a hot topic in the industry.
- More sophisticated recommendation techniques can be investigated. Recommendation technique itself is another huge area to explore.
- Last, due to the rapid pace of the development in Mobile TV, this thesis may be become outdated quite quickly. Regular updates will be necessary as we get a better understand of the use of Mobile TV.

11 Conclusion

Throughout the above chapters, various aspects of personalized ESG systems have been explored. This chapter presents the summary of the overall findings of the study.

The major challenge during the project was the complexity of the issue at hand, making it very difficult to give a complete overview that covers all possible angles of personalized ESG. There are indeed numerous issues to be looked at and sometimes it is easily to get lost. During the whole project, the author is constantly trying to narrow down the focuses by discussing with the supervisors.

Meanwhile, since ESG for Mobile TV is still a relatively nascent topic, firstly it is hard to target good materials on this subject and secondly free resources are even harder to find out. Another challenge was the lack of industrial experience of the author, which makes the task of designing solution more difficult. The solution can easily be impracticable. This was complemented by gathering first hand inputs from industry, for instance, by talking with the key staffs from DR. Meanwhile, at the early stage of the project, the author spent some time setting up fastESG server produced by Expway, which increase the author’s practical knowledge within this area.

Basically, from the author's point of view, the results completed throughout the thesis work are able to solve the problems proposed initially in the beginning. To conclude, during this project, the following achievements have been fulfilled:

- A business model for Mobile TV with a focus on broadcasters is proposed after conducting stakeholder analysis in content delivery value chain for Mobile TV.
- User analysis ranging from major drivers, user group, usage contexts and consumption patterns was performed, based on which user requirements of ESG are given out.
- Technical requirements are summarized after reviewing how to realize personalized ESG technically.
- A case study of DR was performed with a focus on DR's roadmap for rolling out Mobile TV and its current status regarding metadata deployment.
- A system architecture for providing personalized ESG delivery in converged digital broadcast and 3G environments is proposed and presented.
- Small prototypes are implemented to show the feasibility of the proposed design.

All in all, the overall study demonstrates that Mobile TV is more considered as personal viewing and there is a demand of personalized media selection. In addition, Mobile TV consumption pattern is different than the traditional TV viewing, requiring content to be tailored based on changing context as well. Proposed design should be able to leverage among the requirements, technical issues and practical concerns. The study also proves the feasibility of realizing personalization of ESG.

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Appendix A

A.1 Interview with Peter Looms

Xu: Hi Peter, could you please begin with a brief introduction to DR?

Peter: DR is a public service broadcaster, which is not a state TV, radio and media system, but which is something responsible to the public. It's not a governmental body, the same way you have in china. So it's an old institution going back to the 20's, which is originally radio in line with other public services broadcasting services in Europe. The main aspects we are doing are to inform, to educate and to entertain. There're discussions whether those are the original three. Perhaps it's to be a part of national identity, particularly in a small country like Denmark. So DR is an organization of just about three thousand people.3.5 billion Kroner. At the moment, DR has 2 TV channels, a news channel on internet with 2 more TV channels coming up. We also have four FM radio channels, about 16 DAB channels and another 10-15 internet radio channels. We have the largest content portal in Denmark called dr.dk and it accounts for about 20% of mobile content services in Denmark, with the services on GSM/GPRS and 3G.

Xu: Right now mobile TV seems to be a hot topic. Could you portray the current state of DR's research and development with this specific area?

Peter: Well, it goes further than just research and development. There's also strategy and policy. One of the important thing changed about a year and half ago was in the past we were funded by a "radio and television licenses", replaced by a "media license". So there's not only on TV sets and radio, but general media in any form and on any platforms, therefore it applies to computers, mobile phones. Obviously, if we say that it's public service on all these different platforms, then we also have to have a proper provision of content also on the mobile platform. That's the first dimension.

The second one is demographics. Until fairly recently, nearly everybody in Denmark used DR, between 92%-93% of the population, which means that the funding model of having a license is quite an efficient one. If everybody pays and uses it, it's much cheaper to do it in this way in pay-per-view or pay-per-use model. The problem is that number is declining, in particular the number of people aging 18-25 group using television has dropped significantly. Another fact is to use mobile phones to reach a specific demographic, to the users who are not using traditional platforms. Mobile phones are ubiquitous - that is everybody has one - especially for young people. They are seen primarily as communication devices not so much as media devices. We've seen mobile phone's developing in parallel with iPods, and iPhones.

The third element is the whole area of user generated content. If you go back thirty years ago, any kind of device for making media is expensive. Therefore, if not for other reasons than for economical ones, to make media tended to be made by few rather than many. Now the technologies make the costs low and many people can chose to make media and begin to do so. It's quite important for us as a part of our public service remit to look at how user-generated content links with centrally produced content.

The fourth dimension is the overall trends in which way the media is going to be consumed. In the past, TV viewing was very much decided by schedules and schedulers. So if you go 30 or 40 years back, people just turned on the TV set and they did the same for radio. Now the changes in life styles and expectations mean that we need to take convenience far more seriously. We have to look at the "anything, anytime and anywhere on any device" paradigm. People want to decide whant and when they want to watch TV. And what this translates into is quite dramatic trends. In fact in this year or last year, 99% of the consumption of television was when the programs were broadcast. In the next ten years, we will probably see in the figure that it will drop somewhere between 80%-90%. That means from having synchronous media consumption there is going to be a move to a mix of synchronous and asynchronous

consumption. Therefore there'll be a new challenge of profiling, customization, personalization. Suddenly there'll be an emphasis on metadata to let people to be able to discover content, which is described and accessible in some way. So either indirectly through descriptions or directly through something, for example pattern analysis for music or some visual analysis for videos.

Xu: What's the business goal for DR involving with mobile TV services as a role of public service provider?

Peter: If we were company, our goal would be fairly simple - to earn money. As a public service broadcaster, we normally know what our budget is. The short version would be to make effectively use of our budget to give the best public service for the money. But in line with what I was talking earlier, when it comes to mobile media, we know in general terms that it's important to have a presence of these platforms.

We don't need to earn money but our success criteria are reach and share. Reach is what proportion of population uses, what proportion of those mobile users makes use of something per week or per month. Share is about market, what proportion of those uses we have particular time of the day. We are expected to a major player also in this new platform, because if we don't, then the funding model we have will be undermined. If everybody has to pay but not everybody uses, then the non-users could quite reasonably ask why they are paying for something they're not using. When that number is very small it doesn't really matter, but when the number goes to between 15-20%of the people who have to pay a media license, then we come to a problem for the underlying business model of a media license.

Xu: What's your target group of your mobile TV services? You've mentioned traditional television tends to gradually lose the audiences aged between 18 and 25, does it indicate that your main target group is the youngsters?

Peter: In principle the whole population, but it doesn't mean every platform whether is digital terrestrial, cable, satellite, B2H, internet radio has to cover everybody. Together it has to offer something to everybody. So when it comes to mobile media, one of the major target audiences is the young, but it is not the only, exclusive audience.

Looking at it from another angle we do know from previous work that it is the news, weather, sports results and traffic advisers. They are not just broadcast media, but sometimes even text-based. These services fit in with people's life styles and therefore we also need to get the users interested in those services. We may provide some kind of notification system, perhaps an extension of our existing traffic services. And for those who subscribe sports results, it

makes a lot of sense to be able to push more specific results.

Xu: What's DR's position in terms of distributing mobile content?

Peter: Let's first take some examples for television. We've got analogue TV for another 2 years, digital terrestrial TV, digital satellite TV, two different operators. We have two major cable TV operators, the main big one-TDC, yousee and Telia Stofa. We have a number of IPTV services, which is very small but going up very fast. These are typically offered by electricity distribution companies.There are services running over ADSL. That's for television. Radio is the same. So for each value chain, that's from the rights holders all the way to the consumers. We normally present sometimes just rights holders, producing the content, commissioning content from third parties, aggregating channels means taking programs and packaging as channels. And the same applies for web and mobile services for aggregating services and talking to the third parties to aggregate our service to their platform. For digital terrestrial, we jointly own the transmission system for Mux 1 with TV2, so we have a control over the multiplexes and there will be another gate keeper running the other digital terrestrial muxes.

We are typically involved in a number of value chains for each particular media or service on a given platform. This means we need to have a production strategy, which allows us to produce things in a way can be delivered or transformed for multiple platforms. So we need a cope production platform. "Cope" senses for "create once, publish everywhere". If you take metadata, when you've got descriptions of your content, you should ideally have it in a form where you can parse it, translate it into a number of different forms, a number of different information products. They can be delivered along with the essence of the content. And the same goes for the content itself, you can't afford to have lots of parallel production lines producing essentially the same thing. You have to be able to look at how you can do concurrent production to produce different versions of the same programme in standard definition, in high definition, a version ready for streaming, also looking at the issues of access services like subtitles, deaf signing and audio description making things accessible to people who've got visual or hearing disabilities just the using remote control, something like that.
In terms of production and distribution strategies, COPE becomes quite important. Doing things so that you can repurpose, reuse, redeliver on multiple platforms， so you don't end up at spending more and more money just on delivering content.

Xu: I know that DR has been actively involved in several projects cooperating with CICT recently. Some details of the currently running project?

Peter: In DR's perspective, this is in line with what we did last year in phase 0 of the DVB-H work. We tried to look at what research and development we've been done, what we already know about the users and media primarily in Europe and also in other countries. It also highlighted various things we don't know enough about, like how people discover and use media in these three main contexts: work, on the move and home.

For two and half years, we'll work on a small DVB-H project to get some hands-on experience to find out what does it entail to provide TV channels or radio on DVB-H. But we'll also look at T-DMB.The standards will be decided on a European or national level.

Xu: So DVB-H is not yet a decision?

Peter: Actually we are concerned not very much with technologies but using them. The aim of this small project is to crawl, to walk and then to run. To get the basics in place-what is needed to encode and to distribute television radio channels, what it takes to get an appropriate metadata to in place for the ESG. There are challenges of what kinds of TV and radio do you need, and move to not just synchronous but also asynchronous media. We'll look at profiles, personalization, context-awareness and the issue of hybrid DVB-H/3G or TDMB/3G.
We'll look at how to organize it from a technical perspective but also from a user perspective: how the interface makes people find it helpful rather than time-consuming, and at the end what the business model is underpinning all these, also understanding the market where DVB-H will be a useful thing or a threat to 3G operators who investigated quite heavily in building the networks. Does it offer something that they can grow the market by starting with 3G and moving into hybrid services? We also found a question of size in phase 0. Size matters. If you are big countries like UK, Germany or Italy, you already have lots of channels so there're enough to choose from. If you are in a small market like Denmark, it makes sense to offer some of these on handheld devices.

Xu: How about the big project?

Peter: The big project which will hopefully starts in Jan 2008 isn't completely in place. But that will move further than and stand on the shoulder of the small one. It will explore in particular things like the adaptation of existing internet news channels to make it relevant to handheld devices, what it takes and how do we incorporate user-generated content. Is it just going to be used with news or it will be used in connection with other kinds of content genres.? There're lots of issues we need to clarify to be able to translate knowledge into policies and strategy for the medium term. We don't think that mobile media are going to have a huge market share until 2012 and 2013. It'll take a long time for the consumers to

understand what the user proposition is. With many of the existing use interfaces, there're lots of things needed to be done to understand how this can be done at a level where people find it simple to use.

Xu: Content is quite crucial, as well as in mobile broadcasting I guess. What type of mobile content do you believe will be popular?

Peter: I think it will change overtime. To begin with, we are pretty sure that you need to have existing television channels because people need what those channels are. But we don't think it's a long-term thing. We are sure that over a period of 5 years changes will evolve into something else. They will also be differences in terms of different uses and gratifications, for example, killing time or keeping informed.

Xu: How will they change then, some examples?

Peter: Killing time will be both synchronous and increasingly asynchronous consumptions. We know that for our existing on demand services things like Satire, which is pretty popular in terms of download and access, up to 500,000. So kind of services could be delivered as download besides TV channels in terms of killing time.

Keeping informed depends very much on what time is in the day. For example, radio is a very much morning media, which reaches its peak between 7 and 8 am after which it tails off and has another peak at mid-day associated with mid-day news.

There's another little peak in the afternoon. Television is a late afternoon and evening media. Teletext tends to have a peak before and after television. We know other mobile media research in Europe that you have new peak hours, which can be very different depending on the countries. In Spain there's a new peak during the lunch break between 1 and 3pm. You have a long lunch break in Spain.

Xu: What kind of content will DR deliver? Specifically designed for mobile services or just tailoring the existing content to make it right for mobile?

Peter: It makes a lot of economic sense to build on your existing content brands, perhaps repurposing the content for use on mobile devices. Initially you'll start in the easiest way by extending our existing content brands.

For example, it makes a lot of sense for us to look at DR Update, which is an internet TV channel. That's already combine with the conventional channels in some of the pay TV

systems as options. You get it for free for some of cable systems and some of SMATV systems, which isn't exactly what it was originally designed for. They were in fact designed for people to see a loop but to choose particular use items of interest to them. The problem is to make it linear again. I think taking DR update and adapting it for mobile using DVB-H would certainly in a high return and would have a lot of potential because you have flexibility of the internet and the bandwidth of broadcast. There's a clear advantage that you can work around. You may need a personalization layer, a profile layer and a context layer to explain certain things. So that's a very clear part.

The unclear part is the strategy to cooperate with user generated content. We are also moving into personalization part called myDR on our website. You can adapt the interface with your particular interests and preferences. This general trend of convenience which involves great control from the end user seems to be need to taken considerably. The content targeting to the 18-25 year olds that could be also included to the user generated content.

Xu: How about the traffic advisories? Seems quite useful, are you going to make it complementary with mobile media services?

Peter: The traffic advisories were designed originally as a digital service, RDS, running on FM radio and were developed more than 20 years ago. What it involves are amount of digital codes. Channel ID make you display the name of the channel and broadcaster. PTY codes are different genres and content categories for radio. You can specify if you just want to listen to the news, so that when you are finishing a news program in a channel, it will search all the other channels which have a program with the same PTY codes for news. For traffic information, there's a mechanism in RDS, which is short for radio data system. It allows a radio station to say this is a traffic advice and we'll public the alert. If the radio with RDS is on, it will reach to a certain standard level of volume and switch your channel. What we can do is repurposing those "triggers". In technical perspective they are triggers. There're already triggers and coordinates for the location of the traffic problem.

Xu: You mentioned context-awareness when you're talking about the things DR's quite interested. Why does it matter a lot?

Peter: We need to understand what mobile actually means. There're lots of talks about mobile television, assumptions that people want to use television on the move. The work I did for the last 2-3 years indicated we need to focus on personal pocket media. We need to zom out, and get a holistic sense of how people consume media on handhelds. Because in the European context but not in the Korean context, most of the consumption does not take place on the move, but takes place primarily at home. And we don't fully understand why this is so. It was

seem to be fairly obvious what people want to do when they are what to keep informed, to kill time and to keep contact with other people. When it comes to being at home, we can see from studies that have been done that people start by watching conventional TV channels. In Europe it's a little bit strange because in family households, there're typically 3-4 TV sets anyway. Why should people want to watch television on a small screen when they already have TV sets in their bedrooms? One of the reasons to take part in this project is to have a better understanding of users and context in which mobile media are used. We are not just concerned about TV and radio, but about both synchronous and asynchronous media like watching films, TV programs that are previously recorded and how this links with user generated content and peer-to-peer communication.

Xu: Personalization and interactivity are treated as key issues when designing the electronic service guide? What's your opinion?

Peter: I would like to go back to the beginning to talk about the basis of electronic service guide or electronic programming guide. We have had this for 10 years. We've had them on other cable TV system for probably 15-20 years.
The moment we still have centrally a matrix with a timeline horizontally and different channels on the vertical access, just a text description, which seems to work more or less okay if we've got limited number of channels. But what if you have Sky in the UK you've got upto 600 channels, then does an EPG really help you? You need to scan through pages and pages or screens and screens of information to find what you want.

The 2nd issue is in the country like Denmark, about 6-7% of the population don't read that very well and another 10% are poor readers, which would cause problems to subtitles and service guide as well. So we already know there're problems on big screens. When we decide that we could just move EPG on to a small screen.

I think we need to be very careful about the discovering, navigating and the links between the listing information and choosing to see a particular program.
Again there're also challenges of how to provide unified interface for both television channels and on demand content. In one case you've got time access and the other case you just have duration. So how do you conceptually put synchronous and asynchronous options in the same interface? If you do so, for example, all of the asynchronous ones just appear as options which you could choose in the same first column. I think we need to spend a lot more time on the use of test and icons programs.

We know quirt a lot about discoveringpopular music. It's fairly easy already to give people the musicthey want.

We need to look the conventions for providing non-text information in ESG. So the people can decide what content to choose. ESG at the moment is good for helping people with the content they already know, but not good for people discover things they've never seen before.

It's alright for programs in a series they haven't seen before. But if it's completely new series and if it's different from anything they've seen before, we need to look at the conventions for combine information about what the program is about to give a clear idea what the program is about. Or using the metadata to be able to hide from the view, the kind of recommendation system based on what you like before, like we know from Amazon's that processing metadata in the background and on the basis of those keywords coming out with some suggestions based on your initial log purchase. There is a whole area of things that we haven't done careful studies.

Xu: What's the ideal ESG in your mind?

Peter: I think there're three success criteria [this is a quote from a European Commission report – you can have the reference).

The first is something which perceived to be useful by the users. There should not be cognitive overload, which means it's too demanding for your perception to be able to process it. Lots of text, especially fields with crawlers, or a picture in picture window, don't work very well for certain target groups.

Second are the technical infrastructures to enable reliable and effective delivery. It's not something you can just do a mock-up of. For service guides, you need to have metadata and all the other background information.

Third is a sustainable business model to make people pay for the services. If you've already thrown a lot of money at the ESG and people are not prepared to pay for it, it's not going to be sustainable from an economic perspective. The ESG seems to be a particular challenge for small devices, because it makes existing problems even worse. On the other hand is talking interfaces, text-to-speech, which is not high-quality.

A.2 Interview with Peter Mølsted from DR Medier, Distribution

About TV Sevices

Xu: What DR info does DVB-SI metadata carry in current DVB-T service?

Peter M: We are delivering the basic DVB metadata, includes EIT, presence, following and 7-day schedule. At the moment, we only deliver the mandatory, which means program title, start time, duration and textual synopsis information. In fact, we have two DVB standards: short and long. We delivery the long version which is most used, means the receiver normally look for the long version and cut off depending on how much memory does the box have. It's organized in the way that we have different updating frequencies if you see on the 7-day, the presence, following and the actual 24 hours. We'll update within
10 sec if any changes made of the program within 24 hours. After that, in the longer term, the next data head we are updating only 4 times for each 24 hours. Why we are doing this is to avoid a crash of the boxes due to overloaded memory. Because if we are updating any changes in the 7 days, we'll have a refresh memory probably in very short time spans. The box may go down because the buffer is so small.

Xu: What is the bandwidth requirement of SI carrying all the metadata including a 7-day EPG?

Peter M: It's difficult to say how much we are using, because it's changing depending on the time for programs. So we have about DR1, DR2, TV2 All the SI information is 700k, including the NIT information. I think if only for our two-channel metadata is about 200k.

Xu: Has the DVB-SI genre info been implemented into the transport stream?

Peter M: No yet. But we're working on it right now and expecting to start next year. In fact we have the system internally. If you are not in TV production or broadcast, it may sound very interesting if you say it's a problem to define a genre. From a consumer's point of view, it's very easy to say it's a program for children or it's an action film. In production media, you'll have different way to look at and define it. We have had a process last year to very concentrate, because we need to have this genre defined. It does have more value. For example, there's difference between the programs for small kids and for older kids. So there'll be lots of more detailed discussions. We are focused on very much to get the genre up and realize the mandatory 12 genres for DVB specification. Then we may want to use the

TV-anytime specification.

Xu: As far as I know DR Ekstra is a kind of 2nd generation Teletext on Digital TV. What content is offered and in what format is this made available to the three DVB platforms that could play it out, apart from the MHP application on DVB-T?

Peter M: DR Ekstra is an overlay service in fact. If you are looking DR1 or DR2 broadcast signal and if you have an MHP box, you'll have video, audio and less-than-half information on the screen. The application does contain program information both for TV and radio, international and national news headlines, weather information and sport information. In fact it's the same you can get on Teletext which is the traditional TV text service. DR Ekstra is formatted to an easy reception faster and looks nicer on screen.

The information is delivered in the network in this way: we are broadcasting the application and we don't have the application in the box, because we don't have the control over the box. Typically a pay-TV operator will download the application in the flash memory because it could be accessed faster. But we don't have that possibility. It means when you go into the DR1 channel, it will load the application in the background. When it's loaded, it will give a sign on the screen-a small red button. It will appear for 5-10 seconds and goes back to normal TV signal. If you press the red button, the application will come up on the screen. It gets information from SI, the program information. All the rest is delivered in a private data stream in MHP standard. We are using about 700k of the complete transport stream of the application. So it is expensive.

Xu: What're the sources of news, weather, and sports information then?

Peter M: There're amount of sources. We've built up a system internally for interactive TV. We got sports information in fact externally in XML format. Some of the news is made by usual update in a central system, where both delivered to teletext, web and DR ekstra.

Radio Services

Xu: when we're listening the DR's netradio and DAB radio, we can see the info of runtime playlist information. Where do they come from?

Peter M: It's in fact generated automatically from the Radio Playout System, called DRLE. It has a standing tool in the background. It has broadcasting lists and is delivering this playlist information. The consumer will have the information at the moment the music number starts. Because we don't want our competitors know what music number we want to send. It's okay

when it's on air. We are not giving the information before it is being broadcast. The Playout system information goes with MHP information as the same way that we built up the gateways formatting the information correct for the web and DAB.

Xu: How could we reuse the playlist
Peter M: I think we can use it as what we've done on DAB. The question is if it's interesting to have scheduling information. Now and next information is always interesting. Two days ahead the radio programming, people think the answer is "No" on website, I think it's only 24-hours

Xu: There are PTY codes for classify the radio channels. Could we reuse it as genres? Or to trigger regional traffic information services? How would we map the DR regions into 3G or DVB-H cells?

Peter: Yes, it should be possible. PTY codes have their equivalents for TV. Right now they are used so that if you are tuned to a channel with news and you change location, the device will look for another channel that is offering news
Regional traffic information: the device would need to know how fast the device is moving to work out the range in which traffic advisories would be relevant. We should be able to re-use the data, originally by just duplicating the regional services currently available on FM only. A 2nd generation version could follow. DR update webtv:

Xu: Right now DR update can be accessed via internet. It is also broadcast in some areas? What exactly do they do with it?

Peter M: For broadcast now it's only on satellite and it's a loop like TV2 news, but no interactivity functions. It's designed as a web service. It's built up as a way that you have a cycle-the news of news. It will be updated when a new one is produced. You can always go back using archive function to see the short clips.

Xu: What metadata is associated with DR update?

Peter M: We have RSS feeds. You have the title and synopsis. Now you can just search by key words within one month back. We have some people for 24 hours to make these metadata. In fact we are working a big system to coordinate and automatically generate information. We have a journalist metadata system from the news redaction that we can take the information directly and broadcast it. We are discussing how we can use it, because it allows you to do a much more detailed search.

Xu: So I guess right now no detailed news genres available?
Peter M: No, not yet, but we're planning to do it.

Other Services
Xu: what does the DR extra newsfeeds consist of and how could it be implemented on DVB-H?

Peter M: DR extra is only formatted news and textual information. DR update is a new product and news info on it is delivered as clips. Its redaction is the same as DR online.

Xu: what type of location aware regional traffic information could be made available in a personalized interface based on a dr.dk XML feed describing buses, trains, metro, flights, road repairs and traffic accidents?

Peter M: Yes. We offer traffic advisories in each of the radio regions that correspond broadly to political regions. The challenge depends on the traveler whose needs largely depend on the nature of the journey and the means of transport. Some examples: Someone traveling on the motorway system needs to know what is happening within a radius of perhaps 50-80 kms (ie. 25-45 minutes away from his present location). Someone on a bike or in a bus would be more interested in disruptions with a 10-15 km radius, one thing is the location of the source of disruption, another is the user needs related to that event. The may be very different, depending on the mode of transport and speed of travel.

Xu: Does the xml feed associate with any geographic codes?

Peter M: The information we are delivering don't have a detailed location link. It's only on the regions, for example, only for Copenhagen or Auhus, because we are getting the information from the external database from the traffic companies. They must have the geographic verifying information.

Common questions

Xu: what content package do you think would be the easiest to get started with, i.e. to be offered to mobile users at early stage?

Peter M: Streaming DR1, DR2 and taking DR update, which will make a lot of sense to mobile users. And look into the archive on demand. Then we'll look at what we can specially do for young people. We have a redaction group responsible for youngsters. They will be involved to make something to us and special format for mobile. What we have discussed is

to look at news for young people. Then we'll also look at the
DR Ekstra feature.

Xu: How about radio?

Peter M: Radio yes, but how many channels we don't know yet. During the phase one we've done last year we've seen that radio is a very important part of the mobile reception.

Xu: In the longer term, how about traffic services?

Peter M: Sure we'll look at how we can do it in a smart. In fact we haven't focused on that so much but I do think we have to do that.

Xu: It seems we are confronting different formats when we want to integrate metadata and essence to provide many services. Do you think a common metadata format for describing the content is required?

Peter M: Absolutely. In my point of view, we have to go as standardized as possible because we are broadcaster. We need to follow TV-anytime because it's the only standard we have in the Europe.

Xu: How far have you got with DR's Master EPG?

Peter M: So far the delivery of DTT is via Master EPG. Master EPG has two parts in fact. It is a system where we take all the different inputs and sources, both internally and externally, formatted in the standard way so that they are accessible in a standard format. So the Master EPG is a central database updated from different sources and you can access it from a standard gateway in a standard XML. The work so far is we have a kernel machine working for more than half-year and it was simply starting to work with DTT. Today we have our Content Management System, hooked up with our Master database. All program information in Teletext service is delivered via Master EPG. The next step we are planning is a central system in the future built up with different gateways and formatted in the right formats. So we'll also make a gateway for DVB-H if necessary.

Xu: So currently the current schema is DR's own?

Peter M: We are delivering DVB but not TV-anytime. We are working two test cases with TV-anytime, for example, the genres in a standardized way.

Xu: How about the network signaling? DVB-SI?

Peter M: Yes, DVB-SI. In fact there's been big discussion in TV-anytime forum to next generation TV anytime including a new standard signaling system. I don't believe it will come true in the next couple of years. TV-anytime forum is looking at more advanced features for example you can track the content owners. From my point of view, it's a bit too complicated, because it forces a complete change how you're broadcasting. It means all the broadcasting equipments have to be changed and all the receivers have to be updated. If the Network ID will change, it means all the networks which are already digitalized have to change the set-up. There has to be a very good commercial reason to do that because it's too expensive.

Xu: To implement TV-anytime genres, are you talking about TV service? How about radio?

Peter M: Focusing on TV yes. For radio we do have genre there using our own standard. But we are going to look at to map it to TV-anytime. But it's not easy because the people of programs are not keen on the standards, they do have their idea of how to classify the programs

Xu: How about other services such as podcasting and IP-based video on demand??
Peter M: That's a plan and we're going to work on that. All standardized. The customers will have an easy access to our content and that's the award. However some of producers are very conservative about it, because they are looking from another perspective from us. They are not conservative in making new types of program but very conservative according to regulation and systemization. The producers are focused on making the program. The moment that program is broadcast, their job is done. Of course they care how the people like it, but they don't care how the program is broadcast, in which standard and in which keywords.

Xu: to summarize metadata

Peter M: Basically the same information that we have on TV and that is for sure. The challenge is normally you have short time to watch and the screen is small and to make it searchable in a easy way. So we have to have the same standard metadata so the people will feel safe. If they are looking for drama program, they will get the same program on normal TV and web. I do think we should very much focus on the GUI interface and make it simple. Then we have to work with automatic recommendation features. For the small screen five lines may be enough to read, otherwise text will be very small. It may more like interactive TV to keep it simple. And of course features with geographical codes because there're lots of differences between mobile reception and TV reception. For example, we could do it with

news then we'll have the news in this specific part of the city, along with some interesting local l information like there'll be a band performing up to night. From my point of view, the interesting part of mobile reception is that mobile phone is a personal thing, where the TV set is social function and the PC is still more or less a working tool.

Appendix B

B.1 SQL Statement in MySQL

The SQL statement used to create the table:

```
DROP TABLE IF EXISTS `myesg`.`location`;
CREATE TABLE    `myesg`.`location` (
   `user_id` int(10) unsigned NOT NULL COMMENT 'user ID',
   `home_lac` int(10) unsigned DEFAULT NULL COMMENT 'location area code for home',
   `home_cell` int(10) unsigned DEFAULT NULL COMMENT 'cell ID for home',
   `office_lac` int(10) unsigned DEFAULT NULL COMMENT 'location area code for the office',
   `office_cell` int(10) unsigned DEFAULT NULL COMMENT 'cell ID for the office',
   KEY `user_id` (`user_id`)
) ENGINE=MyISAM DEFAULT CHARSET=latin1;


DROP TABLE IF EXISTS `myesg`.`genre`;
CREATE TABLE    `myesg`.`genre` (
```

```
  `user_id` int(10) unsigned NOT NULL COMMENT 'user ID',
  `news` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  `entertainment` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  `sports` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  `weather` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  `music` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  `radio` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  `series` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  `educate` tinyint(1) unsigned NOT NULL DEFAULT '0' COMMENT 'genre',
  PRIMARY KEY (`user_id`)
) ENGINE=MyISAM DEFAULT CHARSET=latin1;
```

B.2 XSLT Stylesheet

```
<?xml version="1.0"?>
<xsl:stylesheet xmlns:xsl="http://www.w3.org/1999/XSL/Transform" version="1.0"
xmlns:mpeg7="urn:tva:mpeg7:2005" xmlns:tva="urn:tva:metadata:2005">
    <xsl:variable name="title" select="//tva:ProgramDescription/descendant::tva:Title"/>
    <xsl:variable name="g1"
select="//mpeg7:FilteringAndSearchPreferences/descendant::mpeg7:Genre/@href"/>
    <xsl:template match="tva:Genre">
        <h1>
            <xsl:text>The program you want to watch is:</xsl:text>
            <xsl:value-of
select="ancestor::tva:ProgramInformation/descendant::tva:Title"/>
        </h1>
        <h2>
            <xsl:text>The genre you select is:</xsl:text>
            <xsl:value-of select="./@href"/>
        </h2>
        <h2>
            <xsl:text>The final score is: </xsl:text>
            <xsl:value-of select="ancestor::ProgramInformation/descendant::Synopsis"/>
            <xsl:text> </xsl:text>
        </h2>
    </xsl:template>
    <xsl:template match="/">
        <xsl:apply-templates
```

```
select="//tva:ProgramDescription/descendant::tva:Genre[@href=$g1]"/>
            <h3> Program in the database: </h3>
            <xsl:for-each select="$title">
                <li>
                    <xsl:value-of select="."/>
                </li>
            </xsl:for-each>
        </xsl:template>
</xsl:stylesheet>
```