

Preface

Interactive Digital Television Definition

After a decade of interchanging enthusiasm and disappointment *interactive digital television* (iDTV) or simply *interactive TV* (iTV) enters a phase where technology developments and market conditions provide a fertile ground for its growth. The anticipated uptake of iDTV is also supported by the nature of the medium itself as a familiar and trusted medium available in almost every single household in modern societies. At the same time, the opposite is also true; TV content gradually finds its way through Internet and mobile platforms. The most important characteristic of the new medium is its ability to provide digital content enhanced with *interactive* features. Thus, besides the delivery of high quality picture and sound, iDTV promises to change the role of passive viewers of traditional analogue television by turning them into active participants of the television viewing experience.

Several definitions concerning iDTV have been proposed but little consensus has been achieved about which one depicts the characteristics and capabilities of the new medium. For example, from an engineer's point of view iTV can be regarded as digital broadcast and return channel; a content producer would refer to interactive graphics and dynamic text information; a media researcher would describe new content formats such as betting, interactive storytelling, and play-along quiz games, and a sociologist's definition would focus on the interaction between people about TV shows.

We define iTV as a user experience that involves at least one user and one or more audiovisual and networked devices. Previous definitions were focused on the technological aspects and ignored the fact that even traditional TV is potentially interactive. For example, viewers compete mentally with quiz show participants, or between colocated groups. Moreover, viewers react emotionally to TV content, they record and share TV content with friends, and they discuss shows either in real time, or afterwards. iDTV systems (such as digital video recorders, digital broadcasts, electronic program guides, Internet TV, and mobile TV) offer the potential for: (1) support for established behaviors and (2) opportunities for the emergence

of new behaviors. In this sense, instead of a device, or a communication system, or a psychological/social behavior, iDTV could be defined as an experience among people, devices, and audiovisual content.

An important implication of the previous definition is that iTV applications and services are neither limited to the traditional TV device and broadcast delivery nor to the typical channels of satellite, cable, and digital terrestrial networks. In addition, alternative and complementary devices and distribution methods are considered, such as mobile phones (mobile TV), and broadband networks (DSL).

The basic household equipment of a digital television system besides the television set includes a set-top box that decodes the signal and provides additional functionality including processing and storage capabilities enabling interactive applications. The digital television signal may be delivered to households through satellite, cable, or digital terrestrial network or any other broadband IP-based network. In addition, the wide adoption of the Multimedia Home Platform (MHP) as the common open middleware platform opens new opportunities for programmers to develop sophisticated interactive applications independently from the set-top box hardware. Other important developments include standardization efforts for applications development (e.g., TV-anytime forum content metadata definition) and specifications for digital video broadcasting (DVB) through different channels (DVB-S/C/T/H specifications for broadcasting over satellite, cable, terrestrial, mobile networks), providing solutions to incompatibility and interoperability problems that have been holding back the uptake of iDTV.

Taxonomies of Interactive Applications

Interactivity, as the major feature of iDTV, can be defined as a characteristic of a medium in which the user can influence the form and/or content of the mediated presentation or experience (Ha & James, 1998; Snyder-Duch, 2001). Typically, interactivity implies two-way communication between the user and the source (broadcaster) through a return channel such as a PSTN/ISDN line plugged in a modem-enabled set-top box, or through a broadband or cable connection. Interactivity appears in various forms and levels and may be experienced even on low-end set-top boxes without storage or return channel features (called one-way interactivity or pseudo interactivity). This is achieved through the cyclic broadcast of data streams over the network (data carousel). The necessary data and code are retrieved from the network and executed on the set-top box upon user's request. Pagani (2003) classifies digital television systems according to the type of interactivity they support:

- *Diffusive systems* are those which only have one channel that runs from the information source to the user (this is known as *downstream*).
- *Interactive systems* have a return channel from the user to the information source (this is known as *upstream*).

On the other hand, Jensen (2005) suggests three iTV forms:

- *Enhanced TV.* Text, graphics, and video are broadcasted and become available to the users through interactive buttons or banners appearing on top of the normal television content.
- *Personalized TV.* The user is in control of the content through devices such as personal video/digital recorders (PVR/PDR), which can store the content and provide functionality such as pause, stop, play, rewind, forward, and so forth. In addition, advanced set-top boxes may run applications that personalize the content according to the user needs and preferences.
- *Complete iTV.* Two-way communication through a return channel. User's requests and server's responses may be synchronized or sent to the server at certain time intervals and served accordingly.

The majority of existing iTV applications is based on the enhanced-TV form. This can be attributed to a combination of factors including the limited use of return-channel enabled set-top boxes required for full interactivity options.

Interactive television users—from a uses and gratifications theoretical perspective—aim to satisfy ritualized and instrumental needs. Ritualized needs refer to a habitual use of media for time consumption and less for active goal-oriented purposes. Instrumental needs lead to a goal-oriented media usage related to information needs. In a needs-based classification of iTV applications Livaditi, Vassilopoulou, Lougos, and Choriantopoulos (2003) identify four application categories: (1) entertainment and (2) communication applications that focus on ritualized needs; (3) information and (4) transactional that focus on instrumental needs. In a recent survey in five leading—in terms of iDTV penetration—European countries (UK, Italy, Spain, France, Germany), Pagani (chapter XVIII) suggests that entertainment (53%) and information (20%) represent the majority of iTV applications. It is profound that media usage is mainly related to entertainment and therefore most of iTV applications incorporate (or should incorporate) entertainment aspects, thus blurring the distinction between application categories. Hsu, Wen, and Lee (chapter IX) identify five highly overlapping application categories (entertainment, information, education, transactions, and daily living). The latter classification extends the previous ones by the “education” category including applications such as t-learning and t-library as well as by the daily living category that embraces appliance control and t-health applications. Notably the entertainment applications are spread across all five categories. As the digital television market continues to expand and technology enables, more and more applications and application categories emerge. On the other hand, the needs-based classification suggesting the two major classes of ritualized and instrumental applications seems to be the most generic one incorporating existing taxonomies and eventually the future ones.

Interactive Applications: Opportunities and Challenges

Current and emerging applications such as video-on-demand; electronic program guide (EPG); Internet TV and mobile TV; interactive advertising; t-learning; and ambient home media applications provide opportunities and challenges for both business stakeholders and end users (viewers).

Video-on-demand changes the traditional linear viewing experience since viewers may request and receive content, which can be downloaded and stored in a PVR (such as TiVo) or an advanced set-top box. Alternatively, the viewer may pause, forward, rewind, and play causing the storage of content segments by exploiting time-shift capabilities. On the other hand, near-video-on-demand (NVOD) technology enables the selection of content that is continuously broadcasted, providing a limited spectrum of content options but with no hardware requirements (set-top box storage). The power on content provided to users poses threats and challenges to advertisers and media planners since the viewers may skip advertisements embedded in the normal program flow. This opportunity is expected to force the stakeholders involved in the advertising business to change their strategies and adjust to the new medium characteristics, finding new forms of advertising.

The vast amount of available channels turns the selection of content, relevant to the viewers' interests, a cumbersome task. EPG is one of the most widely used applications since it operates not only as a program listing service but as a portal to content-related information (known as interactive program guide [IPG]), or as an advertising message vehicle. One important challenge is the development of intelligent applications that personalize content recommending, for instance, relevant movies. The movie recommendation domain has been one of the most important research directions applying and extending recommendation methods applicable in other interactive media (e.g., Web-based recommender systems).

Television advertising over analogue television platforms has long been established as one of the most effective ways for mass-marketing activities. Digital television platforms provide new opportunities for marketers (Pramataris, Papakyriakopoulos, Lekakos, & Mylonopoulos, 2001) as they can enhance their messages with interactivity options and additional user-requested informative content enabling the collection of valuable data such as actual response rates. One of the most important consequences of interactivity is personalization of advertisements since they can be delivered to users that are most likely to respond positively to advertising messages. Among the key issues for the efficient delivery of personalized messages is the development of personalization algorithms capable of exploiting the available interaction data. The development of suitable for the domain interaction styles which in turn specifies the type of exploitable user-driven data is an important research and practical issue.

Television learning (or t-learning) is a relatively new term that emerged as a combination of typical e-learning methods applied within the iTV domain. Analogue

television has been extensively used for the broadcasting of educational programs but restricting the learners' role to passive viewing. As Lytras, Lougos, and Pouloudi (2002) suggest, three domain characteristics support the learning process through television: (1) the ability to personalize content according to learner's needs and experiences, (2) digitization of content that allows for multimedia presentations of better quality of picture and sound, and (3) interactivity that gives power to users to actively participate in the learning process. However, the nature of the medium poses additional difficulties for e-learning applications. Television viewing is a group activity and mainly a content consumption process with emphasis on entertainment. The combination of television with other personal devices such as mobile phones may be considered as a gateway out of such problems, in particular for language learning applications, as Pemberton and Fallahkhair underline in chapter II where they present a learning environment incorporating TV and mobile devices for language learning.

The term *Internet TV* implies the convergence between different media-related sectors such as broadcasting, telecommunication, and information technology (IT). This convergence can be realized in different forms. On the one hand, Internet content may be accessed through television (this is also known as Web TV or Internet@TV [Jensen, 2005]) through Web browsers, or linked to iTV programs (e.g., interactive advertisements). Communication applications such as messaging, chatting, or voting during certain programs (quizzes, contests, etc.) have proven to strengthen viewer's loyalty to the specific program. However, Internet access via television may contradict with current viewing patterns. The appropriateness of uncontrolled Internet content of doubtful quality for television viewing is also questioned. Nevertheless, since Internet connection can be established via the set-top box, video content exchanges over peer-to-peer (P2P) networks seem as an attracting option for viewers and at the same time a great challenge for both broadcasters and content owners. On the other hand, the delivery of television content over IP-based platforms to personal computers, known as Internet protocol TV (IPTV), provides promising opportunities for content delivery through alternative distribution platforms. Other television content distribution platforms include third generation (3G) mobile networks featuring video-on-demand applications as well as live event broadcasts. There are still several issues to be resolved before realizing a wide acceptance of media convergence, for example, the limitations of the MHP specification to support streaming media delivery through the return channel. Demeyere, Deryckere, Ide, and Martens analyze, in chapter V, an MHP application for live-event broadcasting and video conferencing, bridging IP-based networks and DVB broadcasting.

Mobile TV applications face problems firstly related to the device characteristics (small screen, viewing angle, battery limitations) that affect the quality of video viewing. Knoche and Sasse, in chapter XIV, discuss four major requirements related to quality of service: (1) handset usability and acceptance, (2) technical performance and reliability, (3) service usability, and (4) users' satisfaction with the content. Although broadband connections enable the convergence of different types of media,

one important challenge remains: the production of content that fits the different consumption models of mobile, television, and Internet content.

The convergence among different types of media and consumer electronic devices within a home network also provide the opportunity for ambient media applications. This subdomain includes home media management applications or applications that may satisfy users' needs for content consumption for entertainment/informational reasons as well as utilitarian services for safety/security and assisted living for citizens with physical disabilities. An important requirement for ambient media as a part of users' daily living is to reduce obtrusiveness and provide the means for as simple as possible interaction in particular for IT-inexperienced individuals. For example, applications based upon ambient data audio identification serving as input data without physical interaction with home devices have been proposed (Fink, Covell, & Baluja, 2006). Lugmayr, Pohl, Muehhaeuser, Kallenbach, and Chorianopoulos, in chapter VII, discuss several aspects of ambient media for home entertainment from both a technological perspective and a user-centered point of view.

Despite the aforementioned developments in the digital television domain the majority of current interactive applications are based upon "discount technology" solutions with low-end set-top boxes and the use of phone, or SMS as the return channel (Jensen, 2005). Therefore, the development of successful interactive applications—besides technological parameters—should seriously take into account the factors that affect the adoption of applications and services and the requirements stemming from end users and business stakeholders as well as the characteristics of the medium itself. More than a decade ago Lee and Lee (1995) suggested that in the design of iTV services, traditional viewing behavior should be considered avoiding extended interactivity that contradicts with the current viewing experience. Several researches agree on the profiles of iDTV interactive services adopters as young technology enthusiasts (Bjoerner, 2003; Freeman & Lessiter, 2003; Lekakos & Vrechopoulos, 2006). In the light of the recent developments in media convergence Suni in chapter XVI extends the aforementioned studies identifying specific psychological factors that drive the use of Internet television. On the other hand, Cauberghe and De Pelsmacker in chapter XVII, surveyed Belgian advertisers' perceptions on the medium to reveal that although they acknowledge its main advantages (targeting, two-way communication) they still have limited knowledge on the potential of digital television, although their attitude (intention) towards the exploitation of the medium capabilities is positive. Pagani in chapter XVIII suggests that usefulness, ease of use, and price are highly significant factors among Italians of various age groups with respect to the adoption of interactive services.

Interaction design for digital television applications is considered as one of the main research avenues in the domain, taking into account the characteristics of the medium and its differences to traditional PC-based interaction designs. In addition—as mentioned previously—it is concerned with factors (such as ease of use) that affect the adoption of iDTV applications. One important aspect of iTV applications is that they target a wide range of viewers (ultimately the analogue

television viewers) representing the majority of the total population. This raises several issues concerning usability issues including the interaction of elderly or people with physical disabilities. For example, Springett and Griffiths in chapter VIII, present a number of accessibility requirements for viewers with low vision, while Iatrino and Modeo (chapter XIII) are concerned with text editing issues taking into account the limited input devices (remote control), comparing three different interaction styles. Hsu et al. (in chapter IX), Kunert and Krömker (chapter XI), and Ahonen, Turkki, Saarijärvi, Lahti, and Virtanen (chapter XII) provide solutions and guidelines for designing easy to use and useful interfaces for interactive applications. Haffner and Völkel (chapter X) discuss interaction design issues in order to support the concept of long-term relationships between broadcasters and viewers, while Knoche and Sasse (chapter XIV) provide insights concerning the quality of experience in mobile TV applications.

Book Organization

This book is concerned with certain important aspects of the iDTV domain and is divided into three main sections: Technologies and Applications (Chapters I-VII), Interaction Design (Chapters VIII-XIV), and Business and Marketing Studies (Chapters XV-XVIII). Following the aforementioned structure the book is organized in the following chapters:

Chapter I investigates current technologies and standards for convergence between the worlds of broadcasting and telecommunications. The authors propose the concept of DynamicTV as an approach that may enhance the user experience, implementing upon this concept a prototype in a DTT/IPTV environment.

Chapter II examines the potential application of iDTV to the learning of languages and describes an application that combines the strengths of iDTV with those of mobile phones to create a cross platform learning application for informal language learners.

Chapter III proposes a new hybrid approach for automatic TV content recommendation based on Semantic Web technologies, including an implementation of the approach as well as empirical evaluation results.

Chapter IV presents a model for delivering personalized ads to users while they are watching TV, which models user preferences based on characterizing not only the keywords of primary interest but also the relative weighting of those keywords.

Chapter V introduces a technology framework that can be used to add video conferencing services and live video events on the MHP, based on a bridge between IP networks and DVB broadcast channels in order to stream video that originates from an IP network into the broadcast.

Chapter VI defines a research agenda regarding the software graphics architecture for iTV acknowledging three major topics: (1) definition of a suitable declarative environment for television receivers, (2) television input (as multiple input devices) and output (multiple display devices) capabilities, and (3) models of television distribution and post-distribution.

Chapter VII deals with the development of ambient media, to satisfy the entertainment-seeking consumer. This book chapter glimpses the future of modern ambient home entertainment systems along four major lines: social implications, converging media, content, consumer, and smart devices.

Chapter VIII presents a study that examines and analyzes the performance of users with certain types of sight impairment in different interaction conditions. The outcome is the identification of issues concerning current approaches to DTV display and interactivity design as well as giving significant insights into the possible potential of and difficulties with alternative input methods.

Chapter IX proposes an activity-oriented approach to DTV user interface design, addressing DTV usefulness and usability issues. The user interface design considers both activity requirements and user requirements such as user's related product experience, mental model, and preferences.

Chapter X presents the application of concepts for long-term interaction to support long-term relationships of recipients and broadcasters in the iTV domain in contrast to classical interaction concepts that cover short-term interaction cycles. Three scenarios within the iTV domain illustrate the potential impact and long-term interaction concepts for the design of iTV applications.

Chapter XI proposes a user task-based approach to interaction design guidance for iTV applications to easily integrate with a user-centered application development process. Specific design solutions to support the user tasks "Accessing content item" and "Viewing content item" are described and empirically evaluated.

Chapter XII discusses the practical experiences of evaluating differing iTV services and proposes specific guidelines for ensuring the ease of use of interactive services. These guidelines apply to services that are transmitted in the traditional broadcast system, but they also provide a good basis for designing services in IPTV.

Chapter XIII introduces the usability problems regarding text entry using a remote control in digital terrestrial television context. It describes the comparison of three different text editing interfaces demonstrating a significant relationship between users' level of experience in text editing using mobile phone and their favorite interface.

Chapter XIV provides an overview of the key factors that influence the quality of experience (QoE) of mobile TV services. The chapter highlights the interdependencies between these factors during the delivery of content in mobile TV services to a heterogeneous set of low resolution devices.

Chapter XV examines the relation between the production for television and the Internet based on ethnographic fieldwork in two production units of the Norwegian Broadcasting Corporation (NRK). The study identifies that the two production units under consideration follow different organizational models due to differences in timing of publication on television and on the Web as well as to differences in production cycles.

Chapter XVI compares several basic statistical indicators of broadcast (traditional) television viewing and IPTV used in Estonia and shows how the structural difference between the two types of television results in different consumption models. The main conclusion is that the structure of the content to a large extent determines the uses of media.

Chapter XVII investigates the knowledge, perceptions, and intentions of 320 advertising professionals in Belgium toward the introduction and use of IDTV as a marketing communication tool. The results show that their knowledge concerning the possibilities of IDTV is very limited, but their intentions to use IDTV in the future are relatively promising.

Chapter XVIII outlines the different business models adopted in Europe in terms of contents offered and related revenue opportunities. The study addresses issues concerning how to cross the chasm of knowledge, how to explore the opportunities opened by new technologies, and which trends will influence the launch of new iTV services.

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