Development of a Second Screen Content Platform

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Abstract

Smart televisions are becoming more common in households and with the added capability to both connect to the internet and launch applications they have the possibility to help create a more engaging interactive experience. An interactive experience that extends beyond the classic remote control and into the personal second screen of every viewer. Second screens are frequently used while watching television making them ideal for creating audience participation and extending the television experience.

By looking at upcoming technologies related to interactive television and their interaction with second screens as well as design guidelines related to second screens, interactive television and social television we create a platform for prototyping web-based interactive television.

The platform uses a system based on the technologies found in upcoming televisions and consists of a client and server. The server acts as a television that can be detected by the clients using Universal Plug and Play and then open web pages sent by the client. The client presents a user with a list of second screen content which can include applications, web sites and interactive content shared between television and second screen.
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Chapter 1

Introduction

More and more consumers are investing in so called Smart TVs which are television sets with the added capability to both connect to the internet and launch applications. These connected devices promise to usher in a new age of television where viewers interact with and are actively engaged with the broadcast content. New television sets provide the user with new forms of interaction like voice control, arm gestures as well as point and click remotes.

Different forms of interactive television (ITV) exist today but is fairly limited by the forms of interaction provided by a regular remote control.

When watching television today, people are simultaneously using other devices, such as smart phones, tablets and laptops. These devices are often referred to as companion devices or second screens. They can be used in a variety of ways ranging from simply showing some extra content to actually interacting with, and changing the outcome of live programming. These second screen experiences can be used to enhance an existing experience or keep viewers interested during commercials by producing more engaging content.

Second screens can be used as a more powerful interface to the applications running on the television, whether it is local or broadcast live over the air. By using different techniques the application can synchronize with the content on the television and present the user with relevant information. There are several different second screen applications and two examples are zeebox¹ and Syfy Sync². These belong to two broad categories of second screen applications. zeebox is a general companion in front of the television working as a powerful TV-guide. It can work with any show or channel and provides integration with social networks. Syfy Sync on the other hand has specific and integrated content to several of shows produced by the network.

1.1 Background

The current second screen experiences are very limited in what way they interact with the television set, using the television only as a passive device. The information is sent from the television to synchronize with the second screen. By embedding watermarks, audio that humans can not hear but a microphone can pick up, in the running program a second screen device can easily synchronize with the content. The second screen is synchronized to the content but the TV does not enhance the experience further.

¹http://zeebox.com
²http://www.syfy.com/sync
Modern televisions support a way for second screens to discover the television and request applications to be launched on the big screen. Discovery and Launch (DIAL)\(^3\) is a protocol supported by some modern Smart TVs. This allows for an engaging experience where the television set can be used more interactively without having to resort to the cumbersome process of discovering, installing and starting the TV-application manually using a clunky remote control.

There is currently no easy way for the user to detect and use content for the second screen while watching television. Karppinen\(^7\) compiled a list of possible techniques for discovering second screen content, shown in Figure 1.1. The first way is display a QR-code on the television somewhere. Using a social media or twitter is another possible way. The third example is displaying a short URL. The fourth uses watermarks or fingerprinting for detecting that content is linked to the running program. The fifth is simply informing users during the broadcast of the existence of an application.

The work on this thesis has been done at Dohi Sweden. Dohi Sweden is a holding company that offers products and services in the audiovisual industry. The company has products based around interactive television as well as several partners and customers in and around the area of Smart TV. Working close with these partners, Dohi Sweden does research and development in exciting and emerging markets.

1.2 Goals

The overall goal of this thesis is to explore current technology and possibilities around the Smart TV and interactive television as a platform and how second screens can be used to help users discover and augment interactive content. Also of interest is how to design for second screens, ITV and a

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\(^3\)www.dial-multiscreen.org/
future where connected social television is the norm. Exploring why users switch between devices and examining what needs users have and how these needs can be met inside the same experience as the one they are already experiencing.

Here follows a list of the goals:

– Building a base of knowledge for designing second screen and applications running on an interactive television will be done to avoid pitfalls and take advantage of existing guidelines for good design in these areas. As no material directly related to this area exists, several different sources need to be researched.

– Design a portal for second screen content discovery. The portal should facilitate the access for viewers to content linked to running television programs. The portal should be able to present the user with a list of running television shows and allow the user to open web pages and run applications.

– To be able to evaluate the portal a high level prototype will be programmed. The prototype should run on the iOS platform targeting the iPhone series of smart phones.

– To accompany the application portal, a platform for testing concepts for interactive television is needed. The platform should emulate features found in upcoming Smart TVs to show what interactivity could be possible in the future.

1.2.1 Limitations

One of the limitations is that the prototype will not operate on a real television but will be emulated on a computer connected to a television. The goal is to stay as close to what would be possible on future televisions that use the DIAL protocol.

The second screen experience will be limited to pre-recordings of previously shown content, as some form of preparation will be required when creating interactive experiences.

1.3 Purpose

When watching television it is very easy for the user to lose focus from the content on the big screen, either by changing channels or by switching focus to another device. By providing extra content that better engage the viewers and lowering the barrier for accessing this interactive content it will be easier to keep users focused on a single integrated experience. Creating services on top of the existing experiences will allow the viewer to access more relevant content and services without changing the focus from the television.

This thesis will also function as a base for continued work in this area of development by including information about both technologies and best practices around interactive television and second screen devices. Making it easier to avoid pitfalls in development and design of future second screen experiences.

Exploring the possibilities of ITV and being able to create and test possible use cases before they are even possible puts the stakeholder at an advantage over other companies. Having already tried and discovered what works and does not work and testing what forms of interactions users will find engaging and valuable should make future decisions on investments easier.
1.4 Related Work

This thesis builds on previous work at Dohi Sweden where investigations into the possibilities of Smart TV have been conducted by both thesis students and in-house projects. An earlier proof-of-concept project was focused on the future of television and how these powerful devices could deliver a better experience for the user. The result was a concept where information was embedded on top of the currently running program. The concept focused on synchronizing television content with content on a second screen and presenting rich information on both devices. The concept required sub-second synchronization between what was being broadcast and the data displayed by the television and second screen. This was Delivering these powerful future experiences is something Dohi Sweden is very interested in, what is next, what can we expect in the living room in a few years. Figure 1.2 shows a screen dump from the second screen interface showing information about the currently playing music.

The work of another thesis student[7] focused around the different ways a second screen could connect and synchronize with the content on a television. What technologies existed and how they could be integrated with current solutions. The thesis also covered motivations for using second screens while watching television as well as the social aspects of television. A technological solution for discovering and accessing second screen content was also presented. This thesis was also done at Dohi Sweden to investigate possible advances in Smart TV technologies. For ITV to be successful a simple bridge between second screens and the TV needs to exist, and investigating how this bridge will exist is of great interest.

1.5 Thesis Outline

The first chapter introduces the background, purpose and goals to the thesis. Chapter 2 describes the initial plan of the project and what steps to take to complete those goals. Chapter 4 introduces ITV and interaction specific to social television, interactive television and second screens. Chapter
5. Thesis Outline

5 describes the results of the development of the platform, the different components and how they fit together. Chapter 6 contains the conclusions from the project and lessons learned during the project.
Chapter 2

Method

The general outline of how this thesis was conducted is described in this chapter. From how the planning was done using both a long term plan and the SCRUM methodology to how each step was conducted.

2.1 Outline

- Investigate technologies and current state of the art by performing a pre-study by gathering as much information as possible about the strengths and weaknesses of relevant platforms and systems. This information should function as a base for continued work.

- Using the gathered material and the requirements set by the stakeholder create a design for the content portal. Start by sketching and continue by creating higher fidelity designs. Ending with an “interactive” low-fi prototype.

- Implement a prototype showing that the technology works, as well as the previously discussed platform for creating future second screen experiences. This includes integrating two previous projects.

- Perform an in-depth study into the design and evaluation of interactive television and second screen solutions. Explore articles written about the relevant subjects. This material is to be used in continued work and products at the stakeholder.

2.2 Preliminaries

First a pre-study was done to explore the technologies and possibilities currently available and also to see what was coming in the near future. The study included getting familiar with the existing technology available at Dohi as well reading up on previous thesis work done at Dohi.

The preliminaries will help in deciding what avenues to pursue in future development and what technological platforms are showing promise.

Chapter 3 lists the investigated technologies and how they impacted the the choices for the implementation and platform design.

The research was to be focused on devices empowering interactive content which might traditionally been placed on a TV. The work avoids interactive devices that do not feature support for second screens and does not discuss devices or use cases where the input device is a remote control,
even if it is more advanced than the standard models. This decision was made because dual screen interaction promises a more powerful interactive experience, that can be personalized for each second screen user, even when they are sharing the television.

The different technologies were to be evaluated using a set of qualitative criteria.

1. Modes of available interaction methods (voice, touch, etc.)
2. Computing resources available
3. How they work
4. Limitations

2.3 Planning

Work during the thesis was planned on a project, weekly and daily basis with the help of the SCRUM methodology. The activities were divided into several parts where the work would be mainly focused on that task but still allow for some leeway for quickly changing requirements after feedback was received.

The initial long term planning included the initial design, the different stages of implementation, doing the in-depth research and writing the thesis itself.

SCRUM focuses on the iteration of Sprints which is a limited time-frame where the development of a product is incremented to a potentially releasable product. Each Sprint has a clear and decisive goal that is supposed to be reached in a designated time-frame which usually spans one to a few weeks. Sprints have generally a consistent duration throughout the development and are immediately followed by another Sprint when the current is done. Short iterative steps are used to quickly build prototypes which can be tested to make quick decisions on how to proceed. Companies and project groups usually use their own modified version of the SCRUM development method. The version and work-flow used at Dohi Sweden is a compromise of previous experiences at the company and the limited time span of the thesis project. The daily and weekly SCRUM activities that were held with the external supervisor at Dohi Sweden are the following:

2.4 Design

The design process followed roughly this pattern but in a spiral model, following the agile SCRUM method, so that the solution could be adapted to changes during the lifetime of the project.

2.4.1 Gather requirements and expected features

Design work started with the gathering of requirements, creating a formal specification of the project and the discovery portal. Several workshop were conducted to brainstorm around the portal and its features to determine which of these should be implemented and how.

2.4.2 Produce proposals for possible design

Different designs were imagined and sketched. In the end one was selected for the implementation of the high level prototype. This phase also included reading different materials around design in the iOS ecosystem, human interface guidelines and resources about Objective-C programming. These sketches and ideas were pitched to a small group where input could be received on the technological and feasibility of the presented designs.
2.5 Implementation

After pre-study and initial sketches the work of creating a second screen content discovery portal was started, though the requirements changed drastically. From its inception as a product to be used while watching television to an experimental platform for creating integrated and powerful interactive second screen television experiences.

The implementation phase also followed a spiral model with presentations each week where employees at Dohi Sweden would give feedback on progress and the features demonstrated.

2.5.1 Content Portal

Creating a high-level prototype that can communicate over the network with a television requires working with a real mobile application. The prototype was written on the iOS platform targeting the iPhone. The development environment used was XCode 5. The portal will use the openURL method of UIApplication to launch applications and some web sites. Some links will be opened inside a browser embedded in the application itself to keep users from losing the context of the application.

The work on the Content portal, or client application, would not focus on creating a fully functioning application but on what an integrated ITV and second screen experience might be like. One reason for this switch was the lack of content to actually fill such an application with, though this will probably change in the future. Therefore several features that might be required by an actual product could be emulated, such as receiving information about the running programs and how to actually synchronize live television with the application. Some initial strides were taken during the development to integrate a solution for pinpointing content from recorded audio using the devices microphone, but this was abandoned for other features.

2.5.2 Integrate previous projects

In this part, the aim was to take projects created previously at Dohi Sweden and integrate their functionality into the mobile application. This includes an UPNP bridge between an emulated television and an earlier prototype for a second screen experience. These previous projects will function as examples of how the interaction between the client, a user and the television might look like in the near future. These are projects are described in Section 1.4. The existence of the earlier UPNP prototype is the reason for not creating a solution based around the exact DIAL protocol. As DIAL is based on UPNP several of the same features could be implemented without that much additional work.

2.6 In-depth study

The in depth study (See Chapter 4) creates a foundation of design guidelines relevant to this and future work around ITV, second screens and the social elements of television. The focus was around collecting and summarizing design heuristics, guidelines and principles found in published articles around these subjects. The work has elements from both HCI and ubiquitous computing due to the combination of several devices and the interaction between humans and devices.

2.7 Documenting and tracking results

Throughout the whole project, a project diary was written to keep track of the status of the project. The work for the project diary consisted of noting down the following points each week:
– What was done.
– What kind of experiences I have gained, both good and bad.
– A status update of the schedule, including a revision when the schedule have not been followed.
– Who I have been communicating with and in what way.

During the thesis project at Dohi Sweden, a project management tool called Pivotal Tracker\textsuperscript{1} was used to document the tasks for each sprint and note down what has been done each day and how much time that has taken. It was also used to keep track of the milestones for the project and to generate various backlog information such as burn-down charts and estimations of when milestones and tasks will be completed using a calculated project velocity.

\textsuperscript{1}www.pivotaltracker.com
Chapter 3

Technologies

The availability of consumer electronics is ever shifting and new technologies are always appearing. How these technologies can be used and what possibilities are opening up in the future is very important to the stakeholder.

3.1 DIAL

Discovery and Launch is a protocol for second screens to discover and launch applications on televisions, called first screens. It uses Simple service Discovery Protocol (SSDP) and Universal Plug and Play (UPNP)\(^1\) to enable discovery and control of the television. Application developers register applications in a central registry and receive a unique <Application-URL> for their application.

The supported features of the protocol are listed in Figure 3.1. The problem that DIAL solves is the usability problem that is the starting and installing of applications supporting second screen interaction on a television. As the protocol supports installing new applications on the television when requested, a user would not have to switch between different controls nor find the matching application inside the television. Figure 3.1 shows an example of an application connecting to a previously discovered television, first checking if the application specified by <Application-URL> is supported and then launching it, ending with the confirmation from the first screen.

1. The first operation performs an HTTP GET operation using a pre-determined <Application-URL>. This is used to check if this device supports the specified application.
2. The server returns an HTTP response containing either a 200 OK response if the application is supported or a 404 Not Found if not supported.
3. The client sends an HTTP POST request to the <Application-URL> to start the application.
4. The television installs/starts the application.
5. The communication ends with the television returning 201 Created.

A part of the DIAL specification is also the registry service. It exists to avoid conflicts for application specifiers sent between the second screen and first screen. The registry service only registers names of first screen applications. This means that a single identifier can be used to initiate Youtube videos, making every second screen capable of launching Youtube videos on every first screen that supports DIAL and has a Youtube application.

\(^1\)http://www.upnp.org/specs/arch/UPnP-arch-DeviceArchitecture-v1.1.pdf
### 3.2 Chromecast

The Chromecast is Google’s newest attempt at conquering the living room space. Previous attempts with the Google TV platform have been seen by some as a failure when it comes to capturing the market. This product is aimed directly at the cable cutters, people who are abandoning traditional television and prefer using on-demand internet streaming. The Chromecast does not integrate standard television in any way and aims to leverage the DIAL protocol to make it easy for users to access video content from their second screens on the television.

The Chromecast hardware is similar to that of a smart phone or tablet in processing power. It is a small dongle connected directly into the HDMI port of the television. A second screen uses the DIAL protocol to initiate an application URL that links directly to a webpage containing a video tag. The features supported by the Chromecast are not yet final as the device is still in development. But at this time it contains video playback capabilities and a way to communicate with second screen devices on the same network.

Figure 3.2 shows an overview of the system, the second screen is used to control the video playback. With video served from an internet streaming service which is then displayed on the television.

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3.3 Xbox One

The Xbox One is Microsoft’s newest addition to the video game console as well as the media center market. Microsoft has a history of creating living room devices used for multimedia. Its strength lies in the merging of several input devices with powerful features. It has a camera for gesture controls, a microphone for voice commands and the possibility of using a smart phone as a remote control. The console also comes with a HDMI-in port used to connect the user’s set-top box. Using an IR-blaster the Xbox One can switch channels on the set-top box. This is a one-way communication which can result in the two devices being out of sync. Figure 3.3 shows an overview of how the broadcast signal is transmitted through the Xbox into the television.

As the Xbox is a video games console its hardware is an 8-core 1.75GHz processor making it very powerful compared to the hardware used in other solutions.

A user can control the console with phrases such “Watch ESPN” or “Xbox On” and different hand gestures can be used to control the interface\(^3\).

Microsoft has demonstrated examples of what is possible with the extra interaction while watching television, but no information about how to develop ITV applications on the Xbox platform has been found.

3.4 HbbTV

This is a standard for deployment of Smart TV applications over the broadcast signal aimed at broadcasters. Applications can work both on television and set-top boxes making it easier to spread support of the technology. Instead of deploying through the normal application channels available on a Smart TV the content is hosted by the broadcaster. The television is informed of the existence of extra content and with the press of a button the TV can download a web based application and overlay it on top of the broadcast content. This gives broadcasters control over what is available to the user during different shows and programs. Several deployments exist, mainly geared toward bringing on-demand services to specific channels.

Development on the HbbTV platform is based around the web stack as well, with programming interfaces for accessing specific television features such as the video signal and program information. The specification has both required and optional features that the hardware can support.

\(^3\)http://traffic.libsyn.com/majornelson/Xbox_One_Kinect_Voice_Gesture.pdf
Figure 3.3: Simple model of how the Xbox is able to overlay content on the broadcast signal.

Table 3.2: Summary of the differences between the investigated platforms.

<table>
<thead>
<tr>
<th>Platform</th>
<th>Web based</th>
<th>Voice</th>
<th>Smart Phone</th>
<th>Computing power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromecast</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>Limited</td>
</tr>
<tr>
<td>Xbox One</td>
<td>Unknown</td>
<td>✓</td>
<td>✓</td>
<td>Powerful</td>
</tr>
<tr>
<td>HbbTV</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>Varying</td>
</tr>
</tbody>
</table>

This seems to be the only platform that supports overlaying content on top of the broadcast signal in European market. Because broadcasters are in control of both layers of content.

3.5 Summary and Discussion

The common feature found in most of these devices is the reliance on web technologies. They are based on the familiar web platform, with HTML, CSS and Javascript for building applications. They are weak performance wise and will be able to display some animations and some static overlays on top of television. Animating several elements while simultaneously decoding the video requires a lot of processing power. The support for DIAL in these devices might create a world where the Smart TV simply is a device that is capable of taking orders from a user’s second screen device.

The solution to create a platform for interactive television on top of a web browser was chosen because of the devices’ shared web base. The existing solutions were all too weak performance wise to
render the project described in the introduction. Therefore a more powerful base was required, but the lack of information on Xbox development and its availability made it an impossible choice. The decision to make something similar to DIAL was based on both the possible upcoming pervasiveness of the technique but also the simple interaction the technique promises.

The solution was not based around HbbTV simply because of its heavy connection with a single broadcaster and channel. The lack of direct support for connecting to second screens also moved it outside the scope of this thesis.
Chapter 4

Interactive TV

The term interactive television (ITV) has different meanings in different contexts. It can describe the interactive services offered on some set-top-boxes and the specific technologies powering those. It can also refer to any interaction taking place between a user and a television. Interactive TV can also refer to an even broader term referring to the ongoing convergence of digital media onto the television.

There has been some research into this area but with the arrival of ubiquitous devices such as smart phones and tablets there is a need for a combined view of the interaction between many users and several connected devices. This study can be used to guide further development into the previously discussed content portal and applications targeting both the television and a secondary device. The guidelines presented here are not rules to be followed to the letter but meant to aid in designing novel concepts related to the convergence of media and connected devices.

The first section introduces the concepts and its history. The second section presents several design principles aimed at ITV. The third section lists design guidelines for second screen applications formed from experience. The fourth section provides a list of heuristics to apply when evaluating a social application centered around television. The fifth section tries to explain some common pitfalls that might arise when creating interactive experiences for television. The last chapter contains conclusions and discussions.

4.1 Introduction

Interactive television is not a novel concept, some form of interaction has always been possible with a TV.

One pervasive example is Teletext, where the user, through the remote, selects what page of information to display, other common examples include video-on-demand services, the Electronic Program Guide (EPG) and the ability to pause live television. Some refer to the use of the remote control to change the channel as the simplest form of ITV. These are examples of services with low interactivity, whereas high interactivity services often include some form of return channel where information is returned to the broadcaster. Figure 4.1 shows an overview of an ITV setup where a television signal is broadcast to a set-top box and a return channel is used to communicate with the broadcaster.

Early technologies used information embedded in the broadcast signal to transfer interactive content to the viewers and then used the phone line as the return channel. Modern services can be based entirely on broadband connections.
A current example is the BBC Red Button service[1] which is by far the most popular platform for ITV services with around 20 million monthly viewers[10]. When available the service presents extra material, video and quizzes to the viewer.

State of the art platforms include the modern Smart TV with its capabilities to start applications as well as the Google Chromecast¹, Apple TV² and Microsoft Xbox One³. These platforms try different ways to blend interaction with the television and other devices to create ubiquitous experiences.

The use of second screens as remote controls open up for an entirely new way of interacting with broadcast content.

With TVs becoming more and more interactive and powerful, the possibilities for creating more dynamic and connected experiences are coming closer. An experience where even though people are separated spatially they can still have the same level of interaction possible in a shared living room. A lot of research and testing has been done in the field of HCI on the usability of interfaces for computer applications. This research has led to a set of design guidelines that are centered around a computer work station. One important principle of design is efficiency, but studies showed that users in a lean back mode of interaction would prefer a more relaxed interface[5] over the more efficient interface. Showing that the design principles might need to be adapted for the living room setting.

A connected social television experience wishes to capture the essence of watching television together with friends and family and deliver the same experience when separated spatially.

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³[www.xbox.com/xbox-one](http://www.xbox.com/xbox-one)
4.2 ITV Design principles

Designing a user experience for an ITV or second screen product is difficult because of the complex environment the TV is often placed in. There are different remote controls, speakers and amplifiers in almost every living room.

Chorianopoulos[4] proposes the following list of principles when designing for interactive television. These principles are geared towards a general ITV platform but they are still hold value for more specific applications running on a platform based around the TV.

1. **Empower the viewer with features borrowed from a TV production studio.**
   Different viewers have different preferences and while some enjoy the added interactivity others prefer a more passive experience. Avoid adding interactive elements in such a way that they conflict with the passive viewers entertainment. Interactivity that makes the viewer a participant through some game element or by playing along with the contestants of the show is a simple way of creating good interaction. Giving viewers control over what information is presented on screen such as statistics in a sports program lets users produce their own experience matching their own preferences.

2. **Instead of information seeking, support relaxed exploration.**
   With television going from a few channels to hundreds, finding the right program to watch becomes troublesome. People watch television differently, some want to see a specific show or channel and some are looking for unspecified entertainment. The system should both provide an enhanced experience for both use cases.

3. **Release the content from the fixed broadcast schedule and augment it with out-of-band content delivery.**
   With the added possibilities, a connected television can provide out-of-band content, allowing viewers to watch and re-watch content they might have missed. This allows viewers to take control of their experience and using the interactive features to enjoy broadcast material in a way that suits their needs. If possible keep interactive features available when re-watching content.

4. **Consider social viewing that may take place locally, or remotely.**
   Watching television is often a social event where friends and family gather together. An interactive system should take the preferences of all viewers into consideration when creating recommendations for “personalized” viewing. If content is targeted towards many viewers, make sure that the added extras increase the entertainment value for all viewers. The system could provide opportunities for playing or communicating with other viewers both remote and present.

5. **Users do not have to be attentive for the application to proceed.**
   The amount of concentration viewers place on the television varies. Do not assume that the viewer is attentive and ready to respond. Support a lean back mode of interaction where the user might not respond to input at all. Make sure that input dialogues disappear before they are made irrelevant by the progress of the running content.

6. **Enhance the core and familiar TV notions (e.g. characters, stories) with programmable behaviors (e.g. objects, actions).**
   When enjoying entertainment in the living room in a lean back mode of interaction a different user experience is needed. Avoid using graphic elements from the Web and the PC because they will look out of place among the features provided by broadcast media. An interactive
experience should fit the visual grammar of television programming. To keep viewers engaged and attracted over time, design should be dynamic and surprising.

7. **Provide interactive entertainment elements, which might be further augmented with on-demand information elements.**

   It is difficult to predict the value of added content. By making interactive content on-demand the viewers can themselves make the decision about what extra content to display and in a way get the control previously reserved for the television studio.

### 4.3 Second Screen

With the possibility of adding a second screen and creating a more ubiquitous experience special care needs to be taken. HCI depends on both the input and output of the system, with a more modern approach using smart phones in a multi modal design the situation gets even more complicated. By having two options for the output, the television and the smart phone, there are always two places to put information. Deciding if content should go on the big screen, small screen or both is not always trivial.

Robertson et al.[11] propose the following guidelines that they developed during the design of a real estate application. By combining two devices, a television and a PDA, they created a system where users performed input on the second screen and some presentation was moved to the television.

1. **Distribute information across the appropriate devices.**
   Devices have different properties and some are therefore better suited for presenting content and some for interacting with content. Placing content on the wrong screen can lead to a confusing interface forcing the user to switch focus between the different devices repeatedly.

2. **Combine devices so that the ensemble provides more than each independent device.**
   If the applications running on different devices can co-operate and complement each other the result will be better than two stand-alone applications. One example could be using a smart phone instead of a remote control for a more advanced interactive application running on a television.

3. **Information content strongly determines display format, which should be mapped to the appropriate device(s).**
   The type of information is important when deciding where to place it, not only the strength of device. Is the content better suited for a personal display or being shared between all viewers of the application. Rich media, such as pictures, sound and movies, might be a better fit on the television. Rendering text and simple graphics might be better suited on the second screen.

4. **User tasks influence which device is appropriate for particular types of information.**
   The strength of one device might become a weakness when dealing with a different task. Bringing content on the move is not practical with a television but very simple with a smart phone.

5. **Device coordination is critical. Be sure that the information on different devices is coordinated, consistent, and up to date.**
   If different devices display inconsistent views of the data the user will be confused. Devices should all be synced to the same task.
6. Combine the coordinated information guideline with the appropriate device guideline.
Information can be presented in many ways, and by using the different representations of the same or similar content, users can interact with one representation through the other one. Imagine a travel agency where selection between different travel destinations is made through the second screen. When the users selects something on a map more pictures and movie clips could be played on the television.

4.4 Sociability heuristics

A connected TV will allow users to communicate with strangers, friends and their family about the content they are watching. There are several factors to consider when building systems with a social aspect. Users expect different levels of privacy and security depending on whether they are communicating with a friend or a complete stranger. Geerts[6] presents the following twelve sociability heuristics based on the user testing of several social television systems. These focus on a remote social aspect of communication.

1. Offer different channels and levels for communicating freely.
   When users want to comment on televised content they need ways to communicate quickly. To allow for a quick response to a broadcast, the system could allow the user to send quick emoticons or automatic replies to other viewers. For other uses provide both voice and chat as channels of communication. Provide the ability to communicate privately in groups or with public channels.

2. Use awareness tools for communicating availability.
   As remote viewers are not visible to local viewers provide some way to display if the remote viewer is actually present and what status they have. This tool could also provide information about what they are watching and if they are willing to communicate.

3. Allow both synchronous and asynchronous use.
   With the advent of on-demand content a way of communicating asynchronously about the material is needed. Allowing users to like parts of a show or leave comments and then later showing this to other users when they watch the show was requested by users according to Geerts[6].

4. Support remote as well as collocated interaction.
   Groups of viewers will be spread out over many locations, with some joining bigger groups. Make sure that features work well and are appropriate for combinations of big groups, small groups and individual users, across many different locations.

5. Exploit viewing behavior for informing and engaging other viewers.
   Use the information about the user to create recommendations for the user. Provide a way for users to exploit the information to find shows recommended to all or most of the viewers in a shared session. Create functions that aid users in selecting what material to watch.

6. Give the user appropriate control over actions and system settings.
   A system should give the users power over settings to control how information about them is stored. A remote viewing system could become complex and the needs to fulfill the requirements of many different viewers. Users want control over communication functions as well, such as muting audio and blocking camera feeds. Take special care that this control does not interfere with the lean back nature of television.
7. **Guarantee both personal privacy and group privacy.**
   Users showed great concern about privacy and security. As it is possible that several people located in front of the same system ensuring the correct level of disclosure for each viewer is important. The system should also clearly show if other co-located viewers are present so that users do not make mistakes and share things they did not intend to share to remote users.

8. **Minimize distraction from the television program.**
   Design functionality so that it minimizes distraction. Allow users to decide how much the system should interact with them. In collocated viewing one user might disturb others when interacting with the system, bringing up menus and preferences.

9. **Notify the user of incoming events and situation changes.**
   Without breaking the previous heuristic inform the user about the status of other viewers. As this easily can be distracting, make it a controllable feature. Follow the earlier heuristic about control and give the user the ability to control what types of notifications they receive.

10. **Adapt to appropriate television program genres.**
    As both the content being viewed and the purpose of viewing can be different, matching the functionality to the current genre will be important. When watching a football game with millions of viewers, every single comment made is maybe not that important, but the general consensus would be. While watching a thriller users might not want a happy smiley face to appear because a friend saw something funny on another program.

11. **Let users share content flexibly.**
    Integrate sharing content deeply into the experience. People enjoy sharing and creating powerful tools and flexibility around this is important. Allow users to share scenes or edit small clips themselves while also adding commentary. Make shared content available on different devices and make it easy to transfer it between devices and friends.

12. **Encourage shared activities.**
    Present the user with possibilities to share currently watched programs and channels and help users share and create social experiences. Make remote watching just as simple and enjoyable as watching television together in a living room. This can take the form of communicating, watching together, choosing programs and controlling the display of content.

### 4.5 Pitfalls

One of the big issues with ITV is testability[9], because of the very special environment viewing takes place in. Television is naturally a live experience which makes it very hard to do repeatable testing. If the experience includes features such as polling or live audience interaction testing these before the live broadcast will require simulating other viewers. Creating a test environment matching the living room can be very hard because it should be just as relaxed as the test subjects’ sofa back home. People often watch television together in groups they are familiar with. As television is often targeted at very broad groups, from old to young, experienced to novice, testing needs to take this into consideration. Finding test subjects matching all of these criteria can be difficult.

The many different devices required to watch television can also lead to problems. With some using four or even five different remotes, creating a good user experience will be hard. Bernhaupt states that this generation of ITV systems will fail to reach public acceptance because major changes are needed to every component in the living room[2].

Another cause of problems will be the many different technologies and partners involved, from copyright holders, producers and broadcasters. Different ways of delivering interactive content to
the viewers differ in what ways they can be interacted with and what forms of communication they expose. The lowest common denominator is the remote which is considered worthless by some [3, 12]. Different platforms will support different features so creating an experience combining both different second screen platforms and different first screen platforms will become a very complex undertaking.

Lui[8] notes that too much clutter in the interface will lead to a detrimental experience, and that the interaction should not diminish from the viewers enjoyment of the program. The inclusion of polls and other interactive aspects should bring viewers deeper into the show, not trivialize the content.

Interactive components of a show should be an integral part of the broadcast content. Adding these as an afterthought can easily lead to an experience which does not feel well thought out.[8]

Another problem is how each television and second screen will have its own human interface guidelines and best practices. These will most surely not take into account the use of many other devices and how they should interact. This will make it even harder to create an integrated experience targeting many viewers.

4.6 Conclusion and discussion

Section 4.2 contains guidelines that can help with designing systems that combine interactive features with television content. They are very generally written and would work with other systems as well. As the system was being designed the guideline to release content from the fixed schedule influenced the decision to make the platform able to launch video content and not only second screen content. The system designed can be used to create applications that fulfill several of the suggested guidelines, they are not limited by the platform. Guideline number six, that refers to adding programmable behavior to characters and stories, could be interpreted as adding characters to the user interface. Repeating the mistake of Microsoft’s Office Assistant Clippy, one of the most disliked features in computer interaction, is not recommended.

The guidelines in Section 4.3 are focused around using two interaction devices and how to combine these for better usability. These guidelines have not been used to influence the design of the client application as it is not used with the television. The applications started by the client are supposed to interact with the television and will find more use by these guidelines.

Group viewing radically changes how people interact with systems and what needs and preferences exist. The use of second screens can help with fulfilling several of these by distributing interaction to the personal device of that specific viewer. By placing correct content on correct device content can both be held private but also easily shared to all participants by displaying it on the big screen. The second screen can work as a private portal into whatever system is being created. Users can edit their settings, do personal sharing to local and remote groups and even perform personal interaction with the content.

The second screen principles can be very helpful, if they are adapted some, when designing a solution that communicates with other remote viewing devices such as televisions and second screens.

Weiser published the article “The computer for the 21st century” in which he presents a vision of ubiquitous computers[13]. In this vision computers would have one of three form factors, tabs, pads and boards. Tabs would be small as post-its, pads as a paper and boards would be large as todays classroom white boards. We can today see tabs and pads already realized in the smart phones and tablets of modern computing, not exactly as envisioned by Mark, but close. An interactive television capable of easily communicating with other devices takes us one step closer to Marks vision of these three devices working together to create a seamless experience.
Chapter 5

A prototyping platform for Interactive Television

This chapter documents the implementation that was done during the thesis, the different parts of the system and the components used. How each system fits together and what responsibilities they have.

The work started with some simple sketches and a workshop to explore possible use cases and features that users might expect and want from a future application described in Section 5.1.

Section 5.2 presents the first implemented component which is a server running on a standard computer written in Java. The server is an attempt to emulate a television with features similar to the DIAL specification for launching applications. By displaying pages with video content it takes on the role of emulating a television.

The client application described in Section 5.3 running on the phone presents the user with a range of possible activities and lets the user choose between them. The idea is to simulate an application the user would use in front of the television set to explore possible second screen interactions. A few different simple client applications have been written to demonstrate the usefulness of the overall system. Some use the television in a passive way and some use it more actively.

To accompany the first two components a more demanding interactive application was integrated into the system. This application is the project mentioned in Chapter 1.4. The last section describes this demonstrative application.

5.1 Initial design

To create initial ideas for the client and server application a workshop was conducted with the goal of finding possible use cases. The workshop consisted of two brainstorming sessions with focus on two different questions.

– What would you like to do in front of the television?
– How could this be presented?

The participants were encouraged to use either post-its or just say ideas out loud as they thought of something. The workshop included four participants and one moderator and lasted for one hour. During the meeting the moderator also took notes of the ideas and solutions presented by the participants.
Other workshops also took place later in the project though they were less structured and informal.

Most ideas spawned in the workshop were centered around gaining more control of the broadcast content, controlling what camera angle to show or what information to overlay on the broadcast. This is consistent with the guideline of empowering viewers with features found in the television studio, mentioned in Chapter 4.

From the workshops it was concluded that the direction of the project would go more towards the platform than a generic discovery portal. Exploring these concepts seemed more interesting than simply listing and cataloging existing second screen experiences.

5.2 Server

The server acts as an emulated smart television, capable of displaying web pages with videos as well as receiving addresses to display, sent by the client application.

The program written in Java is composed of two parts. The first one is the system for discovering and communicating with the clients. This system is built on top of UPNP and SSDP. SSDP is used by the client and server to discover each other so that they then can use the control and event components of UPNP to communicate and synchronize content to be displayed. The server uses the external library Cling\(^1\) to support UPNP and SSDP. The UPNP system monitors a variable that can be controlled by the client and notifies the second part.

The second part is the browser, that launches a fullsceen browser to render the content when the UPNP component updates the shared variable on the server. The content at the address could be any web page but most would contain a single video with interactive components overlayed.

After the browser is launched the server application is no longer responsible for the communication between client and server. This is up to the started applications.

5.3 Client

The client is an iOS application created to function as a gateway to the server application.

The client can present the user with second screen content grouped by channel and program, this can be seen in Figure 5.1a. The user can select a program in the list and be taken to a another view containing the second screen content. Some content does not interact with the television, such as links to official web sites or applications relevant to the currently running program, such as IMDB. Other content launches both an application on the server and on the client. The client can inform the user if a server application is present on the same network as the client. Figure 5.1b shows how the client presents information about second screen content to the user.

The user could choose between opening experiences alone or sharing them with someone. Sharing the content would simply present the standard sharing interface provided by the iOS platform with a link to the content. The client would then launch the application on both the server and the client. The second example would simply show the official web page for this show. The third example would launch the IMDB application with the information about this show.

Content is parsed from a file written that contains a list of channels and programs with information about the second screen content.

\(^1\)http://4thline.org/projects/cling/
(a) The client showing a list of programs with second screen content.

(b) A list of second screen content for a selected show presented by the client.

Figure 5.1: Two screenshots from the client application.
Chapter 6

Conclusions

This chapter contains discussions on the results and how well the goals were met. This is followed by some words about the restrictions and limitations of the selected solutions and the project. The last section contains reflections on future possible work around this technology and second screens.

6.1 Discussion

The finished solution meets the goals set in the start of the project. The portal can open display content linked to specific programs and this content can range from static web pages to proper iOS applications.

This solution holds great potential for the future as it is based on an up-and-coming standard for SmartTV. Users could be watching a program and in the application they could discover that there exists an application for playing along in the show. By a single click they are either led to the platforms application store or a web application. This click can also launch the install of an application on the big screen further augmenting the experience. It is an iterative step in the process for more interactive content linked to the television.

Of the technologies mentioned in Chapter 3 the solution is closest to the Chromecast in features and functionality, but could also be made to appear more like a television.

The platform places few limitations on the possible applications that can be built on top of the system as it can launch both native and web-based applications. There should be no problem building something that follows almost all guidelines listed in Section 4.2 and 4.4.

6.2 Restrictions and limitations

Several restrictions were made on the solution, such as not supporting the entire DIAL protocol and supporting several clients at the same time. The content inside the client is hardcoded into the application and does not react to changes in current programming but could easily be changed to return results from an external server keeping track of content.

One limitation of the system is client to client communication, it is possible but not implemented in a fully functioning way. They can all request what URL is displayed on the television but lack any way to resolve an URL specific to the client.
6.3 Further work

There are many possibilities for continued work on this platform. There exist other ways to communicate between the phone and the platform.

- The environment inside the browser could also be improved to support the different programming interfaces inside other television platforms. Interfaces for getting content from the television, communicating directly on the network with different devices and other layers that work differently on different platforms.

- The gateway could be transformed into a stand-alone application possible of acting as a living room companion, helping users discover second screen content. As the platform stands as a base for second screen content it could also form the base for shared communication between viewers using different applications. The platform could provide functionality that fulfilled the guidelines in Section 4.4 so that application programmers would not need to implement these features themselves. A consistent social experience across different applications would simplify for the user.

- The client could be extended with extra features such as detecting what content is showing on the television automatically using the sound from the television. This information could then be used to directly guide users to the related content. A sort of relaxed exploration, allowing viewers to find content without looking as mentioned in Section 4.2.

- Work could be put into creating more elaborate examples using the extra processing power of the television. Interesting avenues could be interactive game shows or creating games with interactive components generated on the fly using the video/audio of the currently running show.
Chapter 7

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References


