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Interactive Television News

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ABSTRACT

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We design and evaluate a way to modify television news to make it interactive for viewers. We allow them to get more of what they want and less of what they don't want. This allows news to break constraints imposed by television broadcast schedules. Our solution is to augment the existing news broadcast structure in the following ways: add a video headlines menu, provide on-demand access to additional story content, provide interactive navigation controls between stories, and a control overlay. For news producers we create a video annotation program and process to help create the interactive news. We use the production tools in a news production room for a week to show viability. We also evaluate the home interactivity by having viewers provide feedback after watching the interactive news produced during that week. Our results show that our solution easily fits into existing news production processes. The solution provides additional depth into stories and individualizes the newscast for each viewer. The interaction for viewers is optional and easy to use, but future work could make it even easier to learn and use.

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Chapter 1 – Introduction

Television is widely used as a medium for people to receive entertainment and information. Currently television is a receive-only mechanism. The only control viewers get over what they see is selection of different channels. The amount and kind of information and entertainment received is limited by the number of channels and the current broadcast schedule of each channel. One way in which people receive information via television is television news.

Television news has been popularized since the middle of the 20th century. The format of the news has remained largely the same since that time. An anchorperson will read prepared statements telling the audience about each story for a short time before moving onto the next. Often certain stories will be prerecorded and explained by individual reporters. Recent additions include live shots from outside the newsroom studio, by satellite feed or otherwise. This can allow conversation between remote reporters and the news anchors. These live feeds allow reporters to remain at the site of the news and show a story in action as it happens, although this rarely occurs in practice [TUGG 01].

Despite all the advances in technology, the news on television has remained very similar in format since its inception. This is at least partly due to the fact that during the entire history of television news it has been delivered to viewers using broadcast technology. By definition, broadcast is a one-size-fits-all approach where every viewer receives the same content at the same time. As a result, whether they like it or not, each viewer has to watch the same news in the same way and at the same time as every other viewer.

This broadcast technology limits television in many ways. For example, because news is delivered across a dedicated channel, the news programs must be limited to a certain time slot in

order to leave room for other programs. Many news programs are set to last exactly 30 minutes.

This also limits the length of any individual story. Stories are set in length often by how

important news producers think the news will be to all viewers. If any particular viewer wants to

see more about a particular story, they have no way to receive additional information about the

story. The length of the story is fixed. Sometimes additional information is available on the

news producer's web site, but it is extremely cumbersome for the viewer to access that

information, both in terms of interface and continuity of experience. Even if the news producer

has much more information about a topic, viewers cannot access this from their television if it is

does not fit in the broadcast schedule.

The broadcast schedule also limits which stories make it into the news. Stories that are not

deemed interesting enough do not get reporters covering them. This is not due to lack of actual

viewer interest in stories, but rather due to lack of perceived aggregate interest. Even though a

potentially large segment of viewers would like to see this type of story, it will not make the cut.

Another result of the broadcast news format is that viewers may not get much of what they want.

Since there are a very limited number of detailed stories that can be included in a newscast,

producers try to show the stories that they feel will be most appealing to the greatest segment of

the audience. This least-common-denominator approach can leave many viewers only getting a

few stories that they are genuinely interested in. Many of the remaining stories are not as

interesting to the viewer. Some of the stories may be so uninteresting that viewers will tune their

televisions to another channel to watch something more engaging.

News producers also can create more newscasts than are needed in order to provide viewers with

live news at more times. This overproduction happens because most news is broadcast live as

news anchors are filmed. Thus multiple newscasts are broadcast to fit viewers' schedules.

These newscasts contain redundant content. If the news could be interactive to fit viewer

preferences and schedules, this excess in production could be reduced.

A final problem of broadcast television news is bias. Since there is a limited amount of time to

dedicate to each story, the story has to be summarized by the reporter. This summary only

includes a portion of the information the reporter gathered and bias can be introduced in the

decisions of which content to show. Bias can also occur when the reporter is very unfamiliar

with the subject matter of the story being covered. The reporter's interpretation of events or

ideas may not match reality in cases such as these. It is also possible that news stations can bias

news stories to promote their own agendas rather than being objective. Bias is a problem for the

viewers because they don't receive an accurate version of the story. If viewers have the ability to

see more of the information that reporters gather, they could have a more accurate picture of

what really occurred and could form more educated opinions and ideas.

Recently, technologies have come available that are capable of delivering video in a different

way than traditional broadcasting. These technologies use Internet transmission to deliver

television-quality video on-demand to individual viewers that request it. The technologies are

also capable of transmitting arbitrary metadata with the video and generating viewer-side video

overlays on-the-fly. A further treatment of these technologies is found in Chapter 2. This new

transmission medium supports a wide array of interactive television techniques. It has the

potential to give users more of what they want and less of what they do not.

Our problem is determining how to modify television news to make it interactive for viewers to

allow them to get more of what they want and less of what they don't want (see Figure 1). Any

solution needs to be easy to learn and use and should provide a deep and individualized experience for each viewer. In addition, this interactive news should be simple to produce.

Figure 1: Our interactive television news solution

The controls for any kind of interactive news should be easy to use and learn. Bucy [BUCY 03] notes that too much interactivity in news can have negative effects, such as the user becoming lost and disoriented or having a negative view of the system. There is a large difference between the low-effort or "lean-back" interaction expected from television and the high-effort or "lean-forward" interaction that occurs on computers and the World Wide Web. Current television setups require only using a remote control to perform simple tasks such as changing the current channel, changing volume, etc. However, the Web requires much more effort for users to receive the content they are seeking, even with news. They must first type in or search for the news provider they are looking for, then make sense of the layout for the news provider's site. After this they must navigate several layers of links possibly combined with searches to find

content. Once they find the content they are seeking, they need to use a mouse to navigate small video playback controls to view the news content. Seeking related content often involves a similar process once the video ends. The entire process can be confusing and usually involves reading large amounts of text. This type of activity is clearly not appropriate for television interaction.

Jensen [JENS 05] also supports this idea of "lazy interaction" for television. He states that interaction for television should require minimal viewer effort and have simpler interfaces. We also feel that, as we are targeting a change in television news, it is necessary to retain as much of the "lean-back" feel of television as possible. Therefore, a viable solution should be able to have its interaction be low-effort as well as optional.

Elberse found in a study on potential interactive news controls [ELBE 98] that people would be more receptive of news that had a rather transparent story selection method. This is quite in contrast to the selection methods found for news on the Web where there is no way around the heavy "learn-forward" story selection method. He further finds that people would like having a smaller selection of stories chosen and presented through an anchor or other agent as opposed to having all possible stories available to them to choose from. This further supports the idea of simple controls and optional interaction for television news.

For interactive television news to be effective, it must be individualized and have depth. Individualization means that the viewers get to have the news modified to suit their personal tastes. This individualization usually requires interactivity as a means to achieve that goal. Depth in this context refers to the viewers being able to easily get more information on a news story than they otherwise would in a traditional news broadcast. Since interactive television

news can be delivered through an individualized video stream, there is no reason from the viewer perspective not to provide additional content on topics they desire. Sometimes extra content is created, but it can only be accessed through the news producer's website. However, shifting from the lean-back television interface to the lean-forward website is undesirable and takes time.

With interactive television news, the viewers can individualize news to their tastes. They can watch television news on their own schedule. They will be able to easily able to access more information on topics of interest to them individually. They can choose to skip stories that are not of interest to them and move directly to more intriguing topics. Research by Elberse [ELBE 98] supports the idea that viewers will benefit by suggesting that people may be receptive of interactive news services if they are implemented properly.

The flip side of more interactivity in news is the increased effort it takes to produce.   If a newsroom has to produce more content for an interactive newscast it will require more time and money. In addition, due to time for shifts in industry trends, news production will still have to occur for traditional newscasts for a long time after any kind of interactive news is introduced. Since supporting both types of newscasts simultaneously could potentially be costly, the additional cost of producing interactive news should be small and have a small impact on the current process to make it easy to implement.

Despite the additional effort of interactive newscast production, news producers stand to benefit from producing interactive news programs. First, news producers will be able to provide more transparent journalism for viewers. Giving viewers extra content can make this transparency possible. Also, if news producers make entire interviews available to viewers, the viewers will be able to detect any bias for themselves. This has the potential for news producers to gain more

trust from their viewers, which is a major advantage in competition between news networks and from other sources of news. In addition to being more transparent, producers could receive the benefit of having viewers enjoy their news more because they can give viewers more of what they want.

In summary, both viewers and producers could benefit from interactive television news. However, to be good, an interactive news solution should meet certain requirements:

- The controls must provide "lean-back" interaction and be easy to learn.

- The interaction should not be required.

- The effort required by news producers to make interactive news should be small.

- The interaction must allow for a deep and individualized viewing experience.

For our interactive television news solution, we address both the needs of news viewers and news producers. For viewers, we create a viewer interface that allows them to watch and interact with the news (Figure 2).

Figure 2: Screens from news viewer interface with important features numbered

There are five main features of this interface as shown in Figure 2. The first (1) is a video headlines menu that allows viewers to express preference about stories in the newscast at the beginning. The second (2) and third (3) are a navigation menu and navigation controls. The navigation menu allows viewers to see all of the content in a newscast and jump directly to what they are interested. The navigation controls allow viewers to skip around between stories when they choose. The fourth feature (4) is access to the extra content associated with each story. This access is provided during the story and directly from the navigation menu. The last main feature (5) is a control overlay that is consistently accessible. This allows the viewer to easily learn the controls of the system. The details of the viewer interface including details of our prototype implementation are found in Chapter 4.

For producers, we create four main tasks that they must do to make interactive news. The first of these is to produce the video headlines menu. The second is to digitize and upload the raw video

from their normal newscast. Third, they must produce and upload the extra content on stories. Finally, they must use an annotation tool to create the metadata and links needed for the viewer interface to navigate around the newscast. The system and process of creating interactive television news is detailed in Chapter 5.

To adequately validate our solution, we built a working prototype system based on our designs. While developing the system, we worked with BYU Daily News, a university news producer, to ensure the prototype is feasible for news production. The system consists of all the components needed for news producers to create interactive news and all of the components needed for viewers to view interactive news. Testing this system required a two-fold approach to assess the reactions of both of these audiences. We gave our tools to news production staff at KSL News, a professional production newsroom, and had them produce interactive news for one week. We also deployed the news viewer interface in viewer homes for a week. Chapter 6 gives the details on our evaluation setup and the results of that evaluation.

Our results show that viewers enjoy our news viewer interface. They are able to individualize their news and get more depth in stories. The interface is easy to use overall but needs more work to make it easier to learn and use. The extra content providing depth needs to be more accessible and interesting as well. News producers find the system easy to use and that it only requires a small amount of effort on their part. The producers are able to create and deliver interactive news to viewer homes for a week successfully.

Chapter 2 – Related Work

There has been a variety of work done on interactive television news. This is largely due to the recent tractability of storing large amounts of digital video and the even more recent development of delivering on-demand, high quality video over the Internet. The work in interactive television news includes work on actual video news interfaces (some more television-like than others), live interactive news, news annotation, and foundational internet video transport technologies. All of these approaches have shortcomings that fall short of properties we feel important for interactive television news.

2.1 – Video News Interfaces

The most notable of the work done on interactive television news is the MyNews&SportsMyWay project [LARS 08]. This was done as part of the New Millennium New Media project [WILL 07], which did a broad range of interactive television experiments across several genres. MyNews&SportsMyWay creates a whole interactive news viewing experience. Users of the system create profiles in which they select topics that are of interest to them. The system automatically creates newscasts for the users in a variety of different subjects (see Figure 3). These newscasts are generated by linking a variety of story clips from a database of previous clips which have been tagged according to relevant topics. The system allows users a variety of navigation methods between stories. Options include increasing or decreasing the time of the newscast, jumping to other related stories, and skipping stories. This system tries to have a lean-back interface once a user starts viewing a newscast.
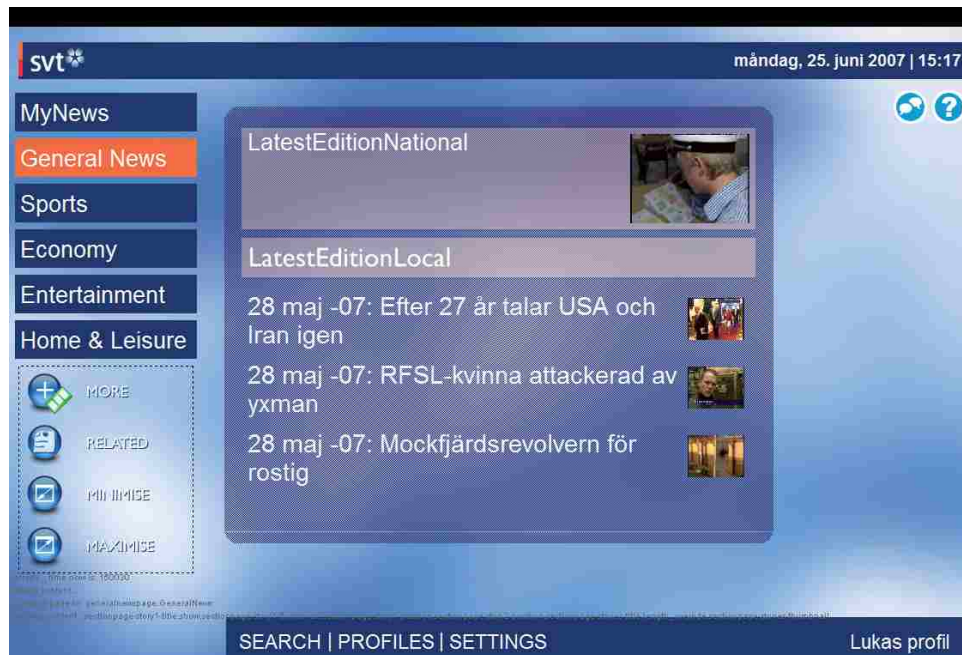
Figure 3: MyNews&SportsMyWay news selection screen

Despite the versatility of MyNews&SportsMyWay, it has some shortcomings. The system ignores integration with existing production processes – the solution given is to replace traditional news production. The system does not allow the user to have additional depth in a particular story, but rather provides breadth by allowing navigation to related stories. The user must go through the lean-forward process of creating a profile in order for the system to start creating news programs. Also, the system omits the inclusion of news anchors to provide cohesiveness for the entire newscast. Lastly, there was no evaluation performed on news viewers to determine how they respond to the system.

MyInfo [ZIMM 03] is a system that records news broadcasts and augments them with automatic segmentation and annotation (Figure 4). Other relevant information from the web is also aggregated into the system. This system uses a user profile to select which stories to display to the user first. The system is divided up into content zones based on category of information such as traffic, weather, headlines, financial, etc. The problems with this system include having too

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much textual content and a larger number of interactions required to view content.   Also, the

system does not address news production, but rather records and uses clips of existing television

newscasts that have been already broadcast. Finally, the only depth in stories from the system is

through content aggregated from the web which is limited primarily to conditions based

information such as weather and traffic conditions as opposed to more information on a

particular news story.

Figure 4: MyInfo interactive news system

SAVANT [BYWA 04] applies a video, audio, and text aggregation system to news. It also uses

a user profile to recommend stories to the user. The user must select desired stories from a list in

order to watch them (Figure 5). The SAVANT system is designed to work across multiple

devices including TVs, computers, and PDAs. This system suffers from similar issues as the

MyInfo system. In particular, it has too much text and ends up being more of a lean-forward interface than is appropriate for television. It also uses recorded news programs from broadcast television content rather than addressing the news production directly.

Figure 5: SAVANT news story selection screen

Informedia [HAUP 97], uses a speech or text query interface to retrieve matching news stories from a database that includes videos, text, and audio sources (Figure 6). This system automatically derives captions for video stories using closed captions or other transcripts. These transcripts are used to help locate content from the user's query. The problems of the system include the required interaction (query and selection) to play each story and the complexity of

the on-screen interface. This makes the interface much more suited to a lean-forward

environment than for television. In addition, since the system is mostly a video retrieval

mechanism, the viewer must know exactly what they want to see in order to request it; there is

no browsing or "show me what happened today" option. This limits the usefulness of the system

for casual news viewers who are not following a particular topic.

Figure 6: Informedia interactive news

These existing interactive television solutions have largely ignored the news production process.

They either take existing already-broadcast news and restructure it or completely redesign the

production altogether. It is important to address the creators of the news for any viable news

solution because they will ultimately be the ones in charge of the content. Having news staff

aware of how interactive news is produced can help them make better decisions as to how to

create news for that type of interaction. In addition to this, since traditional news broadcasting

needs to occur in conjunction with any adopted solution until a complete transition can be made,

any viable production of interactive news must be have a low overhead and work well with the

traditional news production process.

The BBC's Red Button interactive TV [BRIT 09] is notable because it is currently in production

use. Viewers watch the normal newscast but can call up an on-screen menu with more

interactive options using a designated red button on the remote (Figure 7). This menu allows

them to show text-based headlines, skip to a news video feed of their choice and even watch a

split-screen mode with four news feeds at a time.

Figure 7: BBC Red Button interactive TV news

The major problem with the BBC system revolves around its use of broadcast technology for the

implementation. This means it is not a true video-on-demand system. Multiple broadcast

channels are used to deliver each of the different possible videos. The videos on these channels loop continuously. This obviously makes it very easy for viewers to miss the beginning of the video and be forced to wait for the next loop. The amount of content viewable at any one time is limited to the number of broadcast channels being dedicated to the content. This content must be replaced by updated material when new material is ready. This inhibits viewing of archived content and still forces the user to have to watch on a schedule for the loops. The broadcast system prevents a completely individualized experience and also limits the amount of depth possible for additional information on stories.

2.2 – Live Interactive News

A different approach to interactivity in news has been live interaction: where the viewers can directly influence the news reporting process in real-time as it occurs. One system proposed by Every [EVER 04] has the reporter receive live comments and questions from the viewers as they are performing an interview. This allows the reporter to ask the viewers' questions directly to the person being interviewed. Similar systems have been tested in the UK. These include live viewer polls and live comments or questions to news discussion panels. These types of systems have viewers enter responses from on-screen overlay prompts that are relayed back to the production studio through a low-bandwidth connection. Unfortunately, these types of interaction do not work well for many viewers, since they are unable to watch the news at the time of an interview or news discussion panel. In addition, the reporter or panelist can only respond to questions or comments of a few of the viewers. Thus these systems are not very individualized, even if they are interactive.

2.3 – Automatic News Annotation

There has been a significant amount of work in trying to automatically segment and annotate news video into stories with attached textual labels and script. Examples of this include the work by Dowman et al. [DOWM 05], Haas et al. [HAAS 02], and Hauptmann and Witbrock [HAUP 97]. This often involves using speech analysis in conjunction with transcripts such as closed captions and image processing to determine story boundaries and the content of those stories. We consider this work unnecessary for interactive television news because news producers already create most if not all of this information in the process of creating their news broadcasts. Modern newsroom computer systems, such as Avid iNEWS [AVID 09], track all of this information in computerized form already. For example, the content of the story is already in place from the script that the news anchors read. Also, the divisions between stories are determined by the producer controlling which video to show or which camera shot to broadcast. We feel that a manual annotation by newsroom staff or even a direct connection to existing newsroom computer systems would be sufficient to capture all necessary annotation on news video content. This process would give news producers more control over the annotation process as well, helping them tailor the annotation as they like it.

2.4 – Interactive Television

Numerous attempts at consumer level interactive television of one sort or another have been tried over the last few decades. Our purpose here is not to detail other types of interactive television genres outside of news. Jensen has written a succinct history of interactive television [JENS 08]. He notes that many past systems have suffered from the lack of usefulness of the interactive features over normal television. He also notes that a large problem has been affordable and efficient technology for the delivery of the content and interaction data.

2.5 – Video Unicasting Technology

Recently, new technology has been developed that allows for the transmission of high-quality video over the Internet. This allows each individual user to receive a video stream that is unique and independent from other users. We will refer to this technique as video unicasting. When video is transmitted unicast, the viewers can watch television on their own timetable, without having to conform to a broadcast schedule or rely on a personal video recorder (PVR) for time-shifting the content.

The pioneer in making video unicasting technology viable is Move Networks. Their adaptive streaming approach [MOVE 09] takes digital video content and splits the content into short segments (usually two seconds each – called streamlets). These segments are encoded at multiple bitrates and posted on web servers as files. The client player technology can access these segments and reconstruct the video seamlessly. The addition of multiple bitrates for the files allow for varying conditions in Internet connection quality to not interrupt playback for buffer time: the player requests the video segment that is most suitable for the current transfer rate (Figure 8). In addition, the same video does not have to be re-encoded for platforms that have different bandwidth profiles (e.g. mobile devices).

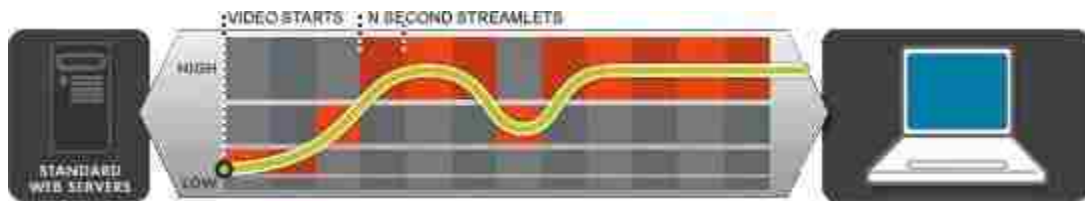Figure 8: Move Adaptive Stream technology – The yellow line represents the current available bandwidth of the connection. The correct video segment (streamlet) is chosen and downloaded in response to variability to the connection.

This multiple encoding of small segments also allows minimal buffering time between requesting a video and starting to play since a lower bitrate segment can be loaded and played

quickly while higher quality segments are buffered in the background. This quick-start allows users to interactively jump around to different videos with little interruption of the viewing experience. The other advantages to the Move's approach are the ability to seamlessly interface with existing web caching technologies for wide-spread distribution over content distribution networks and the ability to encode and quickly play back content to viewers in near live time.

Microsoft has a similar technology called Microsoft IIS Smooth Streaming [MICR 09]. This technology nearly duplicates the Move technology except splitting the file into segments is done later in the process, making live video harder to work with. However, the Smooth Streaming client technology is built into existing GUI and interaction frameworks, namely Windows Presentation Foundation and Silverlight, making it easier to make richer client-side experiences.

Adobe also has an Internet video unicasting solution called Dynamic Streaming [ADOB 09]. This solution has a dedicated server stream the video directly to the client using a custom protocol. The client-side logic attempts to detect when the current bandwidth is not suited to the stream playing and sends a request to the streaming server to play a lower or higher quality stream. The server appropriately switches the stream at the next keyframe in the video to avoid interrupting the playback on the client side. This technology is not as effective as the other technologies for rapidly changing streams but can still provide a relatively seamless experience for viewing video over an Internet connection.

These new video technologies make new types of interactive solutions possible. They allow content to be delivered on-demand and change interactively. However, no existing interactive television news solution can make the best use of these technologies. These current solutions neglect important issues in interactive television news.

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In short, none of the existing interactive television news solutions give users a simple, television-like interface that avoids complexity, has optional interactivity, and addresses the news production process from start to end while giving an individualized and deep news experience.

Chapter 3 – System Overview

We have several goals in creating our solution to interactive television news. First, we are trying to address the needs of both news producers and news viewers. Without addressing the needs of both of these groups, we feel that it will be hard to deliver a high-quality news experience to viewers. Second, we want to create a lean-back interface that is optional and easy to learn. Third, we want to provide a deep and individualized news viewing experience.

Our solution is comprised of several parts that work in concert to make the news viewing and production processes work together. In this section, we describe our particular prototype implementation of the system, however the system's various parts could easily be implemented in different ways. We first describe the way we structure the interactive newscast. We then describe each of the parts of the system architecture and how they interact.

3.1 – Interactive Newscast Structure

The structure of our interactive newscast involves three types of videos: newscast, video headlines menu, and extra content. The videos are segmented into different parts and metadata is added to those segments. This gives us the overall structure of the interactive newscast. We will refer to this structure as annotations because the raw videos comprising the newscast are annotated with this additional structure information.
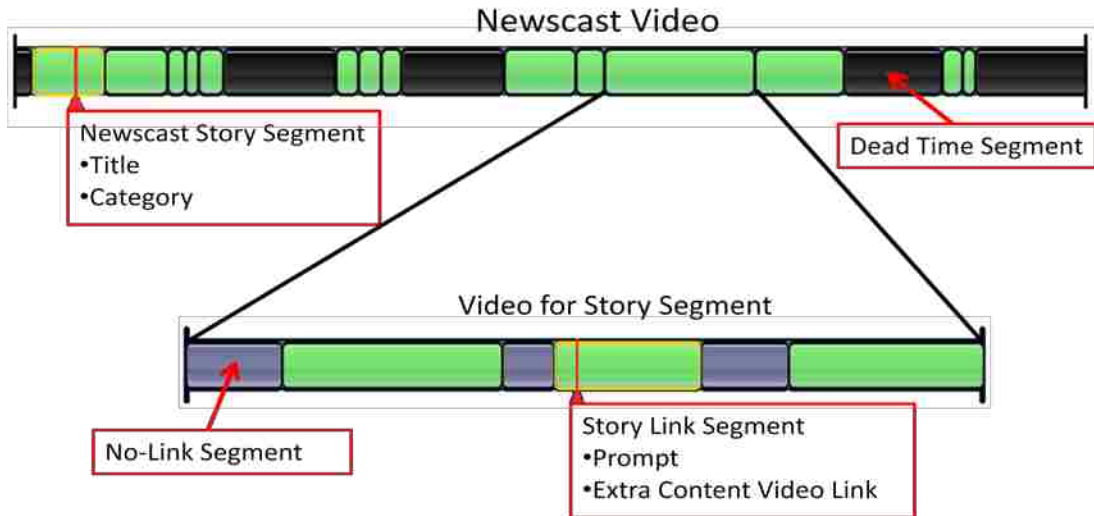
Figure 9: Newscast Video structuring - video is shown as a timeline with blocked segments

The newscast video contains all of the stories that are being reported. As shown in the upper

portion of Figure 9 this video is broken into segments according to story (shown as green

blocks). Each story has a title and category associated with it. Categories for stories include

items such as local news, national news, weather, sports, and so forth. Any additional video in

the newscast that is not a story for the interactive version is marked as a dead time segment

(shown in black). Examples of dead time include commercial advertisements in the newscast

and sections enticing the viewer to continue watching across commercials.

Each story segment in the newscast can contain links to extra content videos (see the lower

portion of Figure 9). These links are segments in the story that correspond to a particular piece

of extra content (such as a clip from an interview). Each of these segments has prompt text to

explain what the linked extra content is. The segment also stores a link to a particular extra

content video. The same story can have multiple segments that link to the same extra content

video if needed. Any sections of the video that should not link to extra content are marked as no-

link segments (shown in gray). These parts of the video are generally include things such as introductory material, anchors talking, and ad-lib sections.

3.1.2 – Video Headlines Menu

Figure 10: Video headlines menu structure

The video headlines menu is a video that briefly introduces important stories in the newscast, one after another. Viewers can use this video menu to express a preference about these stories. The video is broken up into segments (shown as green blocks in Figure 10) that contain a textual prompt and a link to a particular story in the newscast. The sections of the headlines menu that do not contain headlines are no-headline segments (shown in gray). These are parts of the video, such as the beginning, where the anchors are not talking about a particular story in the newscast.

Extra Content Videos

The extra content videos are supplemental videos that contain extra information about a particular story. Unlike the other videos, they have no special segments. These videos are associated with one or more story link segments as described earlier.

3.2 – System Architecture

The interactive news system is composed of several major subsystems. Figure 11 shows the general relation of these systems and how they access each other. This access generally takes

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place across the Internet to allow easy isolation of subsystem parts while maintaining universal access. The subsystems roles and implementations are detailed below:
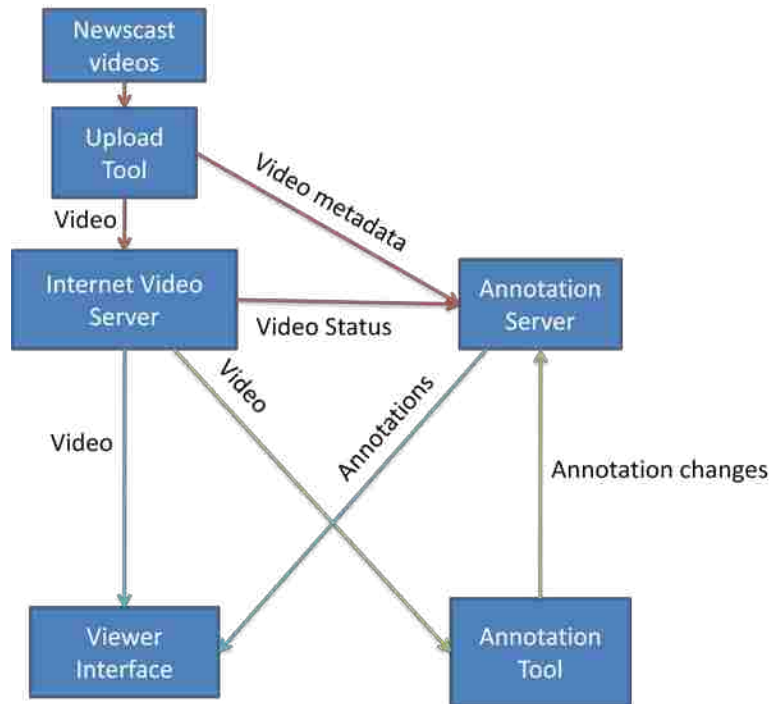
Figure 11: System architecture overview

Newscast Videos: Video files created by the news producers. These include the video of the newscast itself, the video headlines menu, and the extra content videos.

Upload Tool: A tool accessible from the web that allows producers to transfer video files to the rest of the system with some basic metadata.

Annotation Server: A server that stores all annotations on videos in conjunction with a particular newscast. This metadata includes all video segment information as described earlier.

Annotation Tool: A web-accessible tool that allows creation of the annotations used in the annotation server.

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Internet Video Server: A system that takes digital video files as input and creates and delivers versions of these videos suited for Internet streaming delivery.

Viewer Interface: The system that a news viewer sees on their television to view the interactive news.

We will describe the system architecture parts in terms of different stages in the process for producing and viewing one interactive television newscast. The stages of the interactive news process are 1) the production and uploading of the various newscast videos, 2) The annotation and linking of the videos into their various parts as described above, and 3) viewing the completed newscast.

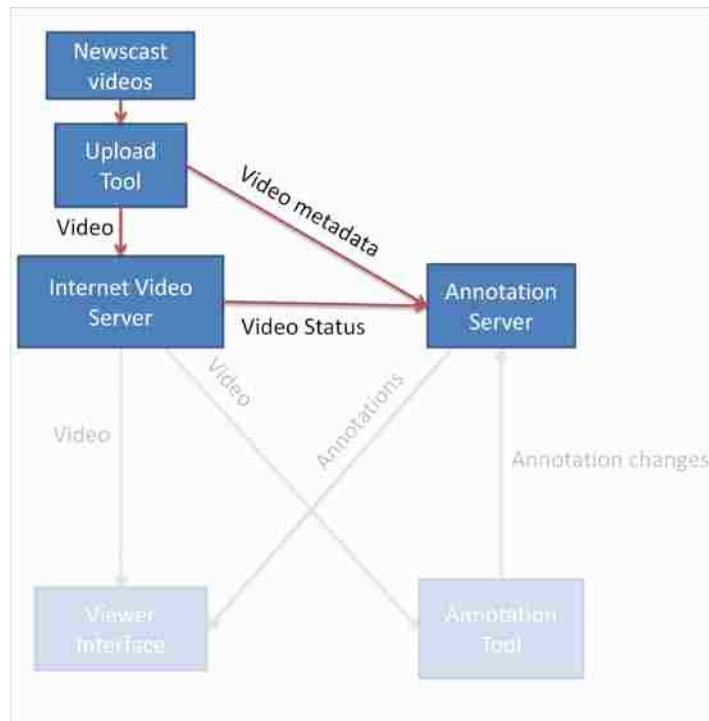### 3.2.1 – Stage 1: News production and uploading

Figure 12: Stage 1 - News production and uploading

To start the interactive news production process, news producers produce the three types of videos for the newscast. The production and uploading stage of the process is highlighted in Figure 12. After creating each of these videos, they are transferred to the Internet Video Server through the video upload tool. The tool also allows them to be tagged with metadata about which kind of video they are and which newscast they belong to. The video metadata is sent to the Annotation Server, which stores that metadata and waits for the Internet Video Server to finish processing the videos. The Internet Video Server takes the video files and converts them into a format for viewing over the Internet. In our implementation, we use the Internet Video Server by Move Networks. This system breaks the video into two second segments and encodes all of those segments at various video bitrates. These encoded segments are made available to the corresponding playback software as individual files over HTTP. As described in Chapter 2, this encoding system allows viewers to start watching the video with minimal buffering and automatically adapt playback bitrates to current available connection bandwidth.

Once the Internet Video Server finishes processing and encoding the video files, the Annotation Server is notified that the videos are now ready (the video status in Figure 12). This marks the newscast video as ready for annotation.

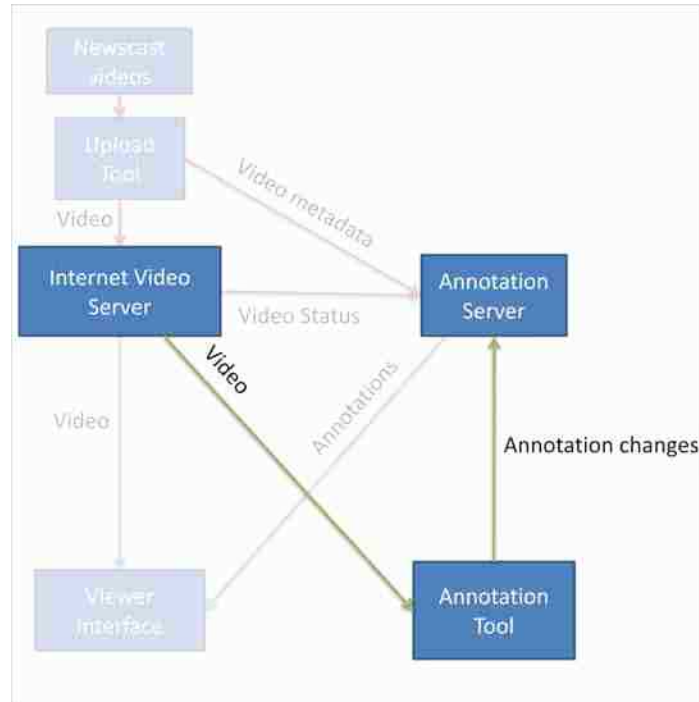### 3.2.2 – Stage 2: News annotation and linking

Figure 13: Stage 2 - News annotation and linking

Once the video is processed, we prepare it for the viewer interface using the Annotation Tool.

Figure 13 shows this stage in the process. The annotation tool is a web-based interface that

allows news producers to mark the videos of the news into segments with metadata and links as

described earlier. The Annotation Tool stores the annotation changes in real-time to the

Annotation Server. This avoids storing all of the annotations in the Annotation Tool. In our

implementation, these annotations are stored in a database through various JSON web-services.

As shown in Figure 13, the annotation tool displays video by contacting and retrieving this video

from the Internet Video Server. As soon as the annotations are complete and all of the video is

ready, the Annotation Server marks the newscast as available for viewing.
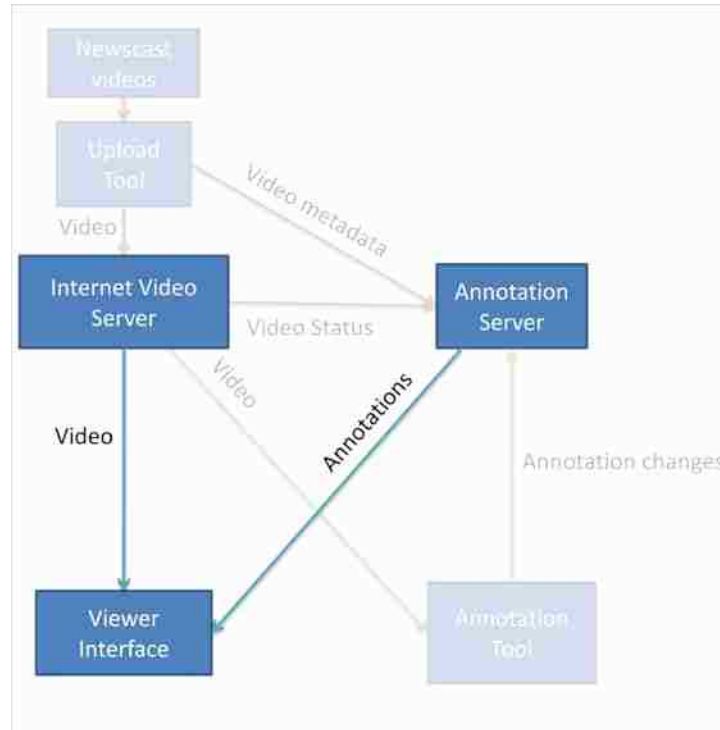
3.2.3 – Stage 3: News Viewing

Figure 14: Stage 3 - News Viewing

Once the annotations to the video are complete, the newscast can be viewed through the viewer interface. Figure 14 shows this stage of the process. The viewer interface first retrieves a list of available newscasts from the Annotation Server. This list allows viewers to select the most recent newscast or one they may have missed. Once the viewer selects a newscast to view, the viewer interface will request the all the annotations for that newscast from the server. The annotations include the identifiers for the videos as they are stored on the Internet Video Server. With this information, the viewer interface can retrieve the correct videos as they are required. The viewer interface does not have to contact the Annotation Server after the initial annotation download. The news viewer interface then builds a playlist of stories in the newscast based on the annotations. The viewer interface first displays the video headlines menu, followed by each of the stories in the newscast. The interface allows navigation through the newscast at any time.

Viewers also have access to the extra video content on particular stories created by the news

producers.

Chapter 4 – News Viewer Interface

The news viewer interface allows viewers of news to see the newscast and interact with it. We describe the news viewer interface before the news production process in order to show the goal of production. This will help frame the description of the production process in the next chapter.

4.1 – Remote and Control Overlay

In our implementation, we use the remote control shown in Figure 15. We prefer a remote that has fewer buttons than a traditional remote because, unlike traditional remotes, we can change the functionality of the buttons at any time. We can change what the buttons do because we can show the current functions of the buttons on screen. This avoids having one button per function as is common on traditional remotes. The remote we use also contains a gyroscope that allows for a tilt-controlled pointer and tilt-based gestures activated with the lower middle button.

Figure 15: Remote control used in our implementation

To aid in learning the controls for the remote, the viewer interface provides a control overlay (Figure 16).

Figure 16: Newscast with control overlay shown

This overlay is displayed at any time by holding the trigger on the back of the remote. As shown in Figure 17, this overlay shows a rendition of the actual remote with labels showing the current function of each button. We feel it is important to have this overlay closely emulate the physical layout and appearance of the remote device itself. This allows novice viewers to quickly associate which buttons have which function on the real remote.

Figure 17: Detail image of control overlay showing basic controls

The viewer interface also shows a control overlay at the bottom of the playlist menu for quick reference since the functions for many of the buttons change significantly while the playlist is showing. The control overlay otherwise serves as a reminder and only needs to be shown when

the viewer does not know or remember what function a particular button has. Thus, the control overlay serves as an aid to learn the functions of the system, but does not unnecessarily encumber the interface.

The viewer interface itself is primarily based on the concept of a playlist of stories. This playlist is generated from the annotations the viewer interface retrieves from the Annotation Server. The default way the newscast plays is to first show the video headlines menu and then show the stories in the playlist in the order specified by the annotations. This allows the newscast interaction to be completely optional. This property makes our solution for news much more suitable for deployment to a wide audience, even those who do not want or would feel uncomfortable using the interactive features.

The main interactive features of the viewer interface consist of a video headlines menu, a playlist menu, navigation controls, and access to extra content.

4.2 – Video Headlines Menu

When viewers start watching a newscast, there is a short introductory segment where the anchors briefly introduce each important story. We call this the video headlines menu (Figure 18).

Figure 18: Example video headlines menu with headlines title prompt highlighted

These 5-10 second summaries are designed to let the viewer know a little about the stories that are contained in the newscast. The total time of the headlines menu can vary between about 45 seconds to 2 minutes in length. While each headline summary is playing, a prompt appears at the top of the screen (Figure 19), showing the viewer the title of the headline summary in the video and a small reminder indicator showing what actions the viewer can take.

Figure 19: Example headline title prompt

During each headline, viewers can indicate using the remote whether they are interested in the story or not. While the headline is showing, a user has three interactive choices:

- **Interested**: The viewer can indicate interest in the story corresponding to the headline by pressing the left button on the remote. This will show a thumbs-up symbol next to the headline title.

- **Not Interested**: The viewer can indicate disinterest in a story by pressing the right button on the remote. This will show a thumbs-down symbol next to the headline title.

- **No opinion**: Viewers also have the choice to press neither button if they have no particular opinion on the story as to interest or disinterest.

The choices made during the headlines menu are a way to quickly and seamlessly indicate which stories they would like to watch and which ones they would not like. Using these indicated preferences, the viewer interface will reorder the stories in the playlist of the newscast as illustrated in Figure 20.
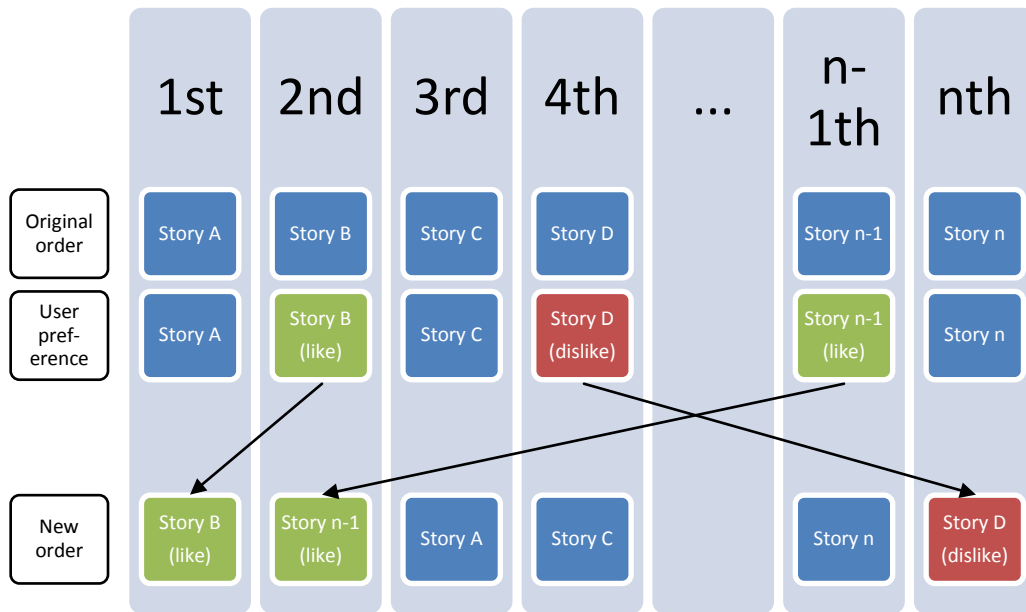
Figure 20: Using the video headlines menu preference selection to reorder stories in the newscast.

In the example shown in Figure 20, the viewer has indicated that she likes story B and story n-1, dislikes story D, and has no preference on the remaining stories. This causes stories B and n-1 to move to the front of the playlist and story D to move to the end of the playlist. The relative orders of the remaining stories remain unchanged. In this way, the stories that the viewer likes are shown to her first and the ones she does not like are shown last. This causes the stories that

were not shown in the headlines menu and those about which the viewer did not express any preference to be shown with secondary priority.

The headlines menu allows viewers to individualize their newscast in a way that gets them to the content they want faster. They also can defer the content in which they are not interested. This provides a quick and easy way to individualize the newscast to viewer preference. The headlines menu is a video menu and therefore provides a lean-back style of interaction that is well suited to television. This is in contrast to the personal profile setup needed to use some existing interfaces including MyNews&SportsMyWay. The headlines menu also does not prevent the user from experiencing other news stories as a simple selection menu could, it simply re-prioritizes them. Also, since the video headlines menu will continue without any viewer interaction, its interaction is completely optional. If the viewer does not interact, the headlines menu is presented similarly to headlines that viewers see in traditional television news.

4.3 – Playlist Menu

The viewer interface provides further individualization through the playlist menu. The playlist menu (shown in Figure 21) contains a listing of all of the stories in the newscast.

Figure 21: The playlist menu

They are shown in the order in which the stories will play and the currently playing story is highlighted in yellow. The viewer can display or hide this menu at any time by pressing the lower right button on the remote.

The playlist menu can be used to provide quick access to any of the content within the newscast. Viewers can scroll up and down this list using the wheel button on the remote to view the stories in the newscast. They can select one of these stories by pressing the wheel button to jump directly to the video for that story. Access is also provided to directly view the additional content clips from each of the corresponding stories in the playlist. The viewer can also replay the headlines menu from the playlist.

The playlist menu serves as a mechanism for the viewers to further individualize their newscast viewing experience. If viewers lose interest in the story they are currently watching, they can display the playlist and scan it for a more interesting story. This not only gives them a better

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idea of what is in the newscast, but also allows them to jump directly to another story that might be of interest. Thus they can interactively change what news is currently showing to something they desire.

4.4 – Navigation Controls

The news viewer interface also provides the ability to navigate linearly through the newscast. At any time during a story, the viewer can press the right button on the remote to skip directly to the next story in the playlist. This allows the viewer to make a low-cognition decision that they are no longer interested in the story that is showing. In effect, this is like saying, "please show me something else instead". In this way viewers can modify what they are watching to something more of interest to them without having to take the effort to open and scan through the playlist.

The viewer interface also provides the option to navigate backwards through the newscast with the left remote button in case the viewer wants to see a story again. In addition to this, viewers can pause the playback of video at any time with the lower left button on the remote.

4.5 – Extra Content

The viewer interface provides access to additional content on particular stories, helping provide depth in the newscast. As described in Chapter 5, these stories can provide more details on a story by providing background or other additional information. For example, the extra content can be a larger portion of an interview that a news reporter did for a story. In traditional news, the viewer would be only shown what the reporter felt were the most important parts of the interview, even if the interview contains extra pertinent information. This allows viewers to access more information on stories they care about and not as much on stories which they do not care about.

In the news interface, the viewer has two ways to access the extra content associated with a story. The first of these ways is directly while watching a story. While the interface is showing a section of a news story that has extra content associated with it, a prompt will appear that allows the viewer access to that extra content (Figure 22).

Figure 22: Newscast showing prompt for extra content

As shown in Figure 23, the prompt for extra content shows a short title describing what that extra content is. There is also a reminder showing which button on the remote can show the extra content.

Figure 23: Extra content prompt detail
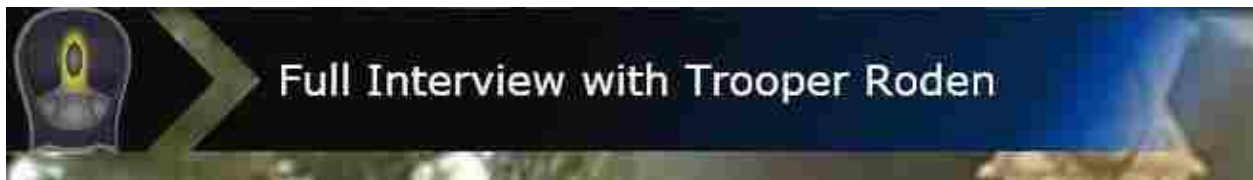
In this example, the viewer can watch the full interview from which the currently playing clip was taken. When the viewer presses the wheel button on the remote, the main video is paused and the interview starts to play in a smaller window on top of the main video (Figure 24). This allows the viewer to easily recognize that they are watching the extra content instead of the main news story.

Figure 24: Watching extra content

To return to the newscast story where the viewer left off, he simply presses the wheel button again or waits for the extra content video to finish. He can also recognize the context of the main video in the background when he finishes watching the extra content to make the transition less jarring.

The second method to access the extra content is through the playlist menu. Stories that have extra content associated with them have a small arrow to the right of their titles in the playlist (Figure 25).

Figure 25: Playlist menu showing story with extra content.

When viewers highlight these stories in the playlist, the titles of all the associated extra content clips are shown to the right. Viewers can then select and watch the extra content from the menu

as well. This feature allows viewers to watch extra content in which they might be interested without having to watch through a story again to find the places in the story where it is available.

4.6 – Summary

The news viewer interface features accomplish our goals for interactive television news. The small amount of interface clutter and small interaction effort help it to be a lean-back interface more reminiscent of traditional television. The interface also provides context sensitive controls to allow viewers to learn the controls easier. The newscast will also play by itself without any user interaction, making interaction optional. The viewer interface allows viewers to get more information on stories of interest to them, providing depth and individualization. Additional individualization is provided by the video headlines menu and navigation controls.

Chapter 5 – News Production Process

Our solution to interactive television news augments the existing news production process. We design our process to work well with the existing news process while changing only a small amount. This allows news producers to simultaneously produce both the traditional news and the interactive news at the same time with little additional overhead. This is accomplished in part by reusing content that the news producers already create while producing the traditional news.

The news production process can be described in terms of the following steps: story planning, reporting and extra content, newscast production, video headlines menu production, and video annotation. We outline each of these steps and show where we have added additional work to the process.

5.1 – Story Planning

News producers have story planning meetings to determine what should be in each newscast for traditional television news. Often, these meetings are carried out well in advance of the actual airtime of the newscast. The production staff decides what stories should be in each newscast. They decide which stories are worth reporting and how to go about doing the reporting. They make assignments for reporters so that the reporters can go and gather information on these stories. They also make any other decisions relating to the content for the newscast. In order to produce interactive news, we add to this planning process. Now producers decide which stories should have extra content and what type of content that should be.

5.2 – Reporting and Extra Content

Once the reporters have their assignments, they go and gather information. This may involve interviewing key people involved with a story, attending a press conference, filming related scenes and incidents, or even getting news content and information on a story from other news providers. All of this reporting process leads to gathering information and video about the story which they are covering.

With this information and video, reporters can create the story that will appear in the newscast. This can be done by writing a script for news anchors to read, cutting sections from video they have gathered, and voicing over sections of video themselves, among other things.

One thing to note that the finished story is often very short in comparison to the amount of information gathered. Stories can be built from several interviews of five to ten minutes each. The final broadcast stories are often of 30 to 90 seconds in length. This means the additional information gathered goes to waste.

In our solution, we can utilize some of this extra information and video. We have reporters or other news production staff create extra content with additional information on the story. One natural place to obtain this is the interviews of people used in making the story. If the interview contains additional interesting information relating to the story, it can be used with some editing as extra content for the story. This requires little additional effort. Another source of extra content would be speeches or press conferences made by important people that concern the story. These would require more editing effort, but since the video needs to be reviewed for editing in a story in the first place, creating a longer edited version or even including the entire video would not take too much additional effort. One other source of extra content would be background

stories on a longer-running topic which have been previously produced for another newscast. For example, if there was a story on a turn of events in a criminal trial, extra content could be the original story on the trial produced days earlier. These types of extra content are some examples in which the content is relatively easy to produce. More labor-intensive forms of extra content can be produced as seen fit by news producers. We merely focus here on examples of extra content that would take a small amount of extra effort to produce.

A side effect of producing extra content in this fashion is that it can reduce bias in television news. A reporter's summary of events is naturally biased to some degree or another. However, if a viewer has access to additional information on a story, they can better form their own opinions about the topic. Giving access to the interviews that the reporter made in creating the story can lead to more transparency in news journalism. For example, people can make judgments as to whether the reporter asked good questions and see which parts of the interview were left out in the summary given in the main story.

5.3 – Newscast Production

The traditional television news broadcast is produced as well. This involves putting together all of the content and script created by reporters in an outline. This is often done with the assistance of specialized newsroom computer system programs. Additional production will be done such as adding graphic overlays in or between stories, deciding which camera shots to use when, when live anchors will be used, where advertisements will be inserted, etc.

Once the newscast production is finished, it is generally filmed and broadcast live. This filming is interspersed with the prerecorded footage and audio done by reporters and other production staff.

We do not add any additional steps to this process except to record the news broadcast and upload it to the interactive news system using the upload tool.

5.4 – Video Headlines Menu Production

In order to produce the video headlines menu, a small amount of additional production is required. This video highlights important stories in the newscast as described in Chapter 4. News production staff create this short video in addition to the regular news broadcast. Much of the content needed for this story can be taken or derived from content and script in the regular newscast. In addition to this, the content of the video headlines menu is very similar to tease commercials that news producers will often film and broadcast to entice viewers to watch the broadcast news, or to continue watching over a commercial break during the newscast. These factors make the video headlines menu have a relatively small production effort.

Once the video headlines menu is produced, it can be filmed, digitized and uploaded through the upload tool. This filming can occur even before the newscast proper is filmed and broadcast.

5.5 – Video Uploading

Once each video is created, it is sent to the interactive news system using the upload tool. In our implementation, we created a web based tool that takes a digital video file and prompts for other simple metadata about that file including the corresponding newscast, title, and type of video (headlines menu, newscast, or extra content). Figure 26 shows our implementation of the upload tool. The video file and metadata are transferred to other parts of the system as described in Chapter 3. The Internet Video Server begins to process each video and encode it for Internet streaming. The Internet Video Server sends updates of this status to the Annotation Server. This

allows the other parts of the system to know when the video files are ready for Internet
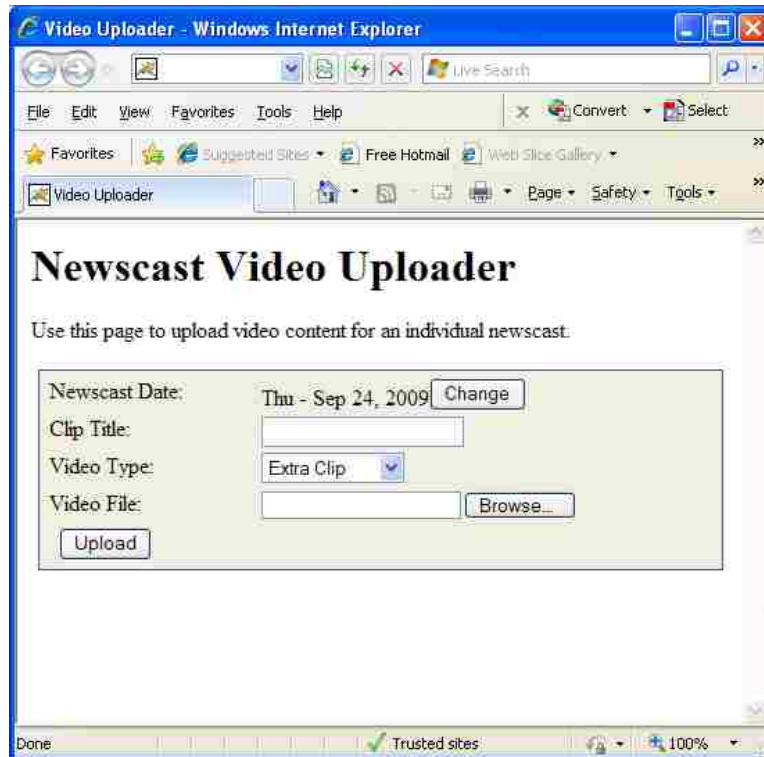
streaming.

Figure 26: Newcast video upload tool (shown in a web browser)

The production and uploading of the video headlines menu and extra content can occur well in

advance of the airtime of the newscast. This allows for more flexibility in the production

schedule and allows producers to complete production of the interactive news sooner.

5.6 – Video Annotation

Once all of the video content required for the interactive television news is created, uploaded and

processed, it must be annotated with metadata and timing information to allow the viewer

interface to display it properly. In our implementation, the annotation tool is a web-based

application. This allows the annotation of the video to be done by any authorized person (the annotator) connected to the Internet with a web browser.

When the annotation tool loads, the user will see a list of newscasts that have metadata stored on the annotation server (Figure 27).
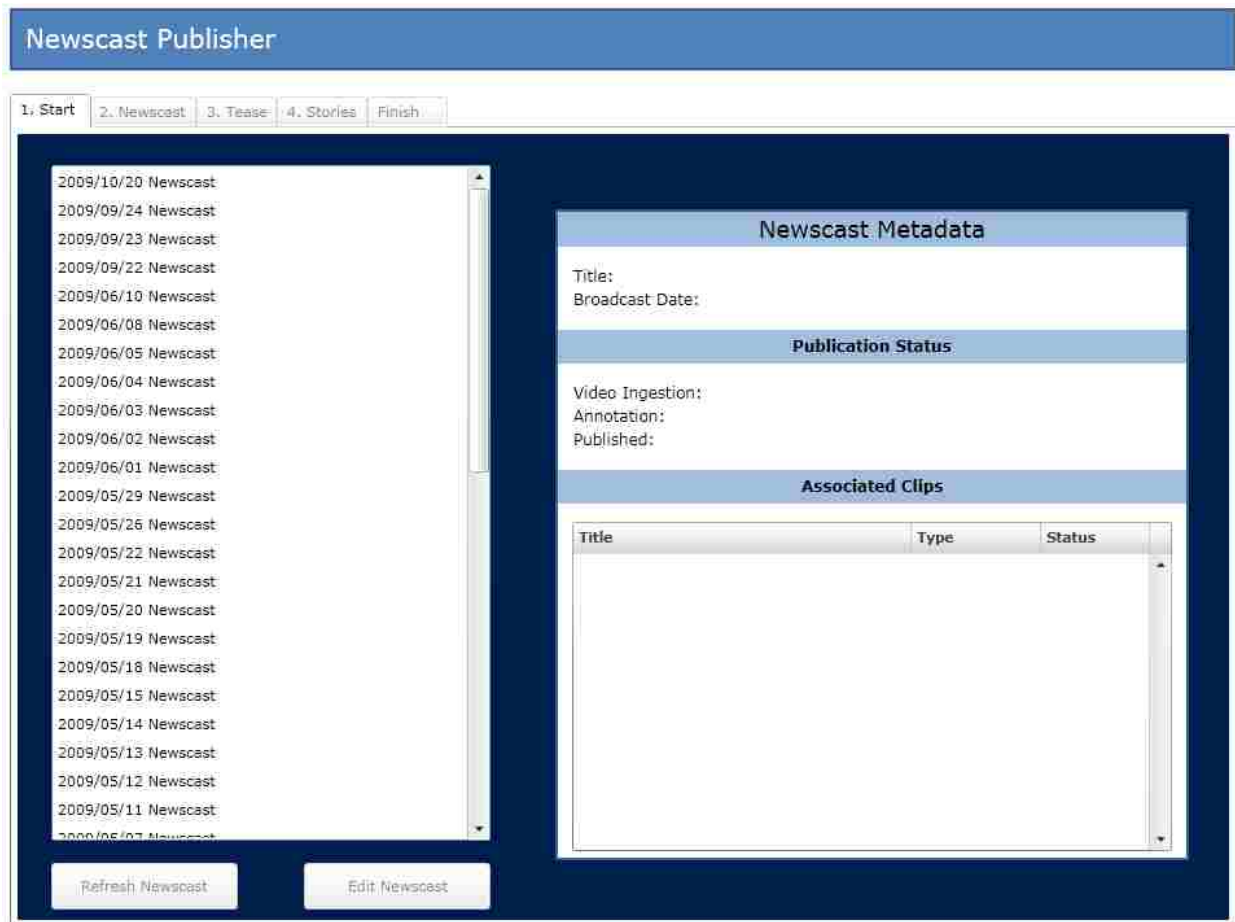

Figure 27: Annotation tool start tab

The annotation process is divided into five different steps. We show each of these steps as a tab in the annotation tool interface. We outline each step in the following sections.

5.6.1 – Starting out

The starting tab of the annotation tool allows the user to select a newscast and view information

about that newscast in the pane to the right (Figure 28).
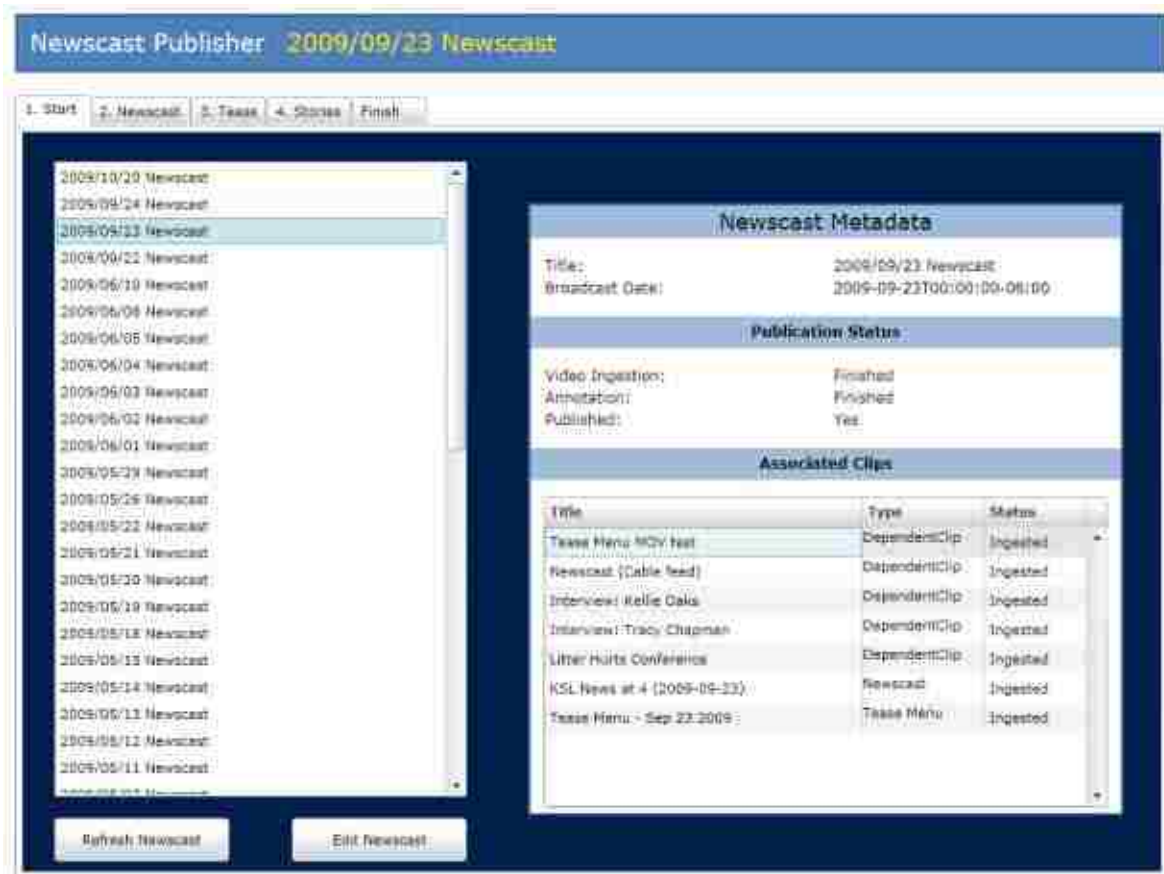
Figure 28: Annotation tool start tab showing newscast and video information

This information includes the date and title of the newscast, whether it has been fully annotated

and published, and information on all of the videos that are part of the newscast. The

information on each of the videos shows the processing status of the Internet Video Server.

Once the Internet Video Server has finished processing the videos for the newscast and the video

headlines menu, the user can start annotation of the newscast.

5.6.2 – Newscast annotation

When annotating the newscast, the user must mark the start and end points for each story in the newscast, as well as enter a title and category for each of those stories. There is also the option of marking portions of the newscast as "dead time". These dead time sections of the newscast video, such as commercial breaks, will not be shown as part of the interactive newscast. An example screen from the newscast annotation tab in the annotation tool is shown in Figure 29.

Figure 29: Annotation tool newscast annotation tab

The user of the annotation tool moves the video to the start point of each story using the timeline marker (shown in red) and the playback controls (shown as buttons below the video). He then presses the New Mark button to split the existing timeline in two segments. This can be done to

divide the entire newscast into parts. Each segment that is dead time is marked as such. Each

story is labeled with a title that will be shown in the viewer interface and a category. Once each

story segment has the appropriate metadata, it will turn green in the interface.

5.6.3 – Video Headlines Menu annotation

The next step in the annotation is to annotate the video for the video headlines menu. The

interface for this process (Figure 30) is very similar to the annotation of the newscast.

Figure 30: Annotation tool video headlines menu annotation tab

Segments of the video corresponding to summaries of different stories are marked and titled.

These titles appear during the playback of the headlines menu in the viewer interface. In

addition to this, each section of the headlines menu is linked to a story in the newscast by

selecting the story from a list. This can be easily done since the stories in the newscast were defined on the previous tab. This linking allows the viewer interface to know what story in the playlist to reorder when the viewer expresses preference on stories while watching the headlines menu.

5.6.4 – Newscast story annotation

The last major step in the annotation process is the annotation of individual stories. The purpose is to link sections of each story to the corresponding extra content video. As shown in Figure 31, the story annotation tab contains a list of all of the stories in the newscast.
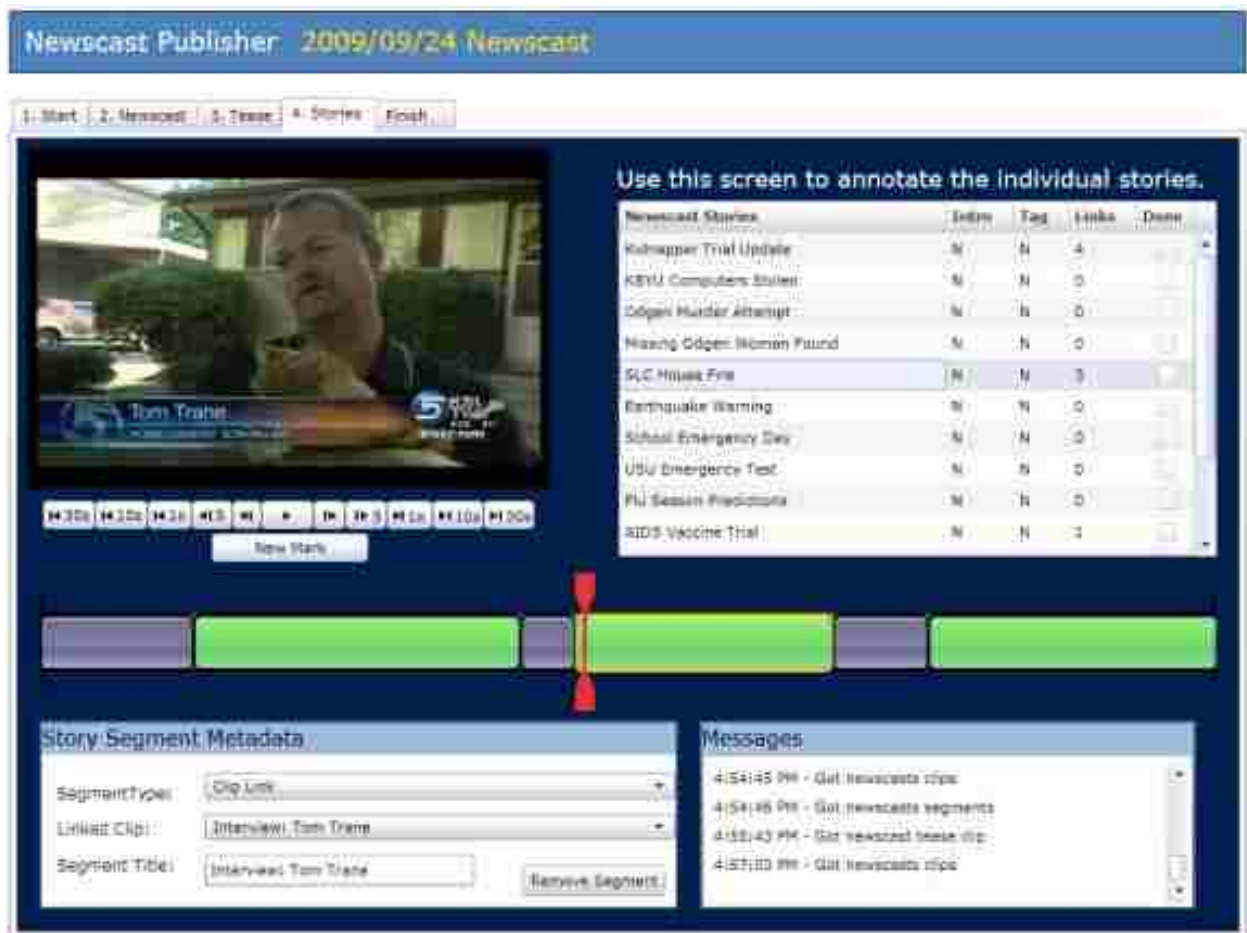

Figure 31: Annotation tool story annotation tab

The user selects a story that has corresponding extra content videos and a timeline for that story will appear along with the video. Then the user makes segments in the video as in other tabs. Each of these segments has a title that will be displayed in the viewer interface for that piece of extra content. The user also picks an extra content video from a list which corresponds to the current section of the story. Optionally, the user can mark each story as completed in the story list to track his progress in annotation of the stories to help him ensure he does not miss one.

5.6.5 – Finishing annotation and publishing

The final step in annotation is to ensure that all of the annotation is completed. The list of stories to help the user determine this is shown in Figure 32.
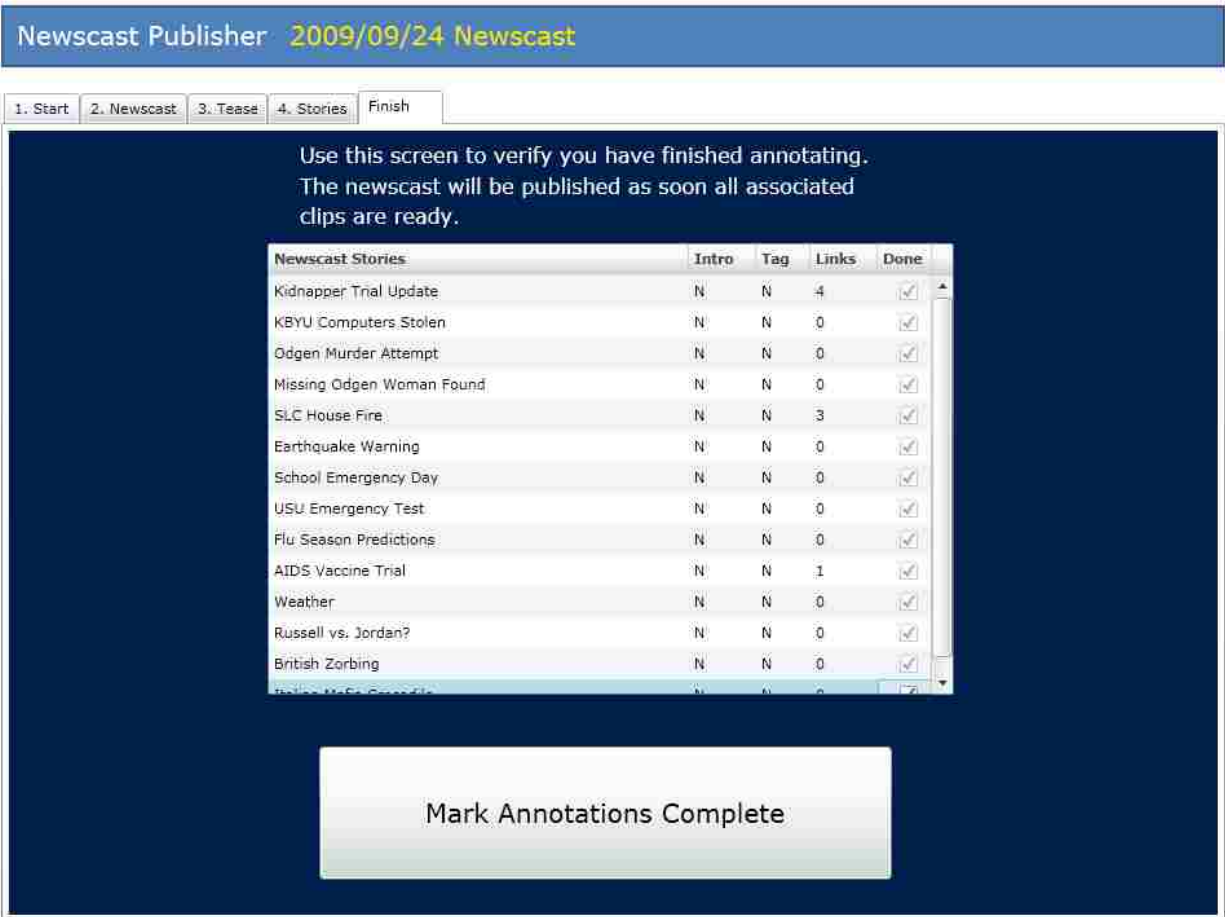
Figure 32: Annotation tool finish tab

Once the annotation is verified to be completed, the user clicks the "Mark Annotations Complete

button". This tells the annotation server that the annotation process is finished and the newscast

can be published as soon as possible. Once the Internet Video Server finishes all processing on

all videos for that newscast (if it has not already done so), the annotation server marks the

newscast as published. This enables the viewer interface requesting available newscasts from the

annotation server to see this newscast. At this point, the viewer interface can request the

annotations from the annotation server and display the newscast to viewers.

The entire news production process is not heavily modified by our solution. Additional

production effort is limited to the planning and production of extra content and the video

headlines menu. The only other needed steps are uploading the videos into the system and annotating the newscast videos. In our implementation, uploading and annotation were separate steps to allow them to occur in conjunction with existing news production systems. However, it would be technically possible to integrate the majority if not all of these steps directly into the newsroom computer system to avoid additional time and labor.

Chapter 6 – Evaluation

To aid our evaluation of our interactive television news system, we built a functional prototype system and deployed that system for one week to gather feedback. This is a formative evaluation focused on gathering feedback on what parts of the system work and what parts need to be improved.

6.1 – Experimental setup

As we were building our prototype system we worked closely with BYU Daily News – a university news production staff that produces a daily newscast. This effort helped us ensure that the production process could integrate well in professional news production facilities with lesser overhead and strain on their facilities.

Once we built the prototype system, we found a professional news producer, KSL News, to help in our evaluation. KSL was an excellent option because they are the largest news producer in Utah. We would know that our system is viable for production use if it worked with KSL. We taught KSL about our interactive news system and what they had to do to produce interactive television news using the system. We then had KSL do two trial runs using our system to ensure it functioned properly during tests with news viewers. Our trail runs went well and we only encountered a few video encoding format problems, which were easily fixed.

Once the news producer was trained in using the system, we prepared for a week of interactive news production using the system. During this same week we installed the viewer interface in test households and had viewers watch the produced interactive news and provide feedback.

To prepare the system for home setup, we loaded our viewer interface on small computers that can be connected to television sets (Figure 33). For these viewer interface devices, we used

Apple Mac Mini computers to connect to NTSC televisions, and Dell Studio Hybrid computers

to connect to HDMI televisions.

Figure 33: Small computers serving as set-top boxes. Left shows an Apple Mac Mini and right shows a Dell Studio Hybrid. Pen and remote are shown for size comparison.

To provide navigation between newscasts, we created a home screen (Figure 34) that allows

viewers to select newscasts as they become available. Viewers select these newscasts using the

gyroscopic pointer functionality of the remote. On this home screen we also provided access to

various on-demand television web sites to give the viewers incentive to use the device for

purposes other than watching news. The home screen and viewer interface were presented in a

full-screen web browser to hide any of the browser's or the operating system's more lean-

forward interface from viewers.

Figure 34: Home screen for news viewer interface prototype

The home screen also included a help button that provided access to video tutorials that explained how to use the system. Viewers could return to the home screen at any point with a gesture using the gyroscopic capabilities of the remote.

Once a viewer selected a newscast to watch, we logged all of their interactions on the news viewer interface and at what time they occurred. This basically recorded any time a viewer pressed a button on the remote and what that action did in the viewer interface. The logging included any usage of the video headlines menu, playlist, navigation, story selection, and extra content.

We set up the viewer interface devices in ten households (see Figure 35 for an example setup) the weekend before the news producers would produce the interactive news. We chose homes with people that said they watched television news on a regular basis in order to gain feedback from people who were already regular news viewers. When we set up the devices we did the following:

- Gave a short tutorial on how the system worked
- Allowed viewers to try the remote and explained its functions
- Explained how to access help features of the system
- Suggested that viewers watch some of the sample newscasts to get a feel for how the system works before KSL started producing newscasts
- Told viewers to watch the news using the system everyday for the next seven business days
- Explained that the newscast would be available each day at or before 6:30 PM and that they could watch it at any time afterward

We collected the viewer interface devices at least a day after the last newscast to allow viewers time to watch that newscast. Then we interviewed members of the household that watched newscasts using the system to get their qualitative feedback.

Figure 35: An example of a viewer interface device attached to a television set in one of the test households

We had the news producer produce interactive news using our system each day Monday through Friday the following week and on Monday and Tuesday of the next week (skipping the weekend) to see how viewers would watch it. We used the earliest evening newscast KSL produced for our daily newscast. This 4:00 PM newscast was mainly comprised of local news stories, and allowed for enough time to have the newscast ready for viewers before the 6:30 PM. Once the interactive newscast was ready, the home screen on the viewer interface device would show the newscast.

6.2 – Production Results

We first describe our results from the perspective of the news producers. We note that the seven days of interactive news production happened successfully. This shows that the process can indeed work with a real, professional news production staff.

The feedback from the news producers was positive overall as well. They were surprised at how easy the process was from their perspective and at how little they had to do to create the interactive news. The process fit well in their time schedules and was not a major burden overall. Their only other feedback they had was on the time it took them to encode video content (primarily extra content) into a digital format that could be accepted by the upload tool. This is because they were using software video encoders supplied with a video editing program. While the software was encoding, they couldn't edit other videos for their newscasts. Fortunately, this is not an intrinsic problem with the system and could be easily rectified with hardware encoding devices that would be used in a production-quality implementation of the system. The approximate time needed to annotate the newscast was 40 minutes.

Overall the effort required to create the interactive news was small and manageable, even for a large news producer. KSL was able to produce interactive news in conjunction with their standard broadcast news production. This shows our system design is viable for production-level newsrooms.

6.3 – Viewer Results

We used the logs recorded by the viewer interface devices from the first day the interactive news was produced (Monday). We interviewed members of the households after the evaluation to get qualitative feedback. Eight of the ten households responded for interviewing (the non-

responding households were the two households that had watched the smallest number of newscasts).

We analyzed the logs in terms of individual newscast-watching sessions (henceforth referred to as sessions) – from when someone started watching the news using the device to when they stopped. We discounted sessions that were shorter than 100 seconds from our analysis, as precursory analysis showed that these sessions were unintentional accesses to the newscast or other behaviors that were not actually watching the news.

6.3.1 – News watched

We first analyze the news watched by test households – when and how much news they watched. Figure 36 shows a histogram of when each session started during the day. The average watching time was 7:47 PM and median watching time was 9:17 PM.
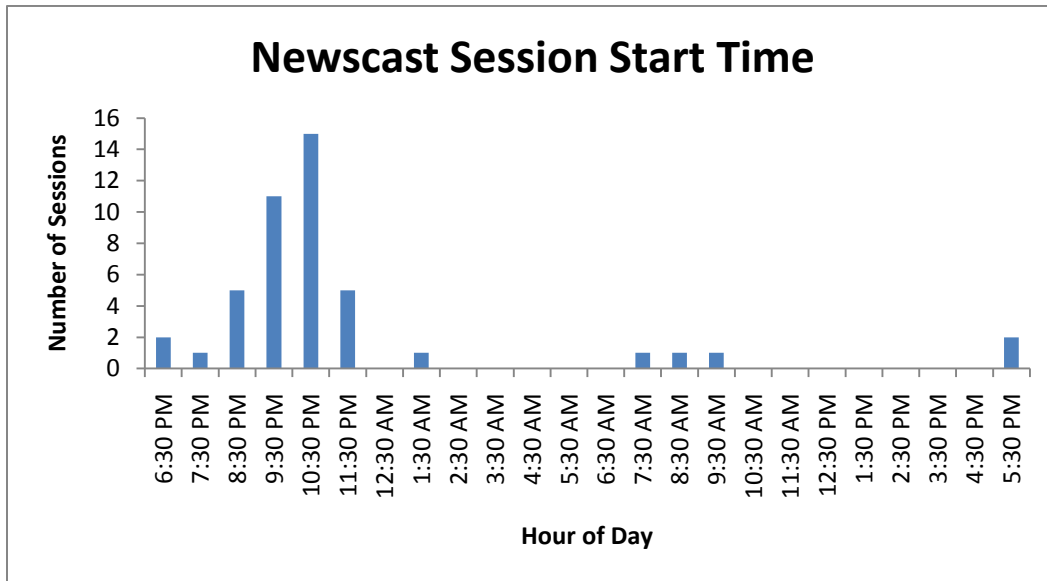

Figure 36: Histogram of times test households starting watching newscasts

There were varied amounts of news watched by each household. Figure 37 shows each individual household and when they watched newscasts over the course of the evaluation period.

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We had a total of seven different newscasts available for watching over the course of the week. Three of the ten households watched two or less newscasts. One of these did not watch any news at all. We discount this household from our results since they did not actually participate in the evaluation in any meaningful way. The average number of sessions watched by each household was 4.4 sessions. The median number of sessions watched was 5. Note that weekend viewing was of newscasts from previous weekdays.
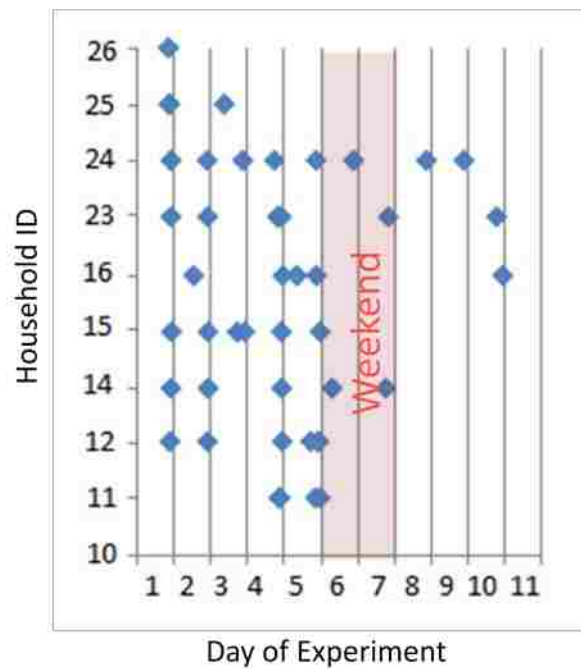
Figure 37: Days each test household watched a newscast

Due to the interactive nature of the newscast, people watching could watch for a different amount of time than was in the normal newscast. Some people watched more and some watched for less time than was available in the normal newscast. The distribution for the percent of time watched per watching session is shown in Figure 38. Overall the average time watched was 80% of the entire time of the newscast itself (Figure 39).

Percent of Newscast Watched per Session

Figure 38: Histogram of percent of total newscast time watched per session

We further broke our analysis down into segments consisting of the first three days of the evaluation and the remainder of the days. This a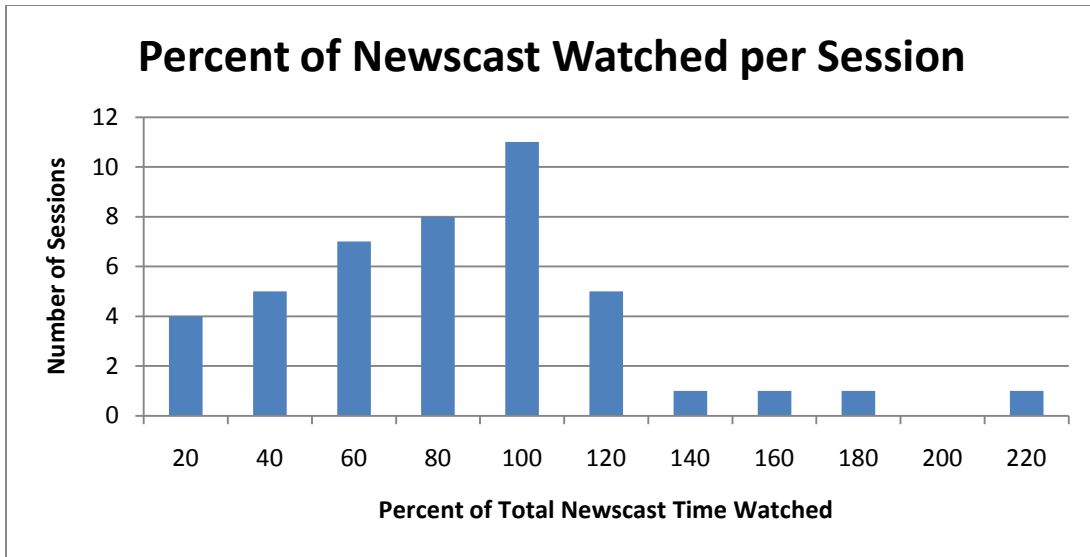llows us to see changes in behavior as people become accustomed to using the interface. We see from Figure 39 that the amount of news watched per session dropped after the first three days. We believe this is due to people experimenting more with the system during the first few days and proactively selecting and skipping content using the interface during the remainder of the evaluation period. However, even given all of the tools provided to skip around and select only interesting parts of the newscast, our test households still watched for about two-thirds of the newscast time overall. This also shows that in general people are skipping and actively selecting content rather than passively watching the newscasts.

Average	Day 1-3	Day 4+
80%	102%	65%

Figure 39: Percent of total newscast time watched per session

6.3.2 – Feature Evaluation

In addition to the amount of news viewed we also evaluate our interactive television news system in terms of the individual features. These include the video headlines menu, the playlist and other navigation or content choice mechanisms, the usability of the controls, the extra content, and the overall reaction of viewers.

6.3.2.1 – Headlines Menu

All of the households that watched news used the video headlines menu at least once. The headlines menu was used during 70% of the sessions. Qualitative feedback was positive for those that actually used the feature on a regular basis. One respondent went so far as to call the feature "crucial" to the interactive news experience. We also noticed different styles of interaction with the newscast from the qualitative feedback as shown in Figure 40.

Participants	Headlines menu usage
38%	Mostly headlines menu
25%	Used headlines menu and other content choice mechanisms together
38%	Mostly playlist selection and not headlines menu

Figure 40: Headlines menu usage from qualitative feedback

This shows that the features of our viewer interface can be used or not used and still leave viewers with a functioning newscast – one of our points of having optional interaction features.

6.3.2.2 – Playlist & Navigation

The playlist was used at least once by all of the households that watched the news. It was used during 78% of the sessions. However, the playlist is only one of the ways viewers can make an active choice about which content they are viewing. They can also skip to the next story or to

the previous story directly using the remote. Figure 41 shows how often viewers used these content choice mechanisms (playlist selection, next story, previous story). The average time between content choices was 79 seconds. This shows that viewers are indeed making active choices with the news instead of just being passive viewers. It is also interesting to note that 79 seconds is similar to the time of one story in a newscast. This time is possibly related to the average attention span of the viewers. The time between choices did not change much over the course of the experiment. The slight increase in time between content choices could be due to viewers learning the controls and not playing around with them as much.

Content Choice	Seconds between
Average	79
Day 1-3	74
Day 4+	82
Change	11%

Figure 41: Time between content choices for viewers in the evaluation

Figure 42 shows the breakdown between different content choice mechanisms. The most common is jumping to the next story, with the least common being selection using the playlist. The breakdown remains rather consistent across the experiment. Once again, the slight decrease in previous story selections may be due to viewers getting used to the controls.

	Playlist Selection	Next Story	Previous Story
Day 1-3	26%	38%	36%
Day 4+	26%	41%	33%

Figure 42: Breakdown of how much each content choice mechanism was used during the evaluation

6.3.2.3 – Help and Usability

We also looked at the usage of the control overlay feature in the newscast to see if it showed any patterns in usage or lack thereof. Figure 43 summarizes this usage.

View Controls	Seconds between
Average	53
Day 1-3	63
Day 4+	48
Change	-24%

Figure 43: Time between viewing control overlay for viewers in the evaluation

On average people showed the control overlay once every 53 seconds. There was more control overlay usage during the latter part of the evaluation. However, we do not see any particular reason for this increase and do not have enough data to tell exactly if this trend has any real meaning.

The qualitative feedback tells us more about what people thought of the controls (Figure 44). 88% of respondents said the controls for the viewer interface were easy to use once learned. However, as seen in Figure 44, reactions were mixed as to how easy the controls were to learn.

Participants	Comment
88%	Controls easy to use once learned
25%	Highly liked controls
50%	Controls easy to learn
25%	Controls not easy to learn
50%	Gyroscopic pointer or gestures interfered

Figure 44: Participant feedback on interface controls

This shows that overall the viewer interface controls are fairly usable but there is still some room for improvement. In addition, the gyroscopic controls in the remote should probably be avoided in future versions for normal operation.

6.3.2.4 – Extra Content

The extra content was used much less than the other features. Only 44% of the households used it at all. Extra content was only viewed in 16% of sessions overall (in 37% of sessions for households that actually used the feature.) It was used 14 times. When used, people watched extra content for 94 seconds on average. The average length of extra content clips viewed was 2 minutes 43 seconds. 75% of people watched the entire extra content clip – the rest exited the clip early. Despite not being used much, the extra content feature received high praise from the qualitative feedback: 88% percent of respondents had positive feedback on the feature.

We think this low usage pattern may be at least partly due to people not noticing the option during news. There were 29 extra content clips across our seven newscasts. However, only 21.5% of stories had extra content available. This could be accessed from the playlist menu or as a link prompt directly while a story was playing. The time these links were available only represented 7.1% of the total newscast story time. In addition to this, one respondent explicitly mentioned not noticing the option when it was available. We think that there need to be more explicit prompts for the viewers to investigate extra content. An effective method may be having anchors directly prompt viewers in the video.

Another factor may be lack of interest in the extra content. 75% of respondents said they were not interested in much of the extra content. We suspect that more work should be done to investigate what kinds of extra content viewers find more compelling.

6.3.2.5 – Other feedback

As part of our feedback from viewer households we asked viewers about the following topics concerning the news watching experience:

- What they liked

- What they didn't like

- What they thought about the controls, the video headlines menu, the extra content, and the on-screen help

- What kinds of navigation features they used

- Any other comments they had

To get a feel for what our system was accomplishing overall, we asked viewers what they liked about the system. Without explicit prompting, 100% of respondents said that the liked watching what they wanted. Also highly mentioned was skipping what they didn't like (63%), and watching on their own schedule (38%). This shows that our system is accomplishing our goal of getting viewers more of what they want and less of what they don't as well as providing an individualized experience.

We also received other comments from viewers apart from what we have previously mentioned. Each of the following comments was reported independently by two respondents:

- Apparent choppiness between stories due to reordering of stories with headlines menu

- Difficulty getting back to the home screen using remote gesture

- Praise of using wheel on the remote for volume control

- Desire for newscast to be even more current for when it was being watched

- Difficulty reading textual prompts on NTSC (low-definition) televisions

- Desire for a physical reference card for basic controls

6.4 – Evaluation Summary

Overall our system seems to be meeting its goals with some room for improvement. The controls appear to be providing a lean-back experience but still need some more work in being easy to learn. The viewer interface succeeds at giving viewers more of what they want and less of what they don't. It provides an individualized experience through usage of content choices and the headlines menu. However, an individualized experience is not required due to these features being optional. The effort required by news producers to make this interactive news does indeed appear to be small and overall production worked rather well. The main area for improvement appears to be in helping viewers get depth in their news through extra content. This is due to the high positive feedback about the feature but low usage. We may need more compelling extra content and also appear to need better prompting in the interface and news about the content to encourage usage.

Chapter 7 – Summary and Future Work

We have designed an interactive television news system that can fit into traditional news production processes with a small amount of effort. The system provides viewers a lean-back interface to view the news that provides individualization through a video headlines menu, other content choice mechanisms, as well as being viewable when the viewer wants (through use of Internet video unicasting). This system is also backwards compatible with regular television news by making news viewing similar to a traditional newscast without interaction. In addition, the system provides depth in individual news stories by giving access to extra content about a particular story. No other system to our knowledge can provide in-line extra video content of the depth that we have available in our system.

We have also performed a formative evaluation of this interactive television news system. We have found that it lives up to most of the design goals. It still needs more work in making the controls easier to learn and making the extra content more easily visible and accessible to viewers. As part of our evaluation, we had news producers create interactive news using our system and have it delivered on-demand to home viewers. To our knowledge, this has never been done before and represents a great move forward for interactive television as a whole.

Future work could improve in areas where our current system is lacking such as the extra content production and consumption and easier or alternate control mechanisms. Other future work could also include using an interface that continuously updates a newscast as new stories are finished and added or tracking what the viewer has seen. Other ideas could combine this technology with other developing interactive television news ideas such as linking to archive stories or other related data, social networking, and user profiling. In addition this idea should be

combined with potential advertising models, particularly those that can be unique to interactive television.

In summary, our work empowers both television news viewers and producers. Producers have the power to deliver deeper and richer news to more people at more times with little effort. Viewers have the power to get more news they want and less news they don't. This work transforms television news and takes it to the next level of interactivity and utility.

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