

# Distributing and publishing newspaper content on a digital TV-platform

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**Abstract:** In this paper we study and evaluate DVB-T broadcasting of newspaper content and user interface on a digital TV platform. The objective of the research was to study a) the data transmission reliability and efficiency, b) user interface and c) the user experience of the *DigiTV Newspaper*. The study was conducted in two stages. First a *facsimile* copy of the newspaper content was generated daily and transmitted in three geographical regions in Finland to test the service for three local newspapers. After this the layout was modified to improve the usability and user tests were conducted. The results show that the *facsimile* representation of the content can be enhanced by using wide format layout, video material and navigational aids. This kind of publishing channel can be a supplementary service especially when the newspaper distribution faces geographical challenges.

Keywords: DigiTV, data transmission, newspaper distribution, user experience

## 1. Introduction

In Finland, newspaper distribution is carried out by early-morning home delivery, which covers about 80 % of the households. In some areas the distribution faces major challenges (like the archipelago and some rural areas). In these areas the distribution is costly and time consuming. To save the costs and time the printed newspaper could be complemented or in some cases even replaced by the digital newspaper.

Because fast internet connections do not cover whole Finland we must consider other networks to distribute digital newspapers. One option is to use DVB-T-networks which are designed to broadcast data for large geographical areas. The DVB-T- infrastructure also has free capacity during the nights and business models suitable for freesheets and subscription based newspapers. The alternatives to digital right management are:

- 1) The user has free access to the data without any limitations. This is suitable for freesheet business model which is based on advertisement income.
- 2) The access is checked at the beginning of the data capture. If the user has proper rights the encrypted material can be decoded and captured to the memory of the reading platform without any further limitations. This model can be implemented by incorporating a slot for a smart card in a DVB television or set-top box with the appropriate hardware facility to view conditional access content that has been encrypted using a conditional access system.

The layout for online newspaper published in internet is not optimal for the digital TV platform. The TV sets typically have aspect ratio of 9:16 different from the broadsheet format commonly used for newspapers in Finland. The user interface can be improved by navigational aids and wider layout that doesn't require scrolling.

In this study we conducted empirical tests with three local newspapers in two stages. In the first stage the reliability and efficiency of the DVB-T distribution was tested for a test period in three geographic regions in Finland. The content was derived from the editorial system, packed and error correction encoded after which a *transport stream* was generated. The data was broadcasted during night time via the DVB-T network. PC- clients with an external DVB-T receiver captured the data and users read the digital newspaper on a HDTV-screen.

A specially designed transport protocol was developed which allowed error free reception of the data even in cases where some of the data packets were missing in the first place. The log files for the data transmission and reception were analysed and the network efficiency calculated.

In the second stage the user interface was modified to suit better into 16:9-format. Indexes in two levels were included and navigation aids introduced. The newspaper was enriched by videos.

The usability of the service was evaluated collecting information by observations and questionnaires. The data included comparison of the target product with a newspaper in printed form and in online form.

## **2. Navigation aids in online newspaper**

Newspaper design pattern is in most cases based on the front page design. Familiarity and recognition are strongly related to the front page design, making positioning of objects and visual patterns important. On the front page of online newspapers, headlines are often the representation of stories that are valued most interesting, resembling the printed format that also presents the top stories on the front page (Ihlström & Åkesson, 2004).

Newspaper sections enable the reader easy access and guidance to information. It does not take much effort to find a particular section e.g. the sport section or the business section, inside a newspaper. The newspaper indexing is the most effective "navigational" tool in newspapers and headlines are the main entry points to text. According to Garcia (Garcia, 1997) all publications, printed or digital, should minimize the number of items that appear as navigational tools. In online newspapers, readers scroll the front page to get an overview of the contents of the news site, which could be compared to browsing and flipping through the printed newspaper.

Two reader patterns for newspaper can be identified. The first one is so called browsing pattern where the reader wants to get an overview of the information. This kind of readers typically read the newspaper linearly by turning the pages sequentially. The other reading pattern is more task-oriented where the reader actively seeks some information by using typically sections (for example politics, sports etc.).

Based on this theory following design principles for digital newspapers have been reported (Ihlström Eriksson, et al, 2006):

- Index – e.g. in three levels (front page, index of sections, index per section)
- Menus – for an easy way of going back and forth to sections and pages
- Turning page – support for both traditional page by page browsing and skimming (browsing through multiple pages very quickly)
- Page indicators – strong indicators that gives an overview of where you are in the total newspaper and support the feeling of an beginning and an end, e.g. page 27/52
- Visual cues concerning which section the reader is currently in – e.g. colour coded sections (sport – pink)
- Headlines – different headlines that helps the user orient themselves on a page
- Hyperlinks – support fast navigation to a specific article without having to browse

## **3. DigiTV Newspaper tests**

We made an experimental evaluation of versions of the *DigiTV Newspaper* where the content was derived from various web-versions of the daily newspaper at three sites, i.e. the Hämeenlinna, Jyväskylä and Turku regions during spring and summer 2006. The voluntary testers were surveyed prior to the experiments including demographic data and habits of media consumption. We urged the testers to keep a diary of daily experiences and opinions on the

*DigiTV Newspaper*. At the final review the testers were interviewed for experiences during the whole test period. There was also a group interview for the whole test group with each of the three distinct test sites. The following report and analysis of reader perception is based on these questionnaires and interviews.

The total number of testers was 26, with 38 % of them female and 62 % male. The age distribution had one quarter of the population below the age of 29; 12 percent in the age group 30-39 and 20 percent in the age group 40-49. The largest population, one third of the total, was with the age group 50-59 whereas the age group of 60 or older had 12 percent of the participants.

### 3.1 Contents transmitted, transmission and reception technology

A standard web-based publication product, essentially a hybrid of a facsimile representation of the daily newspaper and a web-based html edition of the same contents was used as the content source. Some local newspapers have marketed such an online newspaper to subscribers while some other papers have employed similar device for internal editorial work. Technically, the product is based a set of relatively low-resolution facsimile images for each page, where links to text-based representation of individual articles and high-resolution images of photographs, advertisement and graphic-oriented objects are inserted at corresponding positions on the facsimile image. The articles are represented as html mark-up. Links to images and graphics are also represented html-based links from rectangular boxes corresponding to double coordinate pairs on the facsimile canvas. The principle also readily adapts to inclusion of other types of media like videos or audio recordings.

The compilation of the *DigiTV Newspaper* mainly relied on the standard newspaper production process for the online newspaper. Insertion of video links was an experimental process done manually with a dedicated tool. The contents of the *DigiTV Newspaper* were represented as a hierarchical tree-like collection. The root of this information also included pointers to application-specific utility software and generic support contents

The national Finnish DVB-T network (terrestrial digital TV broadcasting network) operated by the national operator *Digita* was used as the delivery channel. While there was no existing infrastructure for the delivery of file-like packaged contents to be cached locally at the receiving end for this network, an *ad hoc* solution was devised for the purpose. *Digita* assigned a dedicated *DVB elementary stream* with a specific constant transfer rate to be used a Private datacast stream during a certain period of each night. There was a transmission server at *Digita* premises. The *DigiTV Newspaper* was compiled off site into a *zip*-based archive and copied to the transmission site right before the on-the-air period. The archive package was also supplemented with *error detection* and *error correction* information (*Reed-Solomon encoding*). Full advantage was also taken of the available transmission slot by repeating the same transmission as many times as there happened to be time based on the size of the daily archive.

The transmission slot typically started at 2am and ended at 6am each night. However, with the last of the three experiments in the Turku region the time slot was available around the clock, but a considerably lower transfer rate. The success of reception was dependent on recording the transmission throughout one complete transmission cycle. However, the included error detection and error correction information allowed for random transmission errors of a few percent of the total number of bytes. In addition, the scheme was able to collect data from subsequent records so that loss of portions of the recorded archive could be compensated by subsequent successful transmission of the missing parts. However, the starting point of the whole concept was to have the receiver on and making any efforts for successful reception throughout the available transmission time slot.

The design of the experimental reception system was based on a laptop computer equipped with a digital TV reception adapter and application-specific software. The laptop could serve as the reading display, but intended way of reading the *DigiTV Newspaper* was an external 32 inch

lcd-based TV monitor. The application software could also be controlled by a dedicated IR controller so that the viewing and reading environment resembled that of a standard digital TV reception setup. However, a wireless mouse was offered as an extra user interface device, since the material from the original online newspaper was intended for mouse-based browsing and changing this would be too cumbersome.

### 3.2 Technical transmission protocols

A specific *DVB-T Private Transport Stream* was developed for the experiments with simplicity and robustness as the primary targets, since there was no established infrastructure to support delivery of media content files over the digital TV transmission network. The solution could be simplified by not placing emphasis on support for multiple operators and content providers nor making provisions for extensions mechanisms for a multi-actor operating environment. Issues related error recovery and security were also left for the responsibility of the application layers. Figure 1 illustrates the structure of the data transmission packet.

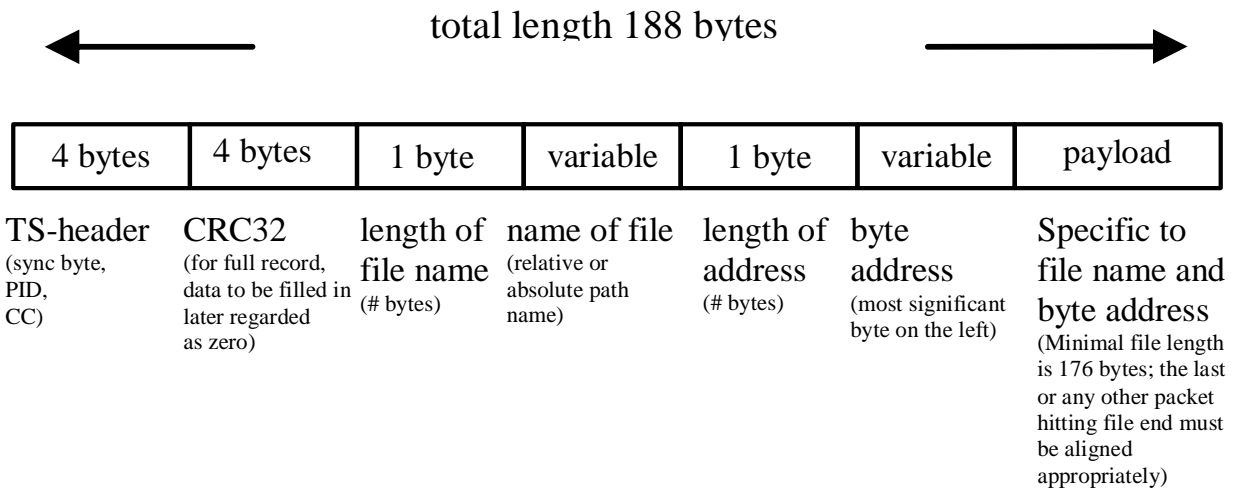


Figure 1. The payload protocol for the *Private Transport Stream* packet stream devised for the experiments.

The protocol specifies the following structure for each packet of the stream, i.e

- DVB-TS header
- CRC32 checksum
- name of file
- location of record
- partial payload (all that fits in; no padding)

The CRC32 is used for detecting the majority of distorted packets (the DVB-TS layers already have stringent error detection mechanism to drop erroneous packets before reaching this stage). As a third layer of error detection and correction, there is an application layer RS (*Reed-Solomon*) coding layer. This was realised using the open source *par2* software, which organises the error correction information as several separate files to be carried separately via the same file delivery mechanism as the contents of the *DigiTV Newspaper* itself. Roughly said, the error correction mechanism is able to correct any number of errors with the media record up to the total number of erroneous blocks corresponding to the cumulative size of the extra error correction information files. In addition, the repetition of the complete data cast transmission record is able to provide still another layer of error tolerance. However, this option has not been exploited up to its full potential, even though missing pieces are automatically filled in when the contents can be recovered from subsequent transmission phases. The relatively strong error detection mechanism is able to filter out almost all distorted packets leaving the result within the capacity of the application layer RS error correction mechanism.

## 4. Results

### 4.1 Reliability and transfer rate of transmission

The following discussion relates to the transmission experiments with the DVB-T network in the Turku region. The bandwidth reserved for broadcasting of the *DigiTV Newspaper* was 345 kbit/s available around the clock. The coastal line near Turku is fragmented with numerous islands (inhabited at least during the summer season). This will make the delivery of daily newspapers highly challenging. The map of Figure 2 illustrates the approximate locations where the testers had their receivers for the majority of their experiments.

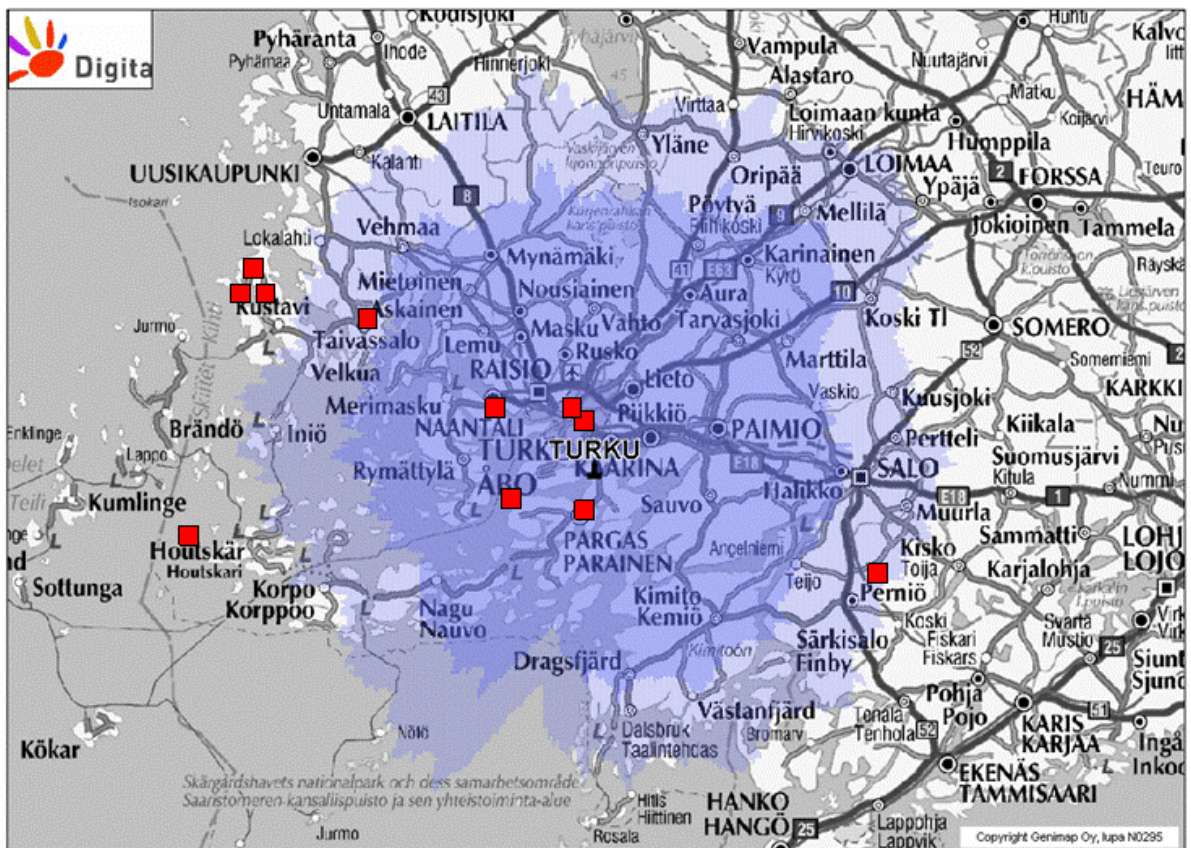


Figure 2. Locations of receivers for the experiments in the Turku region. The area in blue is the area where the field strength is expected to be adequate for digital TV reception according to the transmission network operator (Digita).

Table 1 summarises the success rates of the transmission experiments. Some receivers had rather many failures with reception (e.g. devices 8, 5 and 3). However, the error recovery scheme often succeeded to correct the situation, even though the margin remained low. It is typical to observe such problems at remote locations with inadequate field strength (cf. Figure 2.) or when there are problems with local antenna setup, shading terrain or construction elements etc.

Table 1. Summary of transmission success rate (*DigiTV Newspapers* received / not received that day).

Device index	Days successfully received	Days failed to receive
1	51	1
2	25	0
3	23	5
4	25	4
5	19	11
6	55	0
7	38	0
8	20	18
9	34	3
10	31	0

Devices 6 and 7 proved to be more reliable receivers because of their favourable location site. Figure 3 shows that time for successful data transfer depends linearly on file size during period of 27.6.2006 - 10.8.2006 for these two receivers.

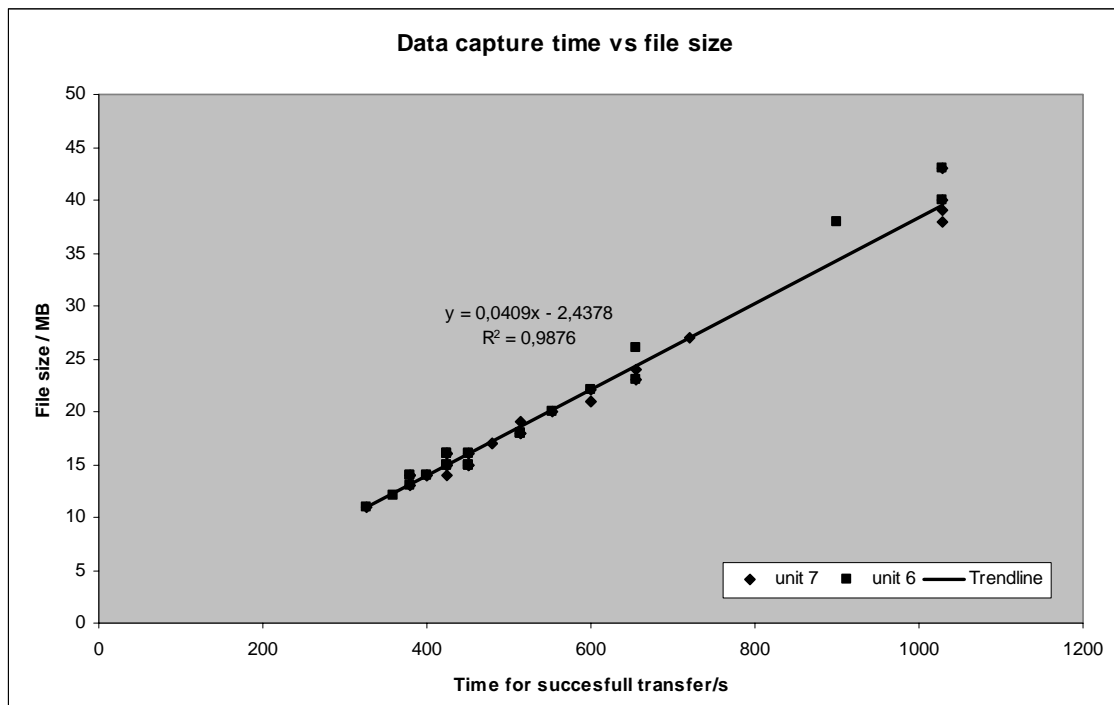


Figure 3. Data capture time vs file size showing constant data transfer speed.

The net transfer rate can be calculated from the recorded number of successful reception and available transfer slot (determined by the receiver alone in this case, while the transmission was continuously on the air in this case). The net transfer rate was 288 kbit/s. Compared with the available bandwidth of 345 kbit/s, this suggest an efficiency of 84%. The rest of the capacity is wasted as protocol overhead, error correction overhead and as truncation errors at the beginning and end of the time window for reception, since transmission and reception begin and end unsynchronised. Real transmission errors were so rare in this case time that the error correction layers are capable of doing full recovery without any loss of net transmission bandwidth.

#### 4.2 The reading experience from lcd-screen

The user feedback for the reading experience was positive. The expectations regarding to the reading and browsing of the content were mostly met. Especially the readers located in the Archipelago of the Turku appreciated the service because in many cases the distribution of the paper based newspaper was impossible or delayed.

The 32-inch lcd-screen was regarded as suitable platform for reading newspaper material. The screen size, format, readability, resolution of the images and videos and the speed for browsing were considered satisfactory.

Majority of the users regarded the reading the newspaper from lcd-screen unnatural and less convenient than reading the paper based newspaper. However some of the younger user gave opposite feedback and read even material that they normally skip in the paper based newspaper.

The readers criticised the lack of portability of TV screen compared with the paper based newspaper.

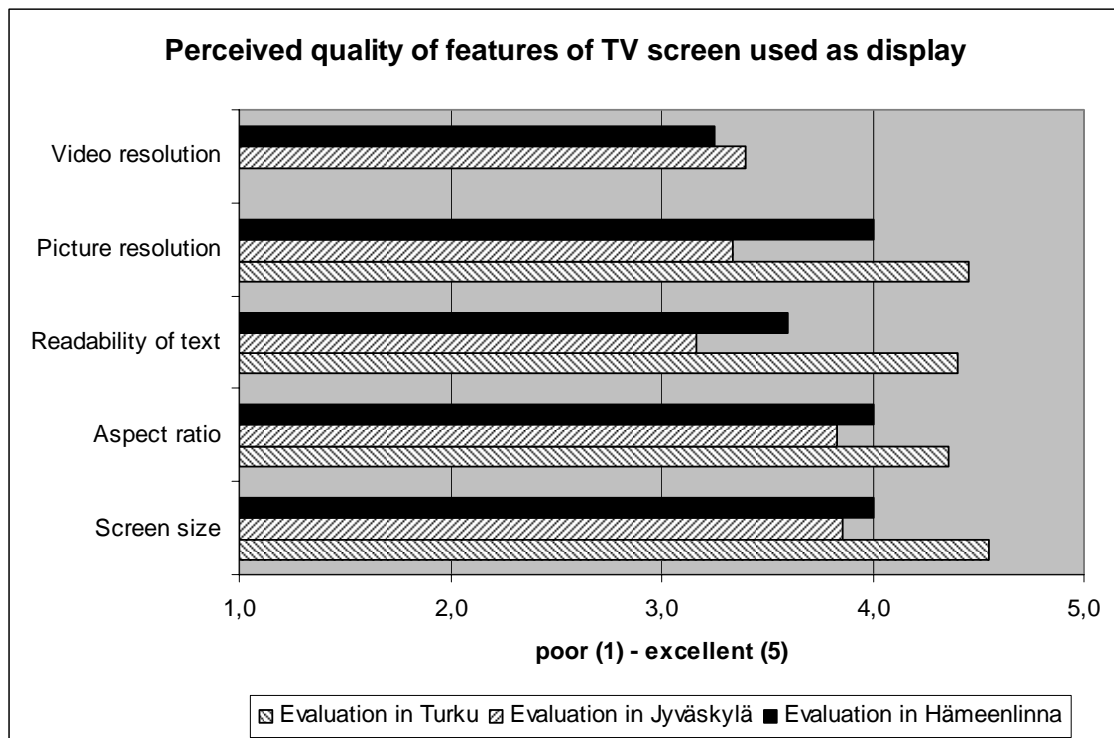


Figure 4. User evaluation about the suitability of lcd-screen to read *DigiTV Newspaper*.

#### 4.3 An enhanced user interface evaluation

In this part the user interface was redesigned to fit into 16:9 format screens for a fixed resolution of 1280 x 768. One of the already published e-newspaper was redesigned with Adobe InDesign, the facsimile images for each page produced and the navigation with browser was done with HTML- and JavaScript.

The usability was improved using chapters and layout where scrolling is not necessary. Page turning buttons were introduced to support the linear reading. Long articles were divided into

parts. Each page had page number to help the reader to identify his location in the e-newspaper.

Indexes in two levels were used. The first level index showed the main article in each section. The section level index showed all of the articles in each section and ingresses. The section index can be reached from main index or menu.

The test persons evaluated the usability of the new layout by answering a questionnaire. They were asked to compare the 19:6 format *DigiTV Newspaper* to the other media formats. According to the result the paper based newspaper is the most convenient format to read the newspaper. The next in the ranking were online newspaper followed by 16:9-format *DigiTV Newspaper*. The mobile news got the lowest ranking.

The redesigned user interface received mostly positive feedback. The user appreciated the fast and easy browsing of the material. Also the video material and the possibility to archive the material were appreciated.

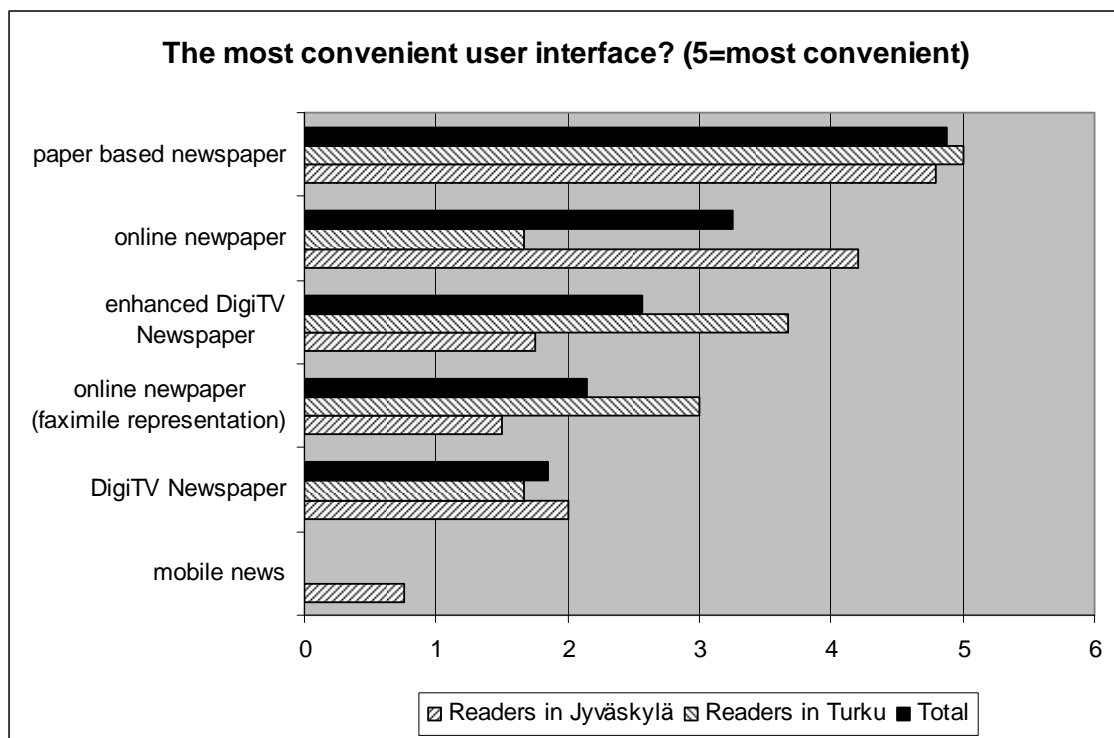


Figure 6. Results from the evaluation of the user interface to the news.

## 6. Conclusions

The reliability of the developed DVB-TS Private Transport Stream protocol was high when the client was within the range of the local sending station. In these cases the data was received reliably by the clients.

The data transmission was tested by sending one newspaper at a time to one geographical location. Technically it is possible to configure the system to distribute and capture several newspapers. Conceptually this model resembles so called joint distribution model where the same carried distributes several newspapers regionally.

The DVB-T-distribution can save costs especially when we consider that the distribution capacity allows 10-40 local newspapers to be distributed at the same time.



Technically reading from lcd-screed with hdtv-resolution was evaluated as suitable for *DigiTV Newspaper* but the reading experience is not at the same level as with the paper based newspaper. With the paper based newspaper the user controls totally the interface and he can also take the newspaper anywhere he wants. When reading the *DigiTV Newspaper* the user has to stay quite near the lcd-screen without the ability to move.

The newspaper content can be published in digital TV but it need to be modified for this publishing channel. The first generation of the product can be the same version that is published in the internet. However the product should be developed further to include also video and up-to-date material.

One interesting result was that during the test period the received newspapers created a personal digital newspaper archive which was regarded useful. In the *DigiTV Newspaper* it is possible to include interactivity like search and calendars.

This service can be regarded as a supplementary service for paper newspaper and it can save distribution costs.

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