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Multimedia data delivery table and improving transfer time on mobile handhelds

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Abstract: This study presents an enhanced method to improve the transfer time of the audio/video file delivery table employed in a mobile handheld, terrestrial-data multimedia broadcasting. The authors analysed the factors responsible for the delay in the dynamic carousel which is transmitted on broadcasting channels. They improved the transfer time and verified using comparison methods and other approaches. In this study, they measured the mobile handheld transmission delay time by analysing and comparing the transmission speed and by showing its characteristics. Proposed method which boosts up time for the mobile handheld data updating can be achieved approximately 20.5% performance improvement.

1 Introduction

As interest in mobile computing rises, many user-friendly services and preferred data services are transmitted on the mobile handsets, terrestrial-digital multimedia broadcasting (T-DMB) [1]. Service operators study methods to use communication networks to provide various interactive services to users. This requires the solving of timing issues such as simultaneous access, electronic programming guide (EPG) update time and low-cost network capacity [2]. T-DMB service has frame rates equivalent to public broadcasting and the ability to transfer high-quality data several times faster than the Internet broadcasting. It can overcome the limitations of existing mobile service media [3]. As the amount of data increases with the demand for various services, a method to transfer a large amount of data efficiently within a limited bandwidth is paramount [4].

We propose a new method that can use existing broadcasting channels and return channels effectively by using delay time and cycle time.

We analysed the file delivery table (FDT), which is frequently used in mobile device for data service, to determine the trade-off point for the return channel decision. The main idea for improving transfer time comprise of two prerequisites: the first condition is the cycle time and the second one is the number of users, which is described in Section 3.

Using the broadcasting channel and return channel from the trade-off point drawn from the analysis, this paper proves that it can provide the desired data, while reducing the transfer time for the user. The proposed method results in improved transfer time of FDT in T-DMB handsets along with minimum channel usage. We analysed and compared the results by measuring the transfer time for the user using a Win CE 5.0 based T-DMB mobile handheld to verify the efficiency of the proposed method.

The remainder of this paper is organised as follows. Section 2 explains the structure of transmitting data services provided by T-DMB. To explain the method proposed in Section 3, this paper presents the problems together with the explanation about the data services and analyses the two factors to obtain the solution. Section 4 shows the testing platform related to the data transmission and explains the T-DMB mobile handheld. Section 5 presents the experimental results using a simulation based on the analysis presented in Section 3. Finally, Section 6 concludes this paper.

2 FDT in mobile handheld

Data service, simply transmission services, that use a broadcasting channel such as DMB may not check the reception of user service because of the characteristics of its means of transmission. Thus, a repetitive transmission method, termed 'Carousel' has been used for the transmission of data service [5]. Carousel is the method that updates data in a certain cycle and transmits the same data repetitively within one cycle, guaranteeing that a terminal receives the carousel data. Conversely, this method requires a delay time to receive new information according to the data size and update cycle of data transmission.

Furthermore, FDT is used as a dynamic carousel format. A set of files is added/deleted/changed in a time-unbounded delivery session. Fig. 1 illustrates the concept of FDT in T-DMB mobile handheld.

In a FDT dynamic carousel, the receiver can detect file changes by observing the FDT instance number changes. The data for FDT and the objects are sent continuously during the session that may be unbounded in time. During transmission, both the FDT instance and the set of files and their content may change.

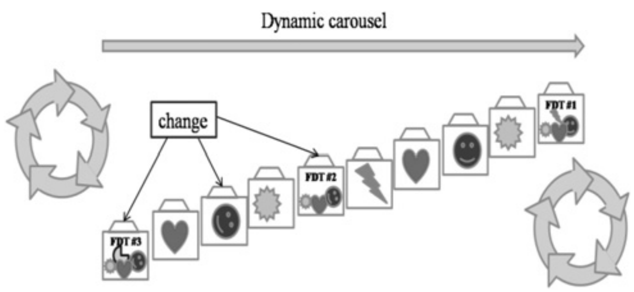

Fig. 1 *Structure of FDT dynamic carousel for T-DMB*

Along with the T-DMB data service, the dynamic carousel includes a simple text message together with the audio service and can provide the program image in relation to the program being broadcasted or the image of music information. It should be noted that the data can be transmitted regardless of the audio. In this case, this can transmit any file if the transmission data protocol has been defined while continuing to provide the services related to the simple webpage information, traffic information, slide show, video etc. Various user-convenience services such as stock information and sports broadcasting are actively developed and are proposed as of the International standard [6].

In order to define the service protocol, regardless of audio/video processing, a data service is necessary to follow the multimedia object transport (MOT) protocol of the T-DMB device [7], which comprises the header core, header extension and body. The dynamic carousel is constructed by the inclusion of the information such as data creation time and validation time, repetitive transmission interval and update cycle within the header extension information [8, 9].

Fig. 2 is an example showing the MOT carousel process. It illustrates that the user has to wait to receive desired data based on the repetitive transmission cycle of the data to be transmitted and the update cycle. In Fig. 2, all the objects in 1, 2 and 3 have to be transmitted before the user obtains the 'lion' data of 'animal'. The user delay time to receive the 'snake' information may be as big as the transmission time of all previous objects, since the object 'lion' also requires at least three repetitions.

3 Improving transfer time

In this paper, we present a factor that reduces the transfer time. We propose a condition to update information to the user as fast as possible. It should be noted that the transfer time is, mostly, dependent on return channels so that our main initiative is to define a broadcast region and a unicast region – two regions are commonly used to generate a trade-off point [10–12].

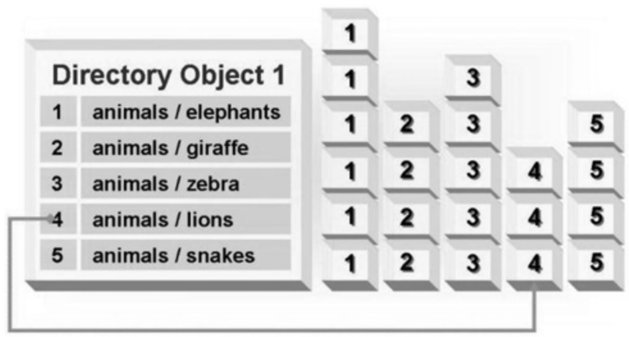

Fig. 2 *Illustration of MOT carousel process*

3.1 Condition # 1 – using 'cycle time'

Generally, with high audio/video processing and fast transfer time, T-DMB cannot transmit updated information before the current carousel cycle finishes. Therefore the carousel transfer time and an update frequency should be compared.

In (1), FDT_i includes a list of data that can be transmitted in the ith cycle. Assume that the transmitted carousel contains FDT, including A/V processing and data; each context is

'First round': $\mathrm{FDT}_1, F_1, F_2, F_3, \ldots, F_n$
'Second round': $\mathrm{FDT}_2, F_1, \alpha F_2, F_3, \ldots, F_n$
'nth round': $\mathrm{FDT}_n, F_1, \beta F_2, F_3, \ldots, F_n$

We define the total transfer time of FDT, τ_{total} of each round as follows

$$\begin{aligned}\tau_{\text{total}} = {} & \mathrm{FDT}_i + F_i \times J_i + F_i + 1 \times J_i + 1 \\ & + F_i + 2 \times J_i + 2 \ldots F_n \times J_i + n\end{aligned} \quad (1)$$

where J denotes the newly altered data that occur periodically for T-DMB. F_i indicates the ith file and V_i indicates the ith version of the file. Therefore we can obtain the formula $J = \sum_{j=0}^{n} F_j V_j$. Hence, the transfer time can be expressed as (2) and for the nth cycle, the average l transfer time, $T_{\text{avg\_FDT}l}$, can be expressed with (3)

$$\tau c = \sum_{i=0}^{n} \mathrm{FDT}_i + F_i + \sum_{j=0}^{n} F_j V_j \quad (2)$$

$$T_{\text{avg\_FDT}l} = \tau_c / n = \left(\sum_{i=0}^{n} \mathrm{FDT}_i + F_i + \sum_{j=0}^{n} F_j V_j \right) \Big/ n \quad (3)$$

As the cycle time, $F(t)$, is longer than the average FDT transfer time, the delay increases when the A/V data is transferred. The function of frequency update, $F(t)$ is

$$F(t)_{\text{frequency\_update}} \geq T_{\text{avg\_FDT}} \quad (4)$$

Therefore the update cycle $F(t)_{\text{frequency\_update}}$ is greater than or equal to $T_{\text{avg\_FDT}}$, which means the cycle time is longer than the average FDT transfer time for the condition of $F(t) \geq 0$.

Practically, $F(t)_{\text{frequency\_update}} \geq 0$ is reasonable when the data is transmitted in unicast region.

3.2 Condition # 2 – using 'number of users'

Where $F(t) < 0$, which is a reverse of (4), we also clarify with another condition for the effectiveness. We deduced the relationship between the delay time and the carousel transfer time to select the suitable transmission mode or return channel. Table 1 shows the comparison of two modes regarding the delay time and the average FDT transfer time.

Since broadcast mode in T-DMB transfers the data with fixed bandwidth, the delay time is almost independent of the number of users. Therefore the delay time in broadcast mode appears as a constant value in Table 1(a). We also tested a factor used in allocated bandwidth because of the limited number of users. If this is not the case, that is, $F(t)$

Table 1 Comparison of broadcast and unicast mode

	(a) Broadcast mode	(b) Unicast mode
delay time	$y = c$	$y = ax^2 + bx + c$ (when a, b, $c > 0$)
average FDT transfer time	$\sum_{i=0}^{n} \text{FDT}_i + F_i + \sum_{j=0}^{n} F_j V_j / n$	$\sum_{i=0}^{n} \text{FDT}_i + F_i / n$

x is the number of users

Table 2 Mobile handheld specifications

Mobile handheld (T-DMB)
CPU: private company chip (400 MHz) GPS: SiRF III built-in module Operating system: Win CE 5.0 Slot: Secure digital/multimedia card slot Power consumption : 62 mW Memory: NAND flash 64 MB and SDRAM 64 MB Chipset specification Processor: ARM-9 (400 MHz) MPEG decoder: RISC processor Cache size: 16 KB instruction cache, 16 kb data cache RAM: 4 kb, NAND flash boot loader with memory management unit Interface: SD host interface v1.0 and multi-media card interface v2.11 Power consumption: on-chip phase-locked loop with clock and power management I/O: 130 general purpose I/O pins

< 0, the delay time is unaffected when data are transferred in broadcast mode.

Although, in most cases, the cycle time is delayed when the users are not updated with the new information each time, we defined (5) and find a trade-off point for the broadcast and unicast modes of the delay time

$$\frac{\partial Y(x)}{\partial t(x)} = 2ax + b \qquad (5)$$

when a, b, $c > 0$.

4 Data service on mobile handheld

The system was tested as an experimental laboratory setup using the T-DMB mobile handheld along with a built-in global positioning system (GPS) module with the specifications listed in Table 2. The T-DMB mobile handheld and GPS navigation were fabricated using the ‘SiRF’ III GPS microcontroller chipset [7]. It has a T-DMB receiver sensitivity of −159 dBm while tracking. T-DMB hardware design is provided by a private company. Software and advanced RISC (reduced instruction set computing) machines (ARM)-9 chipset enables it to connect to the GPS module. The power consumption of CPU is approximately 62 mW.

4.1 Data service

For testing purposes, the T-DMB communication was shown by a windows browser. Table 2 shows that the specification of T-DMB and chipset.

After the device transmitted to the user, specific menus were loaded from the browser as shown in Section 4.2.

The T-DMB software was given some file handling and sharing capabilities. Some data services, such as TV/radio player and history, are identified below. A file contains the information related to the user [7]:

- TV/radio player
- History
  - o Previous videos/radio options
  - o Channels list
- Favourite channels
  - o Channels viewed last time
  - o Favourite channels list
  - o Error notification options
- Multimedia codec
  - o Video player
  - o Audio player
- Transport protocol expert group (TPEG) real-time traffic information
  - o Graphical info
  - o Environmental settings
  - o Major road information
- External camera with sensor
  - o Safety function
  - o Parking surveillance

Whenever the data were loaded by the browser, the file containing the above information was requested from the T-DMB handheld, except for the GPS information. In the case of traffic information, that is, TPEG, the traffic information from the GPS receiver transfers the file to the T-DMB mobile handset. It stores the file temporarily and keeps updating the data file. The file transfer time is critical, so the read/write operation will be a key issue in transferring the data service.

The proposed method in this paper was implemented in the T-DMB mobile handheld receiver including a return channel. The return channel use of the IEEE 802.11 g method and it is fully tested.

4.2 Screen display

Helpful data, as seen in Figs. 3 and 4, can be shown to the user and employ a graphical (presentational) method, such as HTML browser, flash etc. It supports ‘interactive’ services, such as EPG, video on demand, games and news. The application layer used here was EPG. A main chipset based data service options and applications were loaded to the browser for visualisation, as shown in Figs. 3 and 4, respectively.

Transmission bit rate was set to 96 kbps and the channel was used as the data transmission channel. Stock information, traffic information and news information were used for the data. Size of the stock information data, updated every minute, was set to 240 kb, initially. Size of

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Fig. 3 *Screenshots showing updating news information*

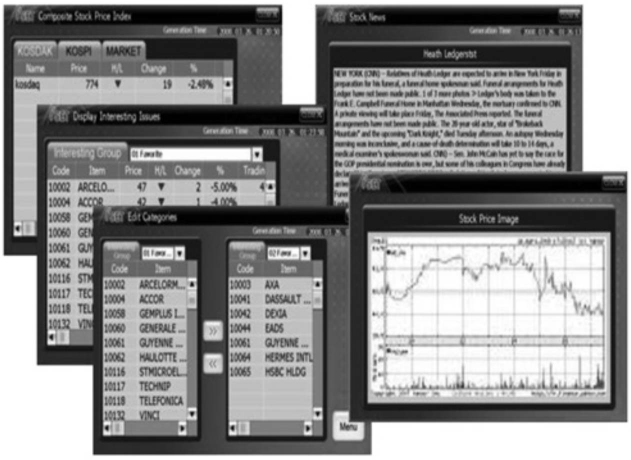

Fig. 4 *Screenshots of stock name and lists*

traffic information was set to about 156 kb and the size of news information to about 20 kb for testing purposes.

Fig. 3 portrays the screen, updating in real-time, main news items. The user, desiring to see the details, can obtain the information using the return channel. In addition, Fig. 4 illustrates stock information, displays the stock code and the stock name; the user can register, remove or edit their favourite stock list. The screen showing favourite items updates the information in real-time. The user can obtain the information that he/she wants using the return channel to see the details of a desired stock.

4.3 Software and design flows

In order to verify the software, we loaded several test files on Win CE 5.0 operating system of embedded graphical user interface in T-DMB mobile platform. The OS/driver layer provides the necessary interfaces to the lower hardware layers, that is, network access, RAM, hard drive, USB-port. Data transmission of T-DMB handsets can be enabled with a plug and play option as well [13]. Test platform setup with T-DMB mobile platform, the software evaluation kit OS/driver layer, is shown in Fig. 5.

Several options, for example, menus and required user interface, were designed using Embest IDE for ARM Development Tools Suite I [11] for data transmission of the T-DMB mobile handheld.

Each user customised data, for example, favourite channels, while they watch TV or listen to radio, were stored in the main CPU; they can be accessed anytime the

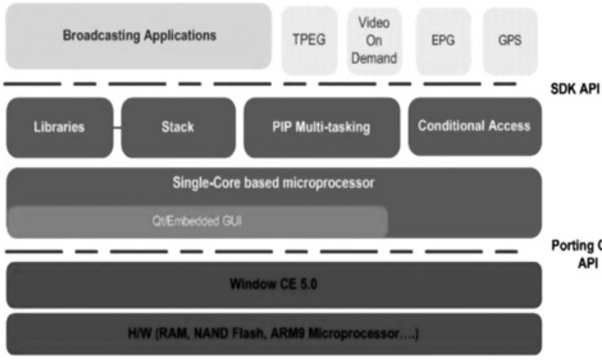

Fig. 5 *Block diagram of T-DMB OS layer*

user wants. After data were transmitted from the T-DMB mobile handheld, the data and information were re-transmitted back to the T-DMB mobile handheld [14]. T-DMB then loads the viewer's favourite menus and data again. The design flow is shown in Fig. 6.

5 Test and results

When FDT is transmitted by the designated cycle time, we express an average user access time as $T_c/2$ [5]. We tested the relationship between delay time and update frequency through simulation. Fig. 7 shows the relationships between delay time and cycle time.

In region I, updated information is transmitted faster by the unicast mode than the broadcast mode and, region II passes the trade-off point as revealed by the simulation program that embodies (5).

We confirm that the delay time decreases when transferring audio/video using broadcast mode in region II, on the right-hand side of Fig. 8, as elucidated in the analysis of Section 3.2.

We tested our proposed method with different data sources, for example, '.avi, .wma, .mpeg-4' etc. from T-DMB product [15]. T-DMB handheld uses the Win CE 5.0 operating system and ARM-9 400 MHz single-core processor.

Table 3 shows the test results of the T-DMB mobile handheld, including the following as the parameters: 'file type, file transmission time' and 'the percentage of improvement'. It should be noted that the file transmission

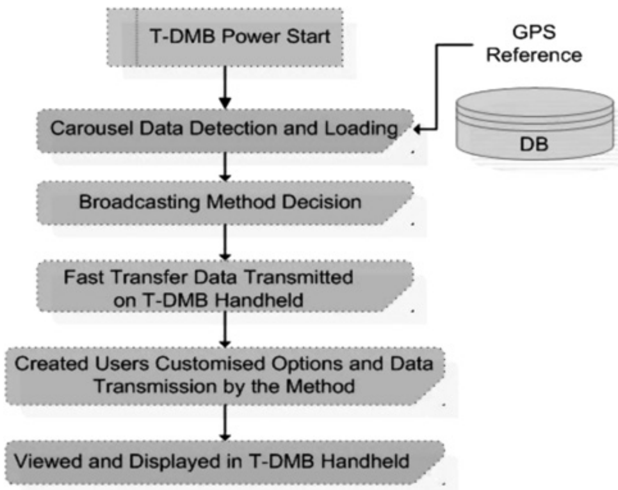

Fig. 6 *Flowchart of mobile handheld*

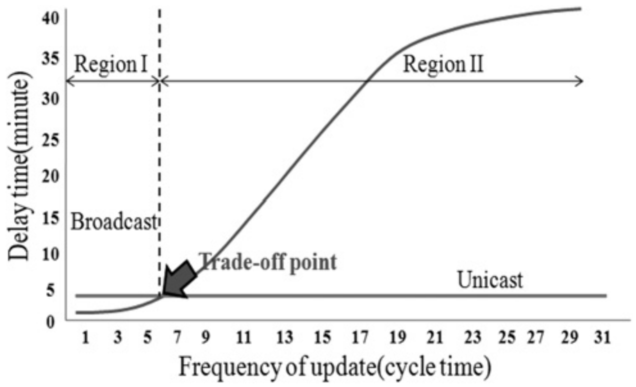

Fig. 7 *Relationship between delay time and cycle time*

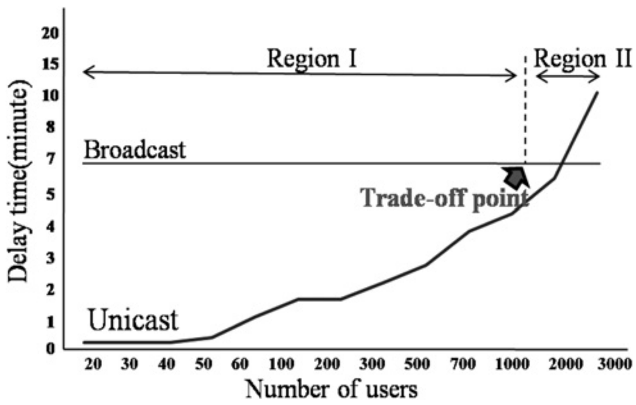

Fig. 8 *Relationship between delay time and number of users*

Table 3 Data transmission test results

File type		File size, kb	Transmission time, ms	Percentage improvement, %
video	.avi	4056	267	12.4
	.wma	3850	224	11.6
audio	sound-1	447	83	20.5
	sound-2	245	39	15.4

time is the duration of the transfer time when the file is loaded from the CPU to the TV screen.

The test results show that video files take more time to transmit than audio files, because of the bigger file size. The file transmission time is a critical issue for T-DMB data service.

This product is commercially available with the TPEG algorithm; so our proposed method is verified (Fig. 9). Fig. 9 shows the experimental result. The delay time (ms) on the left-hand location on the bar graph of each case represents the time taken when transmitting the DMB channel using an existing method. The middle bar represents the time taken using the return channel and T-DMB channel proposed in this paper. The right-hand bar shows the increased rate. 'Video file-1, .avi' file, the first of the four data characteristics used in this experiment, shows the result of transmitting stock information with low usage

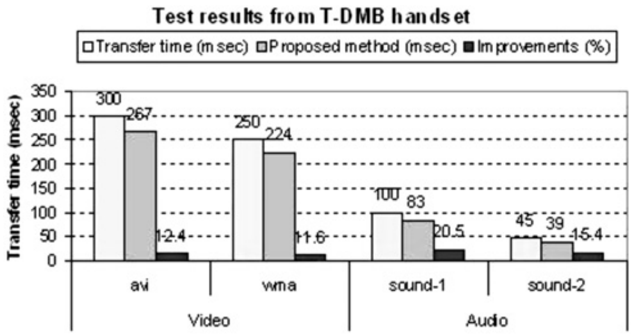

Fig. 9 *Test results from T-DMB handset*

frequency and large data size. When the method proposed in this paper is applied, performance improves by 12.4% and the user delay time was reduced. At the same time, 'video file-2, .wma file', are representing the transmission of a large volume of traffic information with a relatively low usage frequency, shows improved performance of 11.6%, approximately. Finally, the data size of 'sound-1' and 'sound-2' are small and the usage frequency is low; the delay time has a relatively high 20.5% reduction based on the experimental result using news information.

6 Conclusions

This paper presented the delay time of data sources, that is, data service and FDT using a faster transfer method to show an efficient design algorithm for a T-DMB user delay time by the update cycle and number of users. It suggested the effective trade-off points of two transmission methods. We transmitted four different kinds of data directly to the terminal to verify the efficiency of the trade-off point drawn, because of the analysis. The simulated results demonstrated improvement of update information transfer time to a maximum of 20.5%.

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