Abstract: A method for receiving data bursts in a mobile digital video broadcast handheld (DVB-H) communication device (MD) within a mobile communication network having at least two communication cells (C1, C2), which method comprising the steps of: receiving at least a first data burst containing a first service data signal (SSI) within a first communication cell (C1) using a first carrier frequency (f1) and at least a second data burst containing a second service data signal (S2) having identical data content within a second communication cell (C2) using a second carrier frequency (f2) at different times (T, T+AT); combining the first and second service data signals (SSI, S2) received from the first and second data bursts to a resulting service data signal (RSSI) having an improved "Quality of Service" level and decoding the resulting service data signal (RSSI) within the mobile DVB-H communication device (MD).
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Method and mobile communication device for receiving data bursts according to the digital video broadcast handheld (DVB-H) standard

FIELD OF THE INVENTION

The invention generally relates to a method and mobile communication device for receiving data bursts according to the digital video broadcast handheld (DVB-H) standard within a mobile communication network having at least two communication cells.

BACKGROUND OF THE INVENTION

Digital video broadcast handheld (DVB-H) is a new European Telecommunications Standards Institute (ETSI) standard for providing Digital Video Broadcasting (DVB) services to mobile communication devices, particularly handheld devices such as mobile phones etc. Provisions are made in this standard to support low-power receiver implementations. DVB-H provides additional features to support handheld devices and mobile reception that allows power savings, mobility with high data rates, single antenna reception, and Single Frequency Networks (SFN), among others. DVB-H also provides impulsive noise tolerance and increased general robustness as well as a support for seamless handover during power off-times.

All of the foregoing features are achieved by adding options to DVB-T including, but not limited to, time-slicing for power saving, MPE-FEC frames for additional robustness, and 4K mode for mobility and network design flexibility. In DVB-H, data is bundled in data "bursts" at a high rate so that it is possible to switch off the receiving unit of the mobile communication device between such data bursts, realizing up to 90 % energy savings. Time-slicing also permits simple handover during absence of the data service. In order to establish a convergence between the traditional broadcast world and the PC world, IP encapsulation is introduced. To extend this to the small multimedia devices, IP encapsulation is combined with time-slicing.
DVB-H is meant for IP-based services using Multi Protocol Encapsulation (MPE). Additional robustness is provided to such a DVB-H communication system by protecting the MPE-sections with an extra layer of Forward Error Correction (FEC) coding, thus the nomenclature MPE-FEC frame. DVB-H can share DVB-T multiplex with MPEG2 services.

As mentioned before, one of the main advantages of said DVB-H standard is that information is transmitted via data bursts. In Figure 1 per way of example a first and a second transport stream TSI, TS2 are shown in a schematic diagram, wherein the first and second transport stream TSI, TS2 are produced via different transmission stations T1, T2 and transmitted within different geographical areas resp. communication cells C1, C2 within a mobile communication network. Each of said first and second transport streams TSI, TS2 consists of per way of example four time-sliced data service signals SS1 - SS4, which are transmitted in bursts in successive time slots of the respective transport stream TSI, TS2 during a time interval Ton. After transmission of one data burst of said data service signals SS1 - SS4 the transmission of additional service data is stopped for a time interval Toff. The amount of service data contained in a data burst is sufficient to guarantee playtime till the next data burst of the respective data service is received.

So if a user is interested in for example the first data service resp. the first data service signal SS1 only, the receiver unit of the mobile communication device MD can be switched-off during the transmission of the other data service signals SS2 - SS4. In this way a power-saving can be realized, which can be in practice up to 90 %. The actual realizable power-saving is roughly determined by the average service bit rate and the gross transmission bit rate. During the time interval Ton of service, first the MPE-sections containing IP datagram's are transmitted followed by MPE-FEC sections containing the RS parity columns.

UK Patent Application GB 2 401 759 A discloses for instance a method of signaling in a mobile communication network, wherein a terrestrial digital video broadcasting (DVB-T) network is used to transmit IP datagrams to receiving devices using multiprotocol encapsulation (MPE). Therein the content data and the recovery data are transmitted via two different communication channels within the same geographical region of the mobile communication network.
If a mobile communication device MD is located at the boundary of the coverage area of for instance a first and a second geographical area resp. communication cell C1, C2, at a certain moment, when the reception conditions drops below an acceptable level, a decision has to be made to switch over from the first communication cell C1 to the adjacent communication cell C2, if the service of interest is offered in both cells and the Quality of Service level is higher in the adjacent communication cell C2. Preferably the service consumption may be done without interrupt when the service handover is carried out seamlessly.

If the Quality of Service level in the adjacent communication cell C2 isn't high enough either, said mobile communication device MD, which is at the boundary of both communication cells C1, C2 coverage area's can suffer from a bad signal reception because it is far away from the cell's transmission stations T1, T2. In Figure 2 the outlined situation is illustrated, where the mobile communication device MD is located in a transition area TA of the adjacent communication cells C1, C2 having a poor reception characteristic. So far no prior-art is known that solves the problem that reception from both transmission stations T1, T2 within said transition area TA is bad. Currently, handover from the first transmission station T1 of the first communication cell C1 to the second transmission station T2 of the second communication cell C2 is carried out if the reception quality drops under a defined "Quality of Service" level.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide a method and system for receiving data bursts in a mobile digital video broadcast handheld (DVB-H) communication device having an improved reception performance.

The object is solved by a method as defined in claim 1 and a mobile communication device as defined in claim 12. Preferred embodiments of the invention are mentioned in the dependent claims.
According to one aspect of the present invention a method for receiving data bursts in a mobile digital video broadcast handheld (DVB-H) communication device is proposed, comprising the steps of:

- receiving at least a first data burst containing a first service data signal within a first communication cell using a first carrier frequency and at least a second data burst containing a second service data signal having identical data content within a second communication cell using a second carrier frequency at different times;
- combining the first and second service data signals received from the first and second data bursts to a resulting service data signal having an improved "Quality of Service" level, and
- decoding the resulting service data signal within the mobile DVB-H communication device.

Instead of receiving data bursts from one transmission station only, the inventors have discovered that receiving at least two data burst, where each is containing the same desired service data, from two or more transmission stations and combining the received data service signals leads to a resulting service data signal having an acceptable Quality of Service level. One or more data services are transmitted in adjacent communication cells at different carrier frequencies and with a mutual time shift, where the corresponding service bursts have identical contents. Therefore the invention is based on a frequency, spatial and time diversity introducing a new "burst diversity technique". Said "burst diversity technique" requires advantageously less Carrier-to-Noise-Ratio than conventional transmission methods and improves the geographical coverage of mobile communication systems as well as the reception behaviour of mobile DVB-H communication devices.

According to another aspect of the invention the first and second data bursts are received with a time delay by the mobile DVB-H communication device, wherein the at least first and second service data signal are transmitted via at least two different time-sliced transport streams produced by at least two transmission stations of the mobile communication network. The first data burst is transmitted by a first transmission station within the first communication cell and the second data burst is transmitted by a second transmission station within the second communication cell, so the first and second transport streams are transmitted via geographically different transmission paths.
The present invention has the further advantage that said at least first and second data service signals are transmitted via a first and a second MPE-FEC frame, each containing multi protocol encapsulation (MPE) data and forward error correction (FEC) data and each symbol of the at least first and a second MPE-FEC frame is error decoded resulting in at least two level erasure information indicating the reliability of each symbol. Finally based upon the at least two level erasure information said resulting data service signal, preferably a resulting MPE-FEC frame is produced by choosing for each symbol location of the first and second received data service signals the symbol having the highest reliability.

In order to achieve the object defined above, a mobile communication device for receiving data bursts according to the digital video broadcast handheld (DVB-H) standard within a mobile communication network having at least two communication cells is provided, comprising:

- a receiving unit for receiving at least a first data burst containing a first service data signal within a first communication cell using a first carrier frequency and at least a second data burst containing a second service data signal having identical data content within a second communication cell using a second carrier frequency at different times;
- a combiner unit for combining the first and second service data signals received from the first and second data bursts to a resulting service data signal having an improved "Quality of Service" level and
- a decoder unit decoding the resulting service data signal.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail hereinafter, by way of non-limiting examples, with reference to the embodiments shown in the drawings.

Fig. 1 shows a block diagram of a prior art configuration of two transport streams;
Fig. 2 shows a block diagram of two adjacent communication cells, wherein a mobile communication device is located in a poor reception area;

Fig. 3 shows a block diagram of mobile communication device for receiving data bursts according to a preferred embodiment of the invention and

Fig. 4 and 5 show the reception performance improvements achieved by the burst diversity technique.

DESCRIPTION OF EMBODIMENTS

As mentioned before, Fig. 1 shows per way of example a first and a second transport stream TSI, TS2 according to the Digital video broadcast handheld (DVB-H) standard, where the first transport stream TSI is produced by a first transmission station T1 and transmitted within a first communication cell C1. Analogous to that, the second transport stream T2 is produced by a second transmission station T2 and transmitted within a second communication cell C2, where the first and second transport stream T1, T2 contain at least one identical data service.

Said first and second communication cells C1, C2 are adjacent and according to Fig. 2 a mobile communication device MD is located in the transition area TA resp. overlapping geographical area of both communication cells C1, C2. So the first and second transport streams TSI, TS2 are transmitted via geographically different transmission paths resulting in a spatial diversity of the proposed transmission technique.

Said first and second transport stream TSI, TS2 consist per way of example of four time-sliced data service signals SS1 - SS4, SS1' - SS4' which are transmitted via data "bursts" in successive time slots of the first resp. second transport stream TSI, TS2 during a time interval Ton. Within the first and second adjacent communication cells C1, C2 data bursts containing in respect to the service data identical data service signals SS1, SS1' are transmitted at different transmission times, so the data bursts are received by mobile communication device MD within a time delay ΔT. This means that the data burst corresponding to the data service signal SS1 in the first transport stream TSI is received at a time T and the data burst containing the identical service data resp. the data service signal SS1' in the second transport stream TSI is received at a time T + ΔT. So the transmission of the data bursts containing the same data service information is mutual time-shifted, such that
with the same mobile communication device MD the data bursts of one data service can be received both from the first and second transmission station T1, T2. The time delay $\Delta T$ is big enough that the mobile communication device MD has enough time to process both incoming data bursts serially. Thus a seamless handover when moving from the first to the second communication cells C1, C2 is secured.

During the time interval $T_{on}$ of burst transmission, first Multi Protocol Encapsulation (MPE)-sections containing IP datagrams are transmitted followed by MPE-FEC sections containing RS parity columns. After transmission of each data burst allocated to for instance the first data service signal SS1 the next data burst of the respective first data service signal SS1 will be transmitted after a time interval $T_{off}$.

In addition, the time-sliced data service signals SS1 - SS4 are transmitted within the first communication cells C1 via a first carrier frequency $f_1$ and within the second communication cells C2 via a second carrier frequency $f_2$ resulting in a frequency diversity of the proposed transmission technique. In a preferred embodiment of the invention, said first and second carrier frequencies $f_1$, $f_2$ have different frequencies.

Figure 3 shows per way of example a block diagram of a mobile communication device MD for receiving said data bursts according to a preferred embodiment of the present invention. The mobile communication device MD may be perferrably used in a transmission system using digital video broadcasting standards to provide a way of carrying multimedia data services over digital terrestrial broadcasting networks. For example, the mobile communication device MD may be a handheld terminal, a mobile phone or another, especially battery powered apparatus capable of data processing according to the DVB-H standard.

The mobile communication device MD comprises a receiving unit RU having an antenna A, which is connected to a front-end unit FEU. The receiving unit RU receives consecutive data bursts transmitted by the first and second transmission station T1, T2 and outputs a transport stream TSI, TS2. Thereby, each data service signal SS1 - SS4, SS1 '-' - SS4' of said first and second transit stream TSI, TS2 may comprise multiprotocol encapsulation (MPE) data containing IP-data and forward error correction (FEC) data. Timing offset information may be provided to indicate the timing between succeeding bursts.
In case of digital video broadcasting for handheld terminals (DVB-H), such a timing offset information is for instance the time delay $\Delta T$ between two related data bursts.

Furthermore, the mobile communication device MD comprises a demultiplexer unit DEMUX, which is connected to the receiving unit RU. The demultiplexer unit DEMUX is associated with at least one memory unit MU. Said demultiplexer unit DEMUX consists of serveral filter units, for instance a De-encapsulation filter DE-ENC and a Forward Error Correction filter FEC.

The demultiplexer unit DEMUX receives the first and second transport stream TSI, TS2 and demultiplexes the received first and second transport stream TSI, TS2 into at least a first and second data service signals SSI, SSI', perferably a first and second MPE-FEC frame containing the same service data together with their individual corresponding erasure (reliability) information. The first and second data service signals SSI, SSI' resp. MPE-FEC frames are per way of example forwarded to the memory unit MU, which is connected to a combiner unit CU as well as to a decoder unit DEC, preferably a MPE-FEC decoder.

In addition to that, the De-encapsulation filter DE-ENC de-encapsulates the MPE-sections of the first and second MPE-FEC frame using a Forward Error Correction filter FEC. So the demultiplexer unit DEMUX filters out via the De-encapsulation filter DE-ENC the different sections of the contained IP-data, where said de-encapsulation filtering is accompanied by a cyclic-redundancy-check RCE as well as a check sum calculation CSC. Via said Forward Error Correction filter FEC each symbol of the at least two MPE-FEC frames is error decoded resulting in at least two level erasure information EI, EF indicating the reliability of each symbol S, S' of the first and second MPE-FEC frame.

Based upon that, at least two level erasure information EI, EF a resulting data service signal RSSI, preferably a resulting MPE-FEC frame is produced via the combiner unit FC by choosing for each symbol location from the two received data service signals SSI, SSI' the symbol S, S' with the highest reliability. After combining the identified symbols S, S' having the highest reliability to said resulting data service signal RSSI, preferably a resulting MPE-FEC frame with associated erasure information, said resulting data service signal RSSI is saved in the memory unit MU for further data processing. Subsequent to that,
the resulting data service signal RSSI is decoded via the MPE-FEC decoder unit MPE-FEC-DEC resulting in a service data signal having an improved "Quality of Service" level.

In a preferred embodiment a four level erasure information EI, EF indicates the reliability of each symbol S, S' in the first and second MPE-FEC. The lowest level indicates that the examined symbol S, S' is almost for sure correct and the highest level indicates that the symbol S, S' is incorrect, e.g. discarded or missed data. Therefore a low erasure value indicates a high reliability and a low reliability is represented by a high erasure value. An example of such a four level erasure information EI, EF is given below.

<table>
<thead>
<tr>
<th>erasure information EI, EI’ value</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Almost for sure correct</td>
</tr>
<tr>
<td>1</td>
<td>probably correct</td>
</tr>
<tr>
<td>2</td>
<td>probably incorrect</td>
</tr>
<tr>
<td>3</td>
<td>Incorrect (discarded or missed data)</td>
</tr>
</tbody>
</table>

Based upon the erasure information EI, EF value said resulting data service signal RSSI is construed by choosing for each symbol location from the two received MPE-FEC frames the symbol S, S' with the highest reliability. If both symbols S, S' have the same erasure information EI, EF value and also the same symbol value, then the erasure information EI, EF maybe upgraded by decreasing the erasure information EI, EF value, except when the erasure information EI, EF value indicates that both symbols S, S' are incorrect. If both symbols S, S' have the highest erasure value but do not have the same symbol value then one of the two symbols S, S' is incorrect. There the reliability of the symbols S, S' maybe degraded by increasing the erasure information EI, EF value and choosing one of the two symbols S, S' randomly.

In Figure 4 and 5 performance results of the proposed "burst diversity technique" are shown, where in Figure 4 the MPE-FEC Frame Error Rate as function of the Carrier to Noise Ratio (CNR) is shown for a 50 Hz Doppler frequency and in Figure 5 the required Carrier to Noise Ratio (CNR) for achieving a Frame Error Rate of 5% as function of the Doppler frequency is plotted.
The resulting data service signals RSSI, preferably resulting MPE-FEC frames together with the erasure information are combined in the proposed way. The data transmission is carried out using a 8K OFDM mode with a guard interval of GI = 1/4, 16-QAM modulation and a convolutional coding rate $R = 2/3$. The used IP de-encapsulation technique is identical to the method described in the DVB-H Implementation Guidelines, ETSI TR 102 377, V1.2.1, November 2005, such that erasure information is extracted on base of section CRC. In Figure 4 the results of the proposed burst diversity technique are compared to the method without diversity. It is shown that for Frame Error Rates smaller than 10% 2 dB or more a CNR saving is accomplished. The curves depicted in Figure 5 show that for Doppler frequencies greater or equal 90 Hz, 3 dB or more gain can be expected.

Finally, it should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be capable of designing many alternative embodiments without departing from the scope of the invention as defined by the appended claims. In the claims, any reference signs placed in parentheses shall not be construed as limiting the claims. The word "comprising" and "comprises", and the like, does not exclude the presence of elements or steps other than those listed in any claim or the specification as a whole. The singular reference of an element does not exclude the plural reference of such elements and vice-versa. In a device claim enumerating several means, several of these means may be embodied by one and the same item of software or hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

In general the proposed method and mobile communication device MD can be extended to the reception of more than two data bursts having the same service information, which will be at the expense of a larger power consumption of the mobile communication device MD.

The combining of the received service data has been proposed at the MPE-FEC frame level, but the combining of the service data can also be applied in an earlier stage of the DVB-H receiver, e.g. after OFDM processing at sub-channel level.

To limit the memory requirements, it is beneficial to combine the service data signals SSI, SSI' as soon as possible during the processing stage. In a preferred embodiment after having received said first service signal SSI inclusive reliability information, the
comparing with service data from said second service signal SSI' if utilizable fragments of said second service signal SSI' inclusive reliability information are received.
CLAIMS:

1. A method for receiving data bursts in a mobile digital video broadcast handheld (DVB-H) communication device (MD) within a mobile communication network having at least two communication cells (Cl, C2), which method comprising the steps of:
   - receiving at least a first data burst containing a first service data signal (SSI) within a first communication cell (Cl) using a first carrier frequency (f1) and at least a second data burst containing a second service data signal (SSI’) having identical data content within a second communication cell (C2) using a second carrier frequency (f2) at different times (T, T+ΔT);
   - combining the first and second service data signals (SSI, SSI’) received from the first and second data bursts to a resulting service data signal (RSSI) having an improved "Quality of Service" level, and
   - decoding the resulting service data signal (RSSI) within the mobile DVB-H communication device (MD).

2. A method according to claim 1, wherein the first and second data bursts are received with a time delay (ΔT) by the mobile DVB-H communication device (MD).

3. A method according to claim 1 or 2, wherein the at least first and second service data signal (SSI, SSI’) are transmitted via at least two different time-sliced transport streams (TSI, TS2) produced by at least two transmission stations (Tl, T2) of the mobile communication network.

4. A method according to claim 3, wherein the first data burst is transmitted by a first transmission station (Tl) within the first communication cell (C2) and the second data burst is transmitted by a second transmission station (T2) within the second communication cell (C2).

5. A method according to one claim 4, wherein the first and second transport streams (TSI, TS2) are transmitted via geographically different transmission paths.
6. A method according to one of the claims 3 to 5, wherein said first data burst is transmitted via one time slot of the first transport stream (TS1) and said second data burst is transmitted via one time slot of the second transport stream (TS2) during a time interval (Ton).

7. A method according to one of the claims 1 to 6, wherein a first and a second carrier frequency (f1, f2) with different frequencies are used.

8. A method according to one of the claims 1 to 7, wherein said at least first and second data service signals (SSI, SSI’) are transmitted via a first and a second MPE-FEC frame, each containing multiprotocol encapsulation (MPE) data and forward error correction (FEC) data.

9. A method according to claim 8, wherein each symbol of the at least first and a second MPE-FEC frame is error decoded resulting in at least two level erasure information (EI) indicating the reliability of each symbol.

10. A method according to claim 9, wherein based upon the at least two level erasure information (EI, EF) said resulting data service signal (RSSI), preferably a resulting MPE-FEC frame is produced by choosing for each symbol location of the first and second received data service signals (SSI, SSI’) the symbol (S, S’) having the highest reliability.

11. A mobile communication device (MD) for receiving data bursts according to the digital video broadcast handheld (DVB-H) standard within a mobile communication network having at least two communication cells (Cl, C2) comprising:
   - a receiving unit (RU) for receiving at least a first data burst containing a first service data signal (SSI) within a first communication cell (Cl) using a first carrier frequency (f1) and at least a second data burst containing a second service data signal (SSI’) having identical data content within a second communication cell (C2) using a second carrier frequency (f2) at different times (T, T+ΔT);
12. A mobile communication device (MD) according to claim 11, further comprising a demultiplexer unit (DEMUX) consisting of a De-encapsulation filter (DE-ENC) and a Forward Error Correction filter (FEC).

13. A mobile communication device (MD) according to claim 11 and 12, wherein the first and second carrier frequencies (f1, f2) are different.

14. A mobile communication device (MD) according to claim 11 and 12, wherein said service signals (SSI, SSI') are realized as MPE-FEC frames, each containing multiprotocol encapsulation (MPE) data and forward error correction (FEC) data.

15. A mobile communication device (MD) according to claim 14, wherein each symbol (S, S') of the at least first and a second MPE-FEC frame is error decoded resulting in a at least two level erasure information (EI) indicating the reliability of each symbol.

16. A method according to claim 15, wherein based upon the at least two level erasure information (EI, EF) said resulting data service signal (RSSI), preferably a resulting MPE-FEC frame is produced by choosing for each symbol location of the first and second received data service signals (SSI, SSI') the symbol having the highest reliability.
Fig. 1

Fig. 2
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. H04H20/22 H04H60/11

According to International Patent Classification (IPC) or to both national classification and IPC.

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

H04H H04B H04Q H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

Electronic database consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of Box C

See patent family annex

**Date of the actual completion of the international search**

13 August 2009

**Date of mailing of the international search report**

24/08/2009

Name and mailing address of the ISA/

European Patent Office, P B 5818 Patentlaan 2 NL- 2280 HV Rijswijk Tel (+31-70) 340-2040, Fax (+31-70) 340-3016

Authorized officer

Sanahuja, Francesc
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