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(71) Applicant: **NOKIA TECHNOLOGIES OY** [FI/FI]; Karaportti 3, 02610 Espoo (FI).

(72) Inventor; and
(71) Applicant *(for LC only)*: **ZHENG, Naizheng** [CN/CN]; Room-401, Building-2, Taiyangyuan, Dazhongsi, Haidian District, Beijing 100098 (CN).

(72) Inventors: **WU, Chunli**; 12-5-301, Huihuayuan, Huilongguan, Changping District, Beijing 102208 (CN). **ZHANG, Yanji**; Room 1507, Building 2, No. 20 Shao Yao Ju Road, Chaoyang District, Beijing 100029 (CN). **HAO, Nan**; No. 1 Wang Jing East Road, Chaoyang District, Beijing 100102 (CN).

(74) Agent: **ZHONGZI LAW OFFICE**; 7F, New Era Building, 26 Pinganli, Xidajie, Xicheng District, Beijing 100034 (CN).

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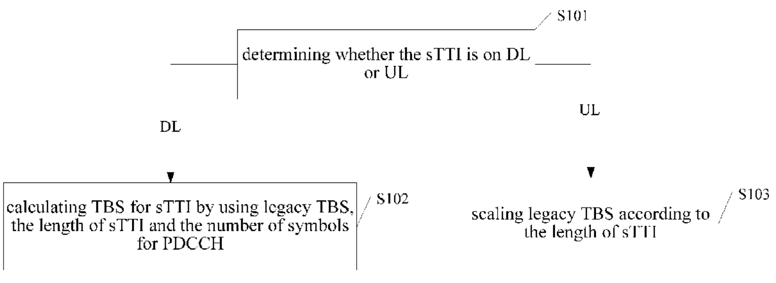

Fig. 1

(57) Abstract: The invention involves a method and apparatus for determining Transmission Block Size (TBS) for short Transmission Time Interval (sTTI), the method comprising: determining whether the sTTI is on Downlink (DL) or Uplink (UL); calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH if the sTTI is on DL; and scaling legacy TBS according to the length of sTTI if the sTTI is on UL. In this way, the provided method and apparatus may derive appropriate TBS corresponding to the sTTI in both DL and UL.

WO 2017/166294 A1

METHOD AND APPARATUS FOR DETERMINING TBS FOR STTI

FIELD OF THE INVENTION

The present invention generally relates to communication network, more specifically, relates to a method and apparatus for determining Transmission Block Size (TBS) for short Transmission Time Interval (sTTI).

BACKGROUND

The study item “Latency reduction techniques for LTE” [RP-150465] was approved in RAN #67, the key objective is to reduce the packet data latency over the LTE Uu air interface for an active UE. TTI shortening is considered as one technique from PHY-layer point of view, in addition, the discussion on how to configure TTI length for DL and UL is still ongoing, the asymmetric TTI length for DL and UL is one potential configuration.

Even though in legacy it is already possible to have different number of OFDM symbols for PDSCH used for PDCCH depending on the number of OFDM symbols, the same table for TBS is used, which results in different coding rates.

As for sTTI, the number of OFDM symbols for PDSCH/PUSCH is much less than that in legacy, the TBS table used in legacy would not be usable for corresponding number of PRBs and MCS index.

Currently in the ongoing sTTI discussion, it is generally assumed that the TBS for sTTI is linearly scaled down as compared with the legacy TBS. However, the detailed description on how to perform it is still unknown.

One straight forward way is to define a new table for each TTI length, but it might not be necessarily needed, especially considering that there might be multiple sTTI length defined.

SUMMARY

In order to solve the above problems, the present invention provides a method and apparatus for determining TBS for sTTI.

According to a first aspect of the present invention, there is provided a method for determining TBS for sTTI, which comprising:

determining whether the sTTI is on Downlink (DL) or Uplink (UL);

calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH if the sTTI is on DL; and

scaling legacy TBS according to the length of sTTI if the sTTI is on UL.

According to a second aspect of the present invention, there is provided an apparatus for determining TBS for sTTI, which comprising:

means for determining whether the sTTI is on Downlink (DL) or Uplink (UL);

means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH if the sTTI is on DL; and

means for scaling legacy TBS according to the length of sTTI if the sTTI is on UL.

In exemplary embodiments of the present invention, the provided method and apparatus may derive appropriate TBS corresponding to the sTTI in both DL and UL.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself, the preferable mode of use and further objectives are best understood by reference to the following detailed description of the embodiments when read in conjunction with the accompanying drawings, in which:

Fig.1 is a flowchart illustrating a method for determining TBS for sTTI in accordance with one embodiment of the present invention;

Fig.2 is a flowchart illustrating a method for determining TBS for sTTI in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The embodiments of the present invention are described in detail with reference to the accompanying drawings. Reference throughout this specification to features, advantages, or similar language does not imply that all of the features and advantages that may be realized with the present invention should be or are in any single embodiment of the invention. Rather, language referring to the features and advantages is understood to mean that a specific feature, advantage, or characteristic described in connection with an embodiment is included in at least one embodiment of the present invention. Furthermore, the described features, advantages, and characteristics of the invention may be combined in any suitable manner in one or more embodiments. One skilled in the relevant art will recognize that the invention may be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages may be recognized in certain embodiments that may not be present in all embodiments of the invention.

The invention proposes the following aspects are considered when scaling the TBS or N_PRB for short TTI:

1. sTTI length (sTTI_length);

2. CFI (control field indicator): number of OFDMA symbols used in the legacy PDCCH region (NPDCCH);

3. index of sTTI within 1ms subframe, which may lead to different number of OFDM symbols used for PDSCH for sTTI (named as sPDSCH hereafter).

If the design of sTTI results in more L1 overhead, e.g. more L1 overhead of control channel and reference signal, a factor may be multiplied to the TBS after scaling. The factor may be either pre-defined, or configured via RRC when configuring sTTI.

Based on the above proposal, as shown in Fig. 1, the present invention provides a method for determining TBS for sTTI, which may comprise: at step S101, determining whether the sTTI is on Downlink (DL) or Uplink (UL); at step S102, calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols (such as OFDMA symbols) for PDCCH if the sTTI is on DL; and at step S103, scaling legacy TBS according to the length of sTTI if the sTTI is on UL.

In this way, TBS for sTTI may be derived based on legacy TBS table without introducing new TBS table.

In an exemplary embodiment, as shown in Fig. 2, the method may further comprise: at step S104, multiplying the calculated TBS with a factor when L1 overhead becomes higher for sTTI, wherein the factor is pre-defined, or configured via RRC.

In an exemplary embodiment, step S102 may further comprise: determining whether a first sTTI starts from Physical Downlink Shared Channel (PDSCH) region after Physical Downlink Control Channel (PDCCH) region or not; and calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH according to whether the first sTTI starts from PDSCH region after the PDCCH region or not.

In an exemplary embodiment, wherein whether the first sTTI starts from PDSCH region after the PDCCH region or not is determined based on whether the value of the following equation is equal to zero:

$(14-N_{PDCCH}) \bmod sTTI\_length$

wherein N_{PDCCH} represents the number of symbols for PDCCH, sTTI_length represents the length of sTTI.

In an exemplary embodiment, wherein the step of calculating TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not may further comprise:

if the first sTTI starts from PDSCH region after the PDCCH region, calculating TBS by using the following equation:

$TBS\_sTTI1 = floor(legacy\_TBS * sTTI\_length/(14-N_{PDCCH}))$

wherein TBS_sTTI1 represents the value of the TBS to be calculated for sTTI, legacy_TBS represents the value of TBS in legacy table;

if the first sTTI does not start from PDSCH region after the PDCCH region, which may means that the first sTTI contains only $((14- N_{PDCCH}) \bmod sTTI\_length)$ number of OFDM symbols for PDSCH,

determining whether the current sTTI is the first sTTI or not, and

calculating TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not.

In an exemplary embodiment, the step of calculating TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not may further comprise:

if the sTTI is the first sTTI, calculating TBS by using the following equation:

$TBS\_sTTI1 = floor(legacy\_TBS * ((14 - N_{PDCCH}) \bmod sTTI\_length) /(14-N_{PDCCH}))$

wherein TBS_sTTI1 represents the value of the TBS for the first sTTI;

if the sTTI is not the first sTTI, calculating TBS by using the following equation:

$TBS\_sTTIx = floor(legacy\_TBS * sTTI\_length/ (14-N_{PDCCH}))$.

In an exemplary embodiment, step S102 may further comprise:

determining the sTTI length;

determining whether the sTTI is the first sTTI or not; and

calculating TBS according to sTTI length and whether the sTTI is the first sTTI or not, taking the number of symbols for legacy PDCCH into account.

For example, a procedure for calculating TBS for DL sTTI may be given as follows:

If (14-N_{PDCCH}) mod sTTI_length = 0 (i.e. the first sTTI start from PDSCH region after the legacy PDCCH region):

TBS_sTTI = floor (legacy_TBS * sTTI_length/(14-N_{PDCCH}))

Else (14-N_{PDCCH}) mod sTTI_length != 0 (i.e. the first sTTI contains only ((14- N_{PDCCH}) mod sTTI_length) number of OFDM symbols for PDSCH):

If 1st sTTI:

TBS_sTTI1 = floor (legacy_TBS * ((14 - N_{PDCCH}) mod sTTI_length) /(14-N_{PDCCH}))

Else:

TBS_sTTIx = floor (legacy_TBS * sTTI_length/ (14-N_{PDCCH}))

In an exemplary embodiment, step S103 may further comprise:

determining the sTTI length;

determining whether the sTTI is the first sTTI or not; and

calculating TBS according to the sTTI length and whether the sTTI is the first sTTI or not, taking the number of symbols for legacy PDCCH into account.

A further detailed procedure for calculating TBS for DL sTTI is given as an example as follows:

For example, for slot level sTTI (i.e. the sTTI length is 7 symbols) :

TBS1 for the first slot: TBS1= floor (legacy_TBS * ((14 - N_{PDCCH}) mod 7) /(14-N_{PDCCH}))

TBS2 for the second slot: TBS2= floor (legacy_TBS * 7/(14-N_{PDCCH}))

Where N_{PDCCH} is the number of OFDMA symbols used for legacy PDCCH

e.g. if 3 symbols for legacy PDCCH region and slot level TTI length

For the first slot, there are 4 symbols for PDSCH, TBS1 = floor (legacy_TBS* 4/(14-3)), wherein (14-3) mod 7 = 4;

For the second slot, there are 7 symbols for PDSCH, TBS2 = floor (legacy_TBS * 7/(14-3)).

Similarly for 2 symbol level sTTI length (i.e. the sTTI length is 2 symbols):

If legacy PDCCH region has 2 or 4 symbols:

TBS for each sTTI: TBS = floor (legacy_TBS *2/(14-N_{PDCCH})).

If legacy PDCCH region has 1 or 3 symbols, the first sTTI will contain only 1 OFDMA symbol for sTTI PDSCH:

TBS1 for the frst sTTI: TBS1 = floor (legacy_TBS /(14-N_{PDCCH}))

TBS for the rest of sTTI: TBS = floor (legacy_TBS *2/(14-N_{PDCCH})).

In an exemplary embodiment, step S104 may further comprise:

determining the sTTI length;

if the sTTI is in slot level (i.e. the sTTI length is 7 symbols), TBS equals to half of the legacy TBS.

According to another aspect of the present invention, it proposes considering scaling the number of PRBs for sTTI.

In an exemplary embodiment, the method may further comprise: calculating the number of PRBs allocated for the sTTI and an alpha defined corresponding to the number of symbols for sPDSCH by using the length of sTTI, Control Field Indicator (CFI) and index of the sTTI in the subframe;

converting the number of PRBs allocated for the sTTI by using the calculated number of PRBs allocated for the sTTI and the alpha corresponding to the number of symbols for sPDSCH; and

finding TBS from a TBS table according to the converted number of PRBs and Modulation and Coding Scheme (MCS).

In an exemplary embodiment, the step of converting is performed by using the following equation:

N_{PRB}= maximum {floor ($N_{PRB}{'}$ * alpha), 1}

where N_{PRB} is the number of PRBs converted for the sTTI, $N_{PRB}{'}$ is the number of PRBs allocated for the sTTI.

Specifically, similar to special subframe for TDD, different alpha value can be defined for PDSCH/PUSCH containing different number of OFDMA symbols. According to CFI, sTTI length and the index of sTTI within the 1ms subframe, the UE calculates number of OFDMA symbols and selects the corresponding alpha value to convert the number of PRB. The calculated N_{PRB} could be applied by the UE together with the MCS to find the TBS in the legacy TBS table.

In such embodiment of defining new alpha: alpha1 ~ alpha7 can be defined corresponding to sPDSCH of 1~7 OFDMA symbols for sTTI. Depending on sTTI length, CFI and index of the sTTI in the subframe, the UE may calculate the corresponding alpha and N_{PRB}.

According to a yet another aspect of the present invention, it proposes new TBS tables introduced for sTTI, for example, new TBS tables for 1-/2-/3-/4-/5-/6-/7-OFDM symbols for sPDSCH may be defined.

In an exemplary embodiment, the method may further comprise:

calculating the TBS table index for sTTI within the subframe by using the length of sTTI and the number of symbols for PDCCH; and

finding TBS from a TBS table according to the number of symbols for sPDSCH corresponding to the TBS table index.

In an exemplary embodiment, the step of calculating the TBS table index may further comprise:

determining whether a first sTTI starts from PDSCH region after the PDCCH region or not,

if the first sTTI starts from PDSCH region after the PDCCH region, the TBS table index equals to the length of sTTI;

if the first sTTI does not start from PDSCH region after the PDCCH region, the TBS table index for the first sTTI equals to the (14-number of symbols for PDCCH) mod length of sTTI, and the TBS table index for the rest sTTI equals to the length of sTTI.

The Table_index may be derived by an exemplary procedure as follows:

If (14-N_{PDCCH}) mod sTTI_length = 0 (i.e. the first sTTI start from PDSCH after the legacy PDCCH region):

Table_index = sTTI_length

Else if first sTTI:

Table index for the first sTTI = (14 - N_{PDCCH}) mod sTTI_length

Else:

Table index for the rest of sTTI = sTTI_length

For example, for slot level sTTI (i.e. sTTI length is 7 symbols), and 3 symbols for legacy PDCCH region:

For the first slot, there are 4 symbols for sPDSCH, Table_index = (14-3) mod 7 = 4, the UE will check from the TBS table which is associated to 4-OFDM symbols.

For the second slot, there are 7 symbols for sPDSCH, Table_index = 7, the UE will check from the TBS table which is associated to 7-OFDM symbols.

According to such embodiment, the present invention may support determining TBS according the exact number of symbols available for sPDSCH.

A multiply of TBS tables are newly defined corresponding to the number of symbols. Preferably, two TBS tables are newly defined corresponding to the number of symbols, one of which is corresponding to 2-symbol sTTI, and the other one of which is corresponding to 7-symbol sTTI; alternatively, three TBS tables are newly defined corresponding to the number of symbols, the first of which is corresponding to 1-symbol sTTI, the second of which is corresponding to 2-symbol sTTI, and the third one of which is corresponding to 7-symbol sTTI.

It is assumed that, in common scenarios, not all symbol length sTTI are supported, for example only 1-symbol, 2-symbol and/or 7-symbol sTTI, or only 2-symbol and 7-symbol sTTI are supported. Then corresponding to TBS table, it is likely that only two TBS tables corresponding to 2-symbol and 7-symbol are designed in the end.

So based on the two TBS table design assumptions, for example with slot-level/7-symbol sTTI, even with the new 7-ysmbol sTTI TBS table, the available data Resource Elements (REs) in either even-slot or odd-slot is still varying a lot depends on the 1) TTI length, 2) sTTI position with 1ms, and 3) CFI size, 4) MIMO TM related to the applied RS. Impact of different number of RS is not considered when selecting table index.

So a TBS-scaling factor discussed in above can also be applied at here. The factor can either be pre-defined in the specification or configured via RRC when configure sTTI.

The present invention further provides an apparatus for determining TBS for sTTI, which may comprise:

means for determining whether the sTTI is on Downlink (DL) or Uplink (UL);

means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH if the sTTI is on DL; and

means for scaling legacy TBS according to the length of sTTI if the sTTI is on UL.

In an exemplary embodiment, the apparatus may further comprise:

means for multiplying the calculated TBS with a factor when L1 overhead becomes higher for sTTI, wherein the factor is pre-defined, or configured via RRC.

In an exemplary embodiment, wherein means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH is further configured to:

determine whether a first sTTI starts from Physical Downlink Shared Channel (PDSCH) region after Physical Downlink Control Channel (PDCCH) region or not; and

calculate TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH according to whether the first sTTI starts from PDSCH region after the PDCCH region or not.

In an exemplary embodiment, wherein whether the first sTTI starts from PDSCH region after the PDCCH region or not is determined based on whether the value of the following equation is equal to zero:

$(14-N_{PDCCH})$ mod sTTI_length

wherein N_{PDCCH} represents the number of symbols for PDCCH, sTTI_length represents the length of sTTI.

In an exemplary embodiment, wherein means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH according to whether the first sTTI starts from PDSCH region after the PDCCH region or not is further configured to:

if the first sTTI starts from PDSCH region after the PDCCH region, calculate TBS by using the following equation:

TBS_sTTI1 = floor (legacy_TBS * sTTI_length/$(14-N_{PDCCH})$)

wherein TBS_sTTI1 represents the value of the TBS to be calculated for sTTI, legacy_TBS represents the value of TBS in legacy table;

if the first sTTI does not start from PDSCH region after the PDCCH region,

determine whether the current sTTI is the first sTTI or not, and

calculate TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not.

In an exemplary embodiment, wherein means for calculating TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not is further configured to:

if the sTTI is the first sTTI, calculate TBS by using the following equation:

TBS_sTTI1 = floor (legacy_TBS * ($(14 - N_{PDCCH})$ mod sTTI_length) /$(14-N_{PDCCH})$)

wherein TBS_sTTI1 represents the value of the TBS for the first sTTI;

if the sTTI is not the first sTTI, calculate TBS by using the following equation:

$TBS\_sTTIx = floor(legacy\_TBS * sTTI\_length / (14 - N_{PDCCH}))$.

In an exemplary embodiment, wherein means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH is further configured to:

determine the length of sTTI;

determine whether the sTTI is the first sTTI or not;

calculate TBS by using the number of symbols for PDCCH according to the length of sTTI and whether the sTTI is the first sTTI or not.

In an exemplary embodiment, wherein means for scaling legacy TBS according to the length of sTTI is further configured to:

determine the length of sTTI;

if the sTTI is in slot level (i.e. sTTI length is 7 symbols), TBS equals to half of the legacy TBS.

In an exemplary embodiment, the apparatus may further comprise:

means for calculating the number of PRBs allocated for the sTTI and an alpha defined corresponding to the number of symbols for PDSCH by using the length of sTTI, Control Field Indicator (CFI) and index of the sTTI in the subframe;

means for converting the number of PRBs allocated for the sTTI by using the calculated number of PRBs allocated for the sTTI and the alpha corresponding to the number of symbols for PDSCH;

means for finding TBS from a TBS table according to the converted number of PRBs and Modulation and Coding Scheme (MCS).

In an exemplary embodiment, wherein means for converting is configured to perform converting by using the following equation:

$N_{PRB} = \text{maximum}\{floor(N_{PRB}' * alpha), 1\}$

where N_{PRB} is the number of PRBs converted for the sTTI, N_{PRB}' is the number of PRBs allocated for the sTTI.

In an exemplary embodiment, the apparatus may further comprise:

means for calculating the TBS table index for sTTI by using the length of sTTI and the number of symbols for PDCCH; and

means for finding TBS from a TBS table according to the number of symbols corresponding to the TBS table index.

In an exemplary embodiment, wherein means for calculating the TBS table index is further configured to:

determine whether a first sTTI starts from PDSCH region after the PDCCH region or not,

if the first sTTI starts from PDSCH region after the PDCCH region, the TBS table index equals to the length of sTTI;

if the first sTTI does not start from PDSCH region after the PDCCH region, the TBS table index for the first sTTI equals to the length of sTTI, and the TBS table index for the rest sTTI equals to the length of sTTI.

In an exemplary embodiment, wherein a multiply of TBS tables are newly defined corresponding to the number of symbols.

In an exemplary embodiment, wherein two TBS tables are newly defined corresponding to the number of symbols, which corresponding to 2-symbol sTTI and 7-symbol sTTI respectively; or three TBS tables are newly defined corresponding to the number of symbols, which corresponding to 1-symbol sTTI, 2-symbol sTTI and 7-symbol sTTI respectively.

At least one of the above means is assumed to comprise program instructions that, when executed, enable the apparatus to operate in accordance with the exemplary embodiments, as discussed above. Any of the above means as discussed above may be integrated together or implemented by separated components, and may be of any type suitable to the local technical environment, and may comprise one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSP) and processors based on multi-core processor architectures, as non-limiting examples. The ROM mentioned above may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor based memory devices, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory.

In general, the various exemplary embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the exemplary embodiments of this invention may be illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

It will be appreciated that at least some aspects of the exemplary embodiments of the inventions may be embodied in computer-executable instructions, such as in one or more program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types when executed by a processor in a computer or other device. The computer executable instructions may be stored on a computer readable medium such as a hard disk, optical disk, removable storage media, solid state memory, random access memory (RAM), and etc. As will be realized by one of skill in the art, the functionality of the program modules may be combined or distributed as desired in various embodiments. In addition, the functionality may be embodied in whole or in part in firmware or hardware equivalents such as integrated circuits, field programmable gate arrays (FPGA), and the like.

Although specific embodiments of the invention have been disclosed, those having ordinary skill in the art will understand that changes can be made to the specific embodiments without departing from the spirit and scope of the invention. The scope of the invention is not to be restricted therefore to the specific embodiments, and it is intended that the appended claims cover any and all such applications, modifications, and embodiments within the scope of the present invention.

CLAIMS

What is claimed is:

1. A method for determining Transmission Block Size (TBS) for short Transmission Time Interval (sTTI), which comprising:

determining whether the sTTI is on Downlink (DL) or Uplink (UL);

calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH if the sTTI is on DL; and

scaling legacy TBS according to the length of sTTI if the sTTI is on UL.

2. The method according to claim 1, further comprising:

multiplying the calculated TBS with a factor when L1 overhead becomes higher for sTTI, wherein the factor is pre-defined, or configured via RRC.

3. The method according to claim 1 or 2, wherein the step of calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH further comprising:

determining whether a first sTTI starts from Physical Downlink Shared Channel (PDSCH) region after Physical Downlink Control Channel (PDCCH) region or not; and

calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH according to whether the first sTTI starts from PDSCH region after the PDCCH region or not.

4. The method according to claim 3, wherein whether the first sTTI starts from PDSCH region after the PDCCH region or not is determined based on whether the value of the following equation is equal to zero:

$(14-N_{PDCCH})$ mod sTTI_length

wherein N_{PDCCH} represents the number of symbols for PDCCH, sTTI_length represents the length of sTTI.

5. The method according to claim 3, wherein the step of calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH according to whether the first sTTI starts from PDSCH region after the PDCCH region or not further comprising:

if the first sTTI starts from PDSCH region after the PDCCH region, calculating TBS by using the following equation:

TBS_sTTI1 = floor (legacy_TBS * sTTI_length/$(14-N_{PDCCH})$)

wherein TBS_sTTI1 represents the value of the TBS to be calculated for sTTI, legacy_TBS represents the value of TBS in legacy table;

if the first sTTI does not start from PDSCH region after the PDCCH region,

determining whether the current sTTI is the first sTTI or not, and

calculating TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not.

6. The method according to claim 5, wherein the step of calculating TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not further comprising:

if the sTTI is the first sTTI, calculating TBS by using the following equation:

TBS_sTTI1 = floor (legacy_TBS * (($14 - N_{PDCCH}$) mod sTTI_length) /$(14-N_{PDCCH})$)

wherein TBS_sTTI1 represents the value of the TBS for the first sTTI;

if the sTTI is not the first sTTI, calculating TBS by using the following equation:

TBS_sTTIx = floor (legacy_TBS * sTTI_length/ $(14-N_{PDCCH})$).

7. The method according to claim 1 or 2, wherein the step of calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH further comprising:

determining the sTTI length;

determining whether the sTTI is the first sTTI or not; and

calculating TBS by using the number of symbols for PDCCH according to the sTTI length and whether the sTTI is the first sTTI or not.

8. The method according to claim 1 or 2, wherein the step of scaling legacy TBS according to the length of sTTI further comprising:

determining the sTTI length; and

if the sTTI is in slot level, TBS equals to half of the legacy TBS.

9. The method according to claim 1, further comprising:

calculating the number of PRBs allocated for the sTTI and an alpha defined corresponding to the number of symbols for PDSCH by using the length of sTTI, Control Field Indicator (CFI) and index of the sTTI in the subframe;

converting the number of PRBs allocated for the sTTI by using the calculated number of PRBs allocated for the sTTI and the alpha corresponding to the number of symbols for PDSCH; and

finding TBS from a TBS table according to the converted number of PRBs and Modulation and Coding Scheme (MCS).

10. The method according to claim 9, wherein the step of converting is performed by using the following equation:

N_{PRB}= maximum {floor (N_{PRB}' * alpha), 1}

where N_{PRB} is the number of PRBs converted for the sTTI, N_{PRB}' is the number of PRBs allocated for the sTTI.

11. The method according to claim 1 or 2, further comprising:

calculating the TBS table index for sTTI by using the length of sTTI and the number of symbols for PDCCH; and

finding TBS from a TBS table according to the number of symbols corresponding to the TBS table index.

12. The method according to claim 11, wherein the step of calculating the TBS table index further comprising:

determining whether a first sTTI starts from PDSCH region after the PDCCH region or not,

if the first sTTI starts from PDSCH region after the PDCCH region, the TBS table index equals to the length of sTTI;

if the first sTTI does not start from PDSCH region after the PDCCH region, the TBS table index for the first sTTI equals to the length of sTTI, and the TBS table index for the rest sTTI equals to the length of sTTI.

13. The method according to claim 11, wherein a multiply of TBS tables are newly defined corresponding to the number of symbols.

14. The method according to claim 13, wherein two TBS tables are newly defined corresponding to the number of symbols, which corresponding to 2-symbol sTTI and 7-symbol sTTI respectively; or three TBS tables are newly defined corresponding to the number of symbols, which corresponding to 1-symbol sTTI, 2-symbol sTTI and 7-symbol sTTI respectively.

15. An apparatus for determining Transmission Block Size (TBS) for short Transmission Time Interval (sTTI), which comprising:

means for determining whether the sTTI is on Downlink (DL) or Uplink (UL);

means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH if the sTTI is on DL; and

means for scaling legacy TBS according to the length of sTTI if the sTTI is on UL.

16. The apparatus according to claim 14, further comprising:

means for multiplying the calculated TBS with a factor when L1 overhead becomes higher for sTTI, wherein the factor is pre-defined, or configured via RRC.

17. The apparatus according to claim 14 or 15, wherein means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH is further configured to:

determine whether a first sTTI starts from Physical Downlink Shared Channel (PDSCH) region after Physical Downlink Control Channel (PDCCH) region or not; and

calculate TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH according to whether the first sTTI starts from PDSCH region after the PDCCH region or not.

18. The apparatus according to claim 17, wherein whether the first sTTI starts from PDSCH region after the PDCCH region or not is determined based on whether the value of the following equation is equal to zero:

$(14-N_{PDCCH}) \bmod sTTI\_length$

wherein N_{PDCCH} represents the number of symbols for PDCCH, sTTI_length represents the length of sTTI.

19. The apparatus according to claim 17, wherein means for calculating TBS for

sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH according to whether the first sTTI starts from PDSCH region after the PDCCH region or not is further configured to:

if the first sTTI starts from PDSCH region after the PDCCH region, calculate TBS by using the following equation:

$TBS\_sTTI1 = floor (legacy\_TBS * sTTI\_length/(14-N_{PDCCH}))$

wherein TBS_sTTI1 represents the value of the TBS to be calculated for sTTI, legacy_TBS represents the value of TBS in legacy table;

if the first sTTI does not start from PDSCH region after the PDCCH region,

determine whether the current sTTI is the first sTTI or not, and

calculate TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not.

20. The apparatus according to claim 19, wherein means for calculating TBS for sTTI by using legacy TBS, the length of a sTTI and the number of symbols for PDCCH according to the sTTI is the first sTTI or not is further configured to:

if the sTTI is the first sTTI, calculate TBS by using the following equation:

$TBS\_sTTI1 = floor (legacy\_TBS * ((14 - N_{PDCCH}) mod sTTI\_length) /(14-N_{PDCCH}))$

wherein TBS_sTTI1 represents the value of the TBS for the first sTTI;

if the sTTI is not the first sTTI, calculate TBS by using the following equation:

$TBS\_sTTIx = floor (legacy\_TBS * sTTI\_length/ (14-N_{PDCCH}))$.

21. The apparatus according to claim 15 or 16, wherein means for calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH is further configured to:

determine the sTTI length;

determine whether the sTTI is the first sTTI or not; and calculate TBS by using the number of symbols for PDCCH according to the sTTI length and whether the sTTI is the first sTTI or not.

22. The apparatus according to claim 15 or 16, wherein means for scaling legacy TBS according to the length of sTTI is further configured to:

determine the sTTI length;

if the sTTI is in slot level, TBS equals to half of the legacy TBS.

23. The apparatus according to claim 15, further comprising:

means for calculating the number of PRBs allocated for the sTTI and an alpha defined corresponding to the number of symbols for PDSCH by using the length of sTTI, Control Field Indicator (CFI) and index of the sTTI in the subframe;

means for converting the number of PRBs allocated for the sTTI by using the calculated number of PRBs allocated for the sTTI and the alpha corresponding to the number of symbols for PDSCH; and

means for finding TBS from a TBS table according to the converted number of PRBs and Modulation and Coding Scheme (MCS).

24. The apparatus according to claim 23, wherein means for converting is further configured to perform converting by using the following equation:

N_{PRB}= maximum {floor (N_{PRB}' * alpha), 1}

where N_{PRB} is the number of PRBs converted for the sTTI, N_{PRB}' is the number of PRBs allocated for the sTTI.

25. The apparatus according to claim 15 or 16, further comprising:

means for calculating the TBS table index for sTTI by using the length of sTTI and the number of symbols for PDCCH;

means for finding TBS from a TBS table according to the number of symbols corresponding to the TBS table index.

26. The apparatus according to claim 25, wherein means for calculating the TBS table index is further configured to:

determine whether a first sTTI starts from PDSCH region after the PDCCH region or not,

if the first sTTI starts from PDSCH region after the PDCCH region, the TBS table index equals to the length of sTTI;

if the first sTTI does not start from PDSCH region after the PDCCH region, the TBS table index for the first sTTI equals to the length of sTTI, and the TBS table index for the rest sTTI equals to the length of sTTI.

27. The apparatus according to claim 25, wherein a multiply of TBS tables are newly defined corresponding to the number of symbols.

28. The apparatus according to claim 27, wherein two TBS tables are newly defined corresponding to the number of symbols, which corresponding to 2-symbol sTTI and 7-symbol sTTI respectively; or three TBS tables are newly defined corresponding to the number of symbols, which corresponding to 1-symbol sTTI, 2-symbol sTTI and 7-symbol sTTI respectively.

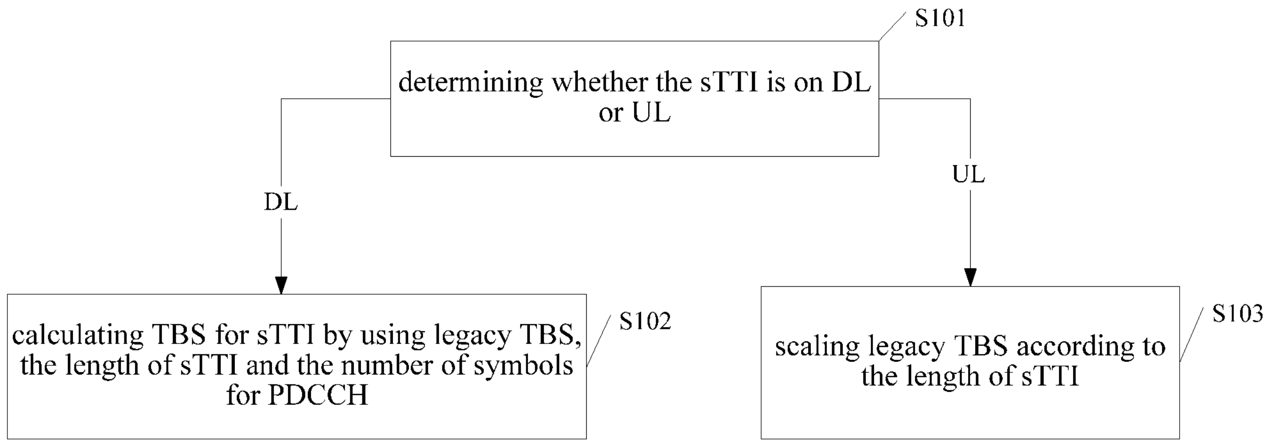
S101
determining whether the sTTI is on DL or UL
DL
UL
calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH
S102
scaling legacy TBS according to the length of sTTI
S103

Fig. 1

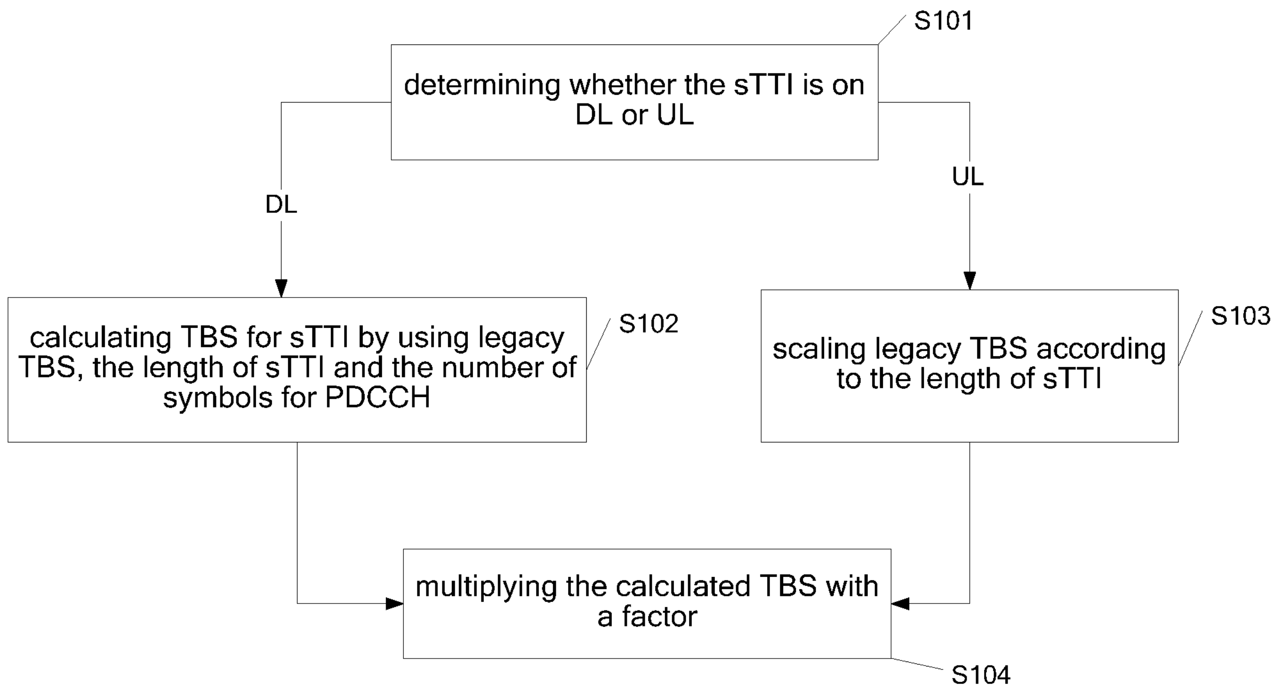
S101
determining whether the sTTI is on DL or UL
DL
UL
calculating TBS for sTTI by using legacy TBS, the length of sTTI and the number of symbols for PDCCH
S102
scaling legacy TBS according to the length of sTTI
S103
multiplying the calculated TBS with a factor
S104

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/078333

A. CLASSIFICATION OF SUBJECT MATTER

H04W 28/06(2009.01)i

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)

H04W H04L H04B

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

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

CNPAT,CNKI,WPI,EPODOC,3GPP:size, tbs, DL, tti, tb, tbsize, short+, UPLINK, stti, UL, DOWNLINK

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2016040290 A1 (INTERDIGITAL PATENT HOLDINGS, INC) 17 March 2016 (2016-03-17) description, paragraphs [0003]-[0009], [0115]-[0124]	1-28
A	WO 2016048593 A1 (QUALCOMM INC.) 31 March 2016 (2016-03-31) the whole document	1-28
A	CN 101032138 A (NOKIA CORP.) 05 September 2007 (2007-09-05) the whole document	1-28
A	ERICSSON et al. "New SI proposal: Study on Latency reduction techniques for LTE" *3GPP TSG RAN Meeting #67 RP-150465,* 12 March 2015 (2015-03-12), the whole document	1-28

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 December 2016	**28 December 2016**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**JIANG,Li**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)61648235**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/078333

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2016040290	A1	17 March 2016	None			
WO	2016048593	A1	31 March 2016	TW	201622372	A	16 June 2016
				US	2016095137	A1	31 March 2016
CN	101032138	A	05 September 2007	WO	2006035274	A1	06 April 2006
				EP	1794962	A1	13 June 2007
				KR	100903527	B1	19 June 2009
				US	2006067229	A1	30 March 2006
				KR	20070051347	A	17 May 2007
				GB	0421663	D0	27 October 2004