



- (51) International Patent Classification:
H04L 12/00 (2006.01)
- (21) International Application Number:
PCT/CN2012/082324
- (22) International Filing Date:
28 September 2012 (28.09.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (71) Applicant: FRANCE TELECOM [FR/FR]; 78, rue Olivier de Serres, F-75015 Paris (FR).
- (72) Inventor; and
- (71) Applicant (for US only): YU, Yifan [CN/CN]; 10F, South Twr. Raycom Infotech Park C, 2 Science Institute South Rd., Haidian District, Beijing 100080 (CN).
- (74) Agent: INSIGHT INTELLECTUAL PROPERTY LIMITED; Suite 19A, 19B, Tower A, InDo Building, No. 48A Zhichun Road, Beijing 100098 (CN).

- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

- (54) Title: METHOD FOR TRANSMITTING DATA CONTENT IN CONTENT CENTRIC NETWORK

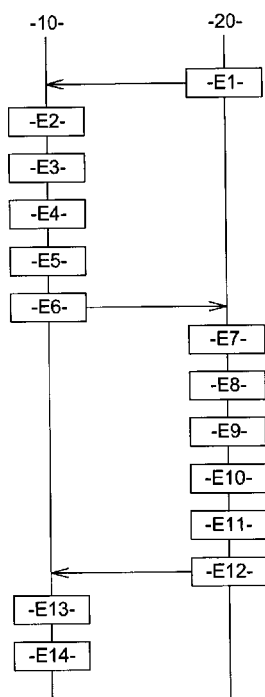


Fig. 2

(57) Abstract: A method for transmitting data content between source equipments and destination equipments is disclosed, the equipments are part of a content centric network. The data content to be transmitted are constituted of at least one symbol. The method comprises, executed by the source equipments, the following steps: - calculating a value of a coding index to be used when coding the symbol constituting the data content, as a function of an identifier of the destination equipment, a number of symbols constituting the data content and an identifier of the source equipment, - transmitting the symbol coded using the calculated value of the coding index to the destination equipment, - upon reception of a feedback message sent by the destination equipment indicating that the destination equipment has already received the coded symbol from another source equipment, calculating an updated value for the coding index.



Published:

— *with international search report (Art. 21(3))*

METHOD FOR TRANSMITTING A DATA CONTENT IN A CONTENT CENTRIC NETWORK

The present invention generally relates to content centric networks and more particularly to the data dissemination in a communication network.

The concept of Content Centric Network (CCN) has been proposed by PARC (Palo Alto Research Center) and is considered as a promising candidate architecture for the future Internet.

CCN architectures have been disclosed for instance in documents US20090288163, US20090287835, and US20090285209.

The different nodes of the CCN declare their interest in some content by sending an Interest packet with the name of the wanted content to other nodes of the CCN. Upon the reception of Interest packet, a node determines whether the content satisfying the interest is available. If so, the corresponding content is sent to the terminal which asked for the content or Interest packet owner in the terminology of CCN. Otherwise, the Interest packet is marked as pending in the receiving node and forwarded to a second node in the CCN based on the interest. After receiving content from the second node in response to the forwarded Interest packet, the node un-marks the Interest packet as pending and sends the content to the Interest packet owner.

A node of the CCN routes a packet based on the action corresponding to the condition as specified in the routing policy of the CCN. A node of the CCN comprises a routing table containing three main data structures: a base called FIB (Forwarding Information Base), a buffer memory called ContentStore, and a table called PIT (Pending Interest Table).

The FIB is used to forward Interest packets toward potential source(s) of matching data. It is similar to an IP (Internet Protocol) FIB except it allows for a list of outgoing faces rather than a single one. The term face is used to represent a node registered in the routing table. The ContentStore is similar as the buffer memory of an IP router. The PIT is used to keep track of Interest packets that have been forwarded upstream toward content source(s) so that returned data can be sent downstream to its requestor(s).

A user device asks for content by broadcasting an Interest packet. A node receiving the Interest packet and having data that satisfies it can respond with a Data packet containing data related to the content. Data packet is transmitted only in response to an Interest packet.

The UDP (*User Datagram Protocol*) is used in content centric networks for the delivery of data packets from a source equipment to a destination equipment. In order to do so, the source equipment establishes a connection with the destination equipment using UDP sockets to send the payload encapsulated in a UDP packet. In a network comprising a plurality of source equipments, a connection is established between each source equipment and the destination equipment resulting in a lack of coordination between the source equipments. Such a lack of coordination between the source equipments leads to the reception of duplicated data packets by the destination equipment and to an increase in the load of the network.

The DCCP (*Datagram Congestion Control Protocol*) can be use instead of the UDP. Such a protocol enables a better management of the congestions occurring in the network. However such a protocol is designed for point to point communication and therefore is not designed for multiple source equipments multiple destination equipments.

5 Thus there is a need for a solution enabling data dissemination in a content centric network overcoming the disadvantages of the existing solutions.

10 In that respect, the present invention relates to a method for transmitting a data content between at least a first equipment, called source equipment, and at least a second equipment, called destination equipment, the first and the second equipments being part of a content centric network, the data content to be transmitted being constituted of at least one symbol, the method comprising, executed by the source equipment, the following steps of :

- calculating a value of a coding index to be used when coding the symbol constituting the data content, as a function of an identifier of the destination equipment, a number of symbols constituting the data content and an identifier of the source equipment,
- 15 - transmitting the symbol coded using the calculated value of the coding index to the destination equipment,
- upon reception of a feedback message sent by the destination equipment indicating that the destination equipment has already received the coded symbol from another source equipment, calculating an updated value of the coding index.

20 Such a method enables efficient data content delivery from multiples source equipment to multiple destination equipment by reducing the amount of duplicated data received by the destination equipments.

The method object of the invention relies on the use of a modified version of fountain coding techniques, such as the Raptor code.

25 In the method of the invention, the value of the coding index used to code the symbols constituting the data content to be transmitted is a function of the destination equipment, i.e. for a same data content to be transmitted, the symbols constituting the data content will be coded with two different value of the coding index, each of these values corresponding to a destination equipment.

30 The value of the coding index can be updated if reception of duplicated data content occurs on the destination equipment side despite everything. This update is triggered by the reception of a feedback message indicating that duplicated data content is received by the destination equipment.

35 This contributes to reducing the amount of duplicated data content received by destination equipments.

According to one characteristic of the method for transmitting a data content object of the invention, the updated value of the coding index is the sum of the calculated value of the coding index and a randomly chosen factor.

It is a very simple and efficient way to update the value of the coding index.

5 According to one characteristic of the method for transmitting a data content object of the invention, the method further comprises a step of determining a number of coded symbols to be transmitted to the destination equipment, the number of coded symbols to be transmitted being the minimum between a number of coded symbols capable of being transmitted by the source equipment and a number of coded symbols capable of being received by the
10 destination source.

The method of the invention allows defining the number of coded symbols that can be transmitted to the destination equipment. It is then possible to limit symbol loss due to an overload in the network.

15 According to one characteristic of the method for transmitting a data content object of the invention, the number of coded symbols capable of being received by the destination source is comprised in the feedback message.

The source equipment knows the number of symbols that the destination equipment is capable of receiving. The source equipment adapts the number of coded symbols to be transmitted to the destination equipment so all the transmitted coded symbols are received by
20 the destination equipment.

According to one characteristic of the method for transmitting a data content object of the invention, when no feedback message received when a timer expires, the number of coded symbols to be transmitted to the destination equipment is set to a minimum value.

25 If no feedback message is received before the expiration of a timer, that may mean that the coded symbols transmitted by the source equipment are not received by the destination equipment. Since there is symbols loss in the network, the source equipment reduces the number of transmitted coded symbols to a minimum in order not to amplify the symbol loss.

30 According to one characteristic of the method for transmitting a data content object of the invention, the coded symbols being encapsulated in at least one data packet of a limited size, the method comprises a step of fragmenting the coded symbols in portions the maximum size of which corresponding to the size of the data packet.

35 Encapsulating a coded symbol a data packet, such as a UDP packet or a DCCP packet, enable the method of the invention to inherit the naming scheme of the content centric network scheme. The method of the invention can thus be implemented in existing content centric networks.

According to one characteristic of the method for transmitting a data content object of the invention, the data packet further comprises a first parameter representing the number of

coded symbols constituting the data content to be transmitted, a second parameter representing the calculated value of the coding index, and a third parameter representing a position of the portions of the fragmented coded symbols.

5 The parameters embedded in the data packet enable the destination equipment to process the received data packets and to generate the feedback message.

According to one characteristic of the method for transmitting a data content object of the invention, the feedback message comprises a first parameter representing the number of coded symbols capable of being received by the destination source, a second parameter representing the number of coded symbols received by the destination equipment, a third
10 parameter representing the number of coded symbols already from another source equipment, and a fourth parameter representing the calculated values of the coding indexes associated with the coded symbols already received from another source equipment.

The feedback message comprises parameters helping the source equipment to adapt the transmission parameters of the coded symbols, such as the value of the coding index and the number of coded symbols to be transmitted to the destination equipment, the transmission
15 conditions in the network, such as symbol loss or symbol duplication.

The invention also concerns a method of communication between at least a first equipment, called destination equipment, and at least a second equipment, called source equipment, the first and the second equipments being part of a content centric network, the
20 method comprising, executed by the destination equipment, the following steps of :

- receiving at least one coded symbol constituting a data content transmitted from the source equipment,
- determining if the destination equipment has already received the coded symbol from another source equipment,
- 25 - if so, sending a feedback message to the source equipment indicating that the destination equipment has already received the coded symbol from another source equipment.

Another object of the invention is an equipment, called source equipment, capable of transmitting a data content to at least another equipment, called destination equipment, the source and destination equipments being part of a content centric network, the data content to
30 be transmitted being constituted of at least one symbol, the source equipment comprising means for :

- calculating a value of a coding index to be used when coding the symbol constituting the data content, as a function of an identifier of the destination equipment, a number of symbols constituting the data content and an identifier of the source equipment,
- 35 - transmitting the symbol coded using the calculated value of the coding index to the destination equipment,

- upon reception of a feedback message sent by the destination equipment indicating that the destination equipment has already received the coded symbol from another source equipment, calculating an updated value of the coding index.

Such an equipment is for example a router.

5 Another object of the invention is an equipment, called destination equipment, capable of communicating with at least a second equipment, called source equipment, the destination and source equipments being part of a content centric network, the destination equipment comprising means for :

10 - receiving at least one coded symbol constituting a data content transmitted from the source equipment,

- determining if the destination equipment has already received the coded symbol from another source equipment,

- if so, sending a feedback message to the source equipment indicating that the destination equipment has already received the coded symbol from another source equipment.

15 Such an equipment is for example a router.

Finally, one object of the invention concerns a computer program, in particular a computer program on or in an information medium or memory, suitable for implementing the method object of the invention. This program can use any programming language, and be in the form of source code, binary code, or of code intermediate between source code and object code such as in a partially
20 compiled form, or in any other desirable form for implementing the communication methods according to the invention.

The information medium may be any entity or device capable of storing the program. For example, the medium can comprise a storage means, such as a ROM, for example a CD ROM or a microelectronic circuit ROM, or else a magnetic recording means, for example a diskette (floppy
25 disk) or a hard disk.

Moreover, the information medium may be a transmissible medium such as an electrical or optical signal, which may be conveyed via an electrical or optical cable, by radio or by other means. The programs according to the invention may in particular be downloaded from a network of Internet type.

30 The present system and method are explained in further detail, and by way of example, with reference to the accompanying drawings wherein:

FIG. 1 represents a content centric network in which the method of the invention is implemented,

35 FIG. 2 represents the different steps of a method for transmitting data content object of the invention,

FIG. 3 represents a header of a data packet transmitted when executing the method of the invention,

FIG. 4 represents a feedback message transmitted when executing the method of the invention,

5 FIG. 5 represents a source equipment capable of executing the steps of the method of the invention,

FIG. 6 represents a destination equipment capable of executing the steps of the method of the invention.

10 A CCN node belonging to a content centric network comprises a routing table containing three main data structures: a base called FIB (Forwarding Information Base), a buffer memory called ContentStore, and a table called PIT (Pending Interest Table).

15 The FIB is used to forward Interest packets toward potential source(s) of matching data. It is similar to an IP (Internet Protocol) FIB except it allows for a list of outgoing faces rather than a single one. The term face is used to represent a node registered in the routing table. The ContentStore is similar as the buffer memory of an IP router. The PIT is used to keep track of Interest packets that have been forwarded upstream toward content source(s), or source equipments, so that returned data can be sent downstream to its requestor(s), or destination equipments.

20 A user device, or destination equipment, asks for content by broadcasting an Interest packet. A node receiving the Interest packet and having data that satisfies it, or source equipment, can respond with a Data packet containing data related to the content. Data packet is transmitted only in response to an Interest packet.

Figure 1 represents a network comprising four CCN routers A_1 to A_4 , and two IP routers B_1 and B_2 . A CCN router A_1 - A_4 may create and update its routing table as explained below.

25 When a media repository M_1 , or source equipment, next to router A_1 is announcing that it can serve Interests matching the prefix '/parc.com/media/art', the router A_1 hears this announcement and, in response, installs a local CCN FIB entry for the prefix '/parc.com/media/art' pointing at the face M_1 where it heard the announcement. Then, router A_1 packages the prefix '/parc.com/media/art' into IGP LSA which is flooded to all nodes of the network.

30 Router A_3 receives the LSA and adds in its routing table FIB a prefix entry for '/parc.com/media/art' pointing to the face A_1 , as represented in figure 1.

Then, when a repository M_2 adjacent to router A_2 announces prefixes '/parc.com/media' and '/parc.com/media/art', router A_2 floods an IGP LSA for these two prefixes.

35 When receiving the LSA from router A_2 , the FIB of router A_3 is updated to contain '/parc.com/media' pointing at face A_2 , and '/parc.com/media/art' pointing to faces A_1 and A_2 .

Then, if a user device, or destination equipment, adjacent to router A_3 expresses interest in index '/parc.com/media/art/impressionisthistory.mp4', this interest will get forwarded to both routers A_1 and A_2 , and routers A_1 and A_2 will each forward it to their adjacent repository M_1 , M_2 .

In such an architecture, a same data content can be transmitted by a plurality of source equipments to a same destination equipment resulting in a duplication of the data content inducing a load in the content centric network CCN.

Figure 2 represents the different steps of a method for transmitting data content between a source equipment 10 and a destination equipment 20, the method being capable of reducing the number of duplicated data content received by a destination equipment.

In a step E1, the destination equipment 20 requests a data content to the source equipment 10.

Upon reception of the request for the data content, the source equipment 10 processes the data content prior its transmission to the destination equipment 20. The data content is divided into a plurality of symbols, the size of which is for example 512 bytes.

The symbols are then coded, for example using a Raptor code. In order to code the symbols, the source equipment 10 calculates, in a step E2, a value of a coding index ln_i where i is the number of destination equipments 20 to which the source equipment 10 transmits the data content.

The value of the coding index ln_i is calculated as follow:

$$ln_i = (i - 1) \times K + A \text{ Mod } 2^{24} - 1$$

where i is the number of destination equipments 20 to which the source equipment 10 transmits the data content, K represents the number of symbols constituting the data content to be transmitted, and A is an identifier of the source equipment 10. For example A may be the last 24 bits of the MAC address of the source equipment 10.

The value of the coding index ln_i is a function of an identifier of the destination equipment 20, a number of symbols constituting the data content and an identifier of the source equipment 10.

For each destination equipment 20, the source equipment 10 calculates a value of the coding index ln_i . The coding index of the invention corresponds for example to the ESI (Encoding Symbol Id) of the Raptor code.

In a step E3, the source equipment 10 codes the symbols to be transmitted using the calculated value of the coding index ln_i in the same way as the Raptor code scheme. The symbols coded with the value ln_i of the coding index can only be transmitted to the i^{th} destination equipment 20 number.

Before their transmission to the destination equipment, the coded symbols are encapsulated in data packets. In a step E4, the source equipment determines if the size of the coded symbol is greater than the size of the data packet. If it is the case, then the coded symbol is fragmented in at least two portions.

Then a header of the data packet is generated by the source equipment 10 in a step E5. Such a header is represented on figure 3. The header of the data packet comprises three fields : a first field I comprising the value of the coding index ln_i , a second field K representing

the number of symbols constituting the data content to be transmitted and a third field S comprising the index of the first byte of the payload of the data packet in the coded symbol before its fragmentation.

5 Then the data packet is encapsulated in a UDP packet or a DCCP packet prior its transmission to the destination equipment 20 in a step E6.

In a step E7, the destination equipment 20 receives the data packets constituting the data content.

In a step E8, for a given source equipment 10, the destination equipment 20 counts the number of received coded symbols N and stores this number N in a database DB.

10 The destination equipment checks, in a step E9, if the coded symbols received from a given source equipment 10 have already been received from another source equipment. If it is the case, the value of the coding index In_i corresponding to the source equipment 10 is stored in the database DB in a list ESI list and the number D of duplicated coded symbols is stored in the database DB.

15 In a step E10, the destination equipment 20 generates a feedback message intended to be sent to the source equipment 10.

20 The feedback message, represented on figure 4, comprises four fields : a first field WS indicating the number of coded symbols allowable for the reception by the destination equipment 20, a second field comprising the number N of received coded symbols, a third field comprising the number D of duplicated coded symbols and the list ESI list comprising the values of the coding index In_i associated with the duplicated coded symbols.

Then the feedback message is encapsulated in a UDP packet or a DCCP packet prior its transmission to the source equipment 10 in a step E11.

25 After the transmission of the feedback message, D is set to zero and the list ESI list is emptied in a step E12.

Upon reception of the feedback message, the source equipment 10 checks in a step E13 if duplicated coded symbols were received by the destination equipment 20, i.e. if $D \neq 0$.

If $D \neq 0$, then the source equipment 10 checks if the value of the coded index In_i associated to the duplicated coded symbols corresponds to a coded symbol it processed.

30 If it is the case, the source equipment 10 updated the value of the coding index In_i corresponding to the destination equipment 20 as follow :

$$In_{i_{new}} = In_i + SF$$

where SF is an adjustment factor randomly chosen.

35 In the meantime, the source equipment 10 reduces, in a step E14, the number $W_{i_{new}}$ of coded symbols to be transmitted to the destination equipment 20 during the next round.

The number $W_{i_{new}}$ of coded symbols to be transmitted to the destination equipment 20 during the next round is equal to $\min(W_i, WS)$ where W_i is the number of coded symbols transmitted to the destination equipment 20 during the current round.

5 In the method of the invention, when no feedback message is received by the source equipment 10 when a timer expires, the number W_i of coded symbols to be transmitted to the destination equipment 20 during the next round is set to a minimum value W_0 .

During step E2, the source equipment 10 calculates the time out value of the timer for the next transmission round.

10 The source equipment 10 keeps a first counter E_i counting the total amount of coded symbols sent to the destination equipment 20 and a second counter S_i counting the coded symbols received by the destination equipment 20.

15 The source equipment 10 has to reduce the number of transmitted coded symbols when the feedback message indicates that the number of received coded symbols is less than that of the transmitted coded symbols. For example, if the source equipment 10 receives a feedback message indicating that the destination equipment 20 has received 10 coded symbols when 15 coded symbols were sent then the source equipment 10 reduces the number of the transmitted codes symbols during the next round.

20 The source equipment 10 may increase the number of transmitted coded symbols when the feedback message indicates that the number of received coded symbols is equal to the number of transmitted coded symbols. For example, if the source equipment 10 receives a feedback message indicating that the destination equipment 20 has received 15 coded symbols when 15 coded symbols were sent then the source equipment 10 increases the number of the transmitted codes symbols during the next round.

25 In a first use case of the method of the invention, a source equipment 10 starts the transmission of coded symbols to two destination equipments 20_A and 20_B . It sets the value of coding index associated to the destination equipment 20_A to ln_A and the value of coding index associated to the destination equipment 20_B to ln_B . The source equipment 10 sends W_A coded symbols to the destination equipment 20_A and W_B coded symbols to the destination equipment 20_B . For example, $W_A = W_B = 8$. The first counter E_A and E_B are both set as 8, while the second counter S_A and S_B are set to 0.

After sending out the 8 coded symbols to the destination equipments 20_A and 20_B , the source equipment 10 stops the transmission and triggers a timer T_A and T_B for each of the destination equipment 20_A and 20_B respectively, and waits for the feedback messages from the destination equipments 20_A and 20_B .

35 Upon receiving the feedback messages from the destination equipment 20_A and destination equipment 20_B which confirm the reception of all the 8 transmitted symbols, namely $S_A=8$ and $S_B=8$, before the timers T_A and T_B expire. The source equipment 10 increases the number of coded symbols to be transmitted W_A and W_B , for example $W_A=16$ and $W_B=16$. Then the

source equipment 10 generates the new coded symbols using new values of the coding indexes $ln_{Anew} = ln_A + 8$ and $ln_{Bnew} = ln_B + 8$. The time out values of the timers T_A and T_B are updated as well. Finally, the first counters E_A and E_B are both set as 24.

Assuming that the destination equipment 20_A only confirms the reception of two coded symbols in the second round due to the loss of other transmitted coded symbols but the destination equipment 20_B acknowledges the arrival of all the transmitted coded symbols, namely $S_A=10$ and $S_B=24$, the source equipment 10 reduces the number of coded symbols to be transmitted W_A to 8 but still increases the number of coded symbols to be transmitted W_B , for example $W_B=32$ and the first counter E_A is set as S_A . The time out values of the timers T_A and T_B are updated, for example using the same rules as in TCP. Then the source equipment 10 generates the coded symbols with a new value of the coding index $ln_{Anew} = ln_A + 24$ and a new value of the coding index $ln_{Bnew} = ln_B + 24$, respectively. However, 8 coded symbols are sent to the destination equipment 20_A and 32 coded symbols are sent to the destination equipment 20_B. Thus, the first counters are respectively set as $E_A=18$ and $E_B=56$.

In a second use case of the method of the invention, two source equipments 10_A and 10_B transmit a same content object to a destination equipment 20. The coded symbols constituting the data content transmitted by the source equipment 10_A arrive at the destination equipment 20 earlier than the coded symbols constituting the data content transmitted by the source equipment 10_B.

The destination equipment 20 finds that 3 coded symbols associated to the following values of the coding index ln_A+5 , ln_A+6 , ln_A+7 sent by the source equipment 10_A and already received were also sent by the source equipment 10_B. In other words, there is $ln_A+5 = ln_B$, $ln_A+6 = ln_B+1$, $ln_A+7 = ln_B+2$.

Then the source equipment 10_B receives a feedback message from the destination equipment 20 which indicates that the parameter $D=3$ and a ESI list comprising ln_B , ln_B+1 and ln_B+2 . The source equipment 10_B reduces the number of coded symbols to be transmitted to 8 and changes the value of ln_B as $ln_{Bnew} = ln_B + SF$, while the source equipment 10_A increases the number of coded symbols to be transmitted, for example using the same rules as in TCP.

On the other hand, the destination equipment 20 resets its duplication reception counter D as 0 after transmitting the feedback message to the source equipment 10_B. Similarly, the ESI list is cleared as well.

After altering the value of the coding index ln_B to ln_{Bnew} , the source equipment 10_B keeps sending coded symbols to the destination equipment 20. The feedback message from the destination equipment 20 indicates that there is no duplicated symbol reception anymore. Then, the number of coded symbols transmitted by the source equipment 10_B increases.

Figure 5 represents a source equipment 10 capable of running the method object of the invention.

The source equipment 10 comprises means for receiving 30 of a request for a data content sent by a destination equipment 20. The source equipment 10 comprises means for

processing31 the data content prior its transmission to the destination equipment 20. The data content is divided into a plurality of symbols, the size of which is for example 512 bytes.

The source equipment 10 comprises means for coding 32 the symbols, for example using a Raptor code. In order to code the symbols, the source equipment 10 comprises means for calculating33 a value of a coding index ln_i where i is the number of destination equipments 20 to which the source equipment 10 transmits the data content.

The value of the coding index ln_i is calculated as follow:

$$ln_i = (i - 1) \times K + A \text{ Mod } 2^{24} - 1$$

where i is the number of destination equipments 20 to which the source equipment 10 transmits the data content, K represents the number of symbols constituting the data content to be transmitted, and A is an identifier of the source equipment 10. For example A may be the last 24 bits of the MAC address of the source equipment 10.

The source equipment 10 codes the symbols to be transmitted using the calculated value of the coding index ln_i in the same way as the Raptor code scheme. Before their transmission to the destination equipment, the coded symbols are encapsulated in data packets. The source equipment comprises means for determining 34 if the size of the coded symbol is greater than the size of the data packet. If it is the case, then the coded symbol is fragmented in at least two portions by fragmenting means 35.

Then a header of the data packet is generated by generating means 36.

Then the data packet is encapsulated in a UDP packet or a DCCP packet prior its transmission to the destination equipment 20 by encapsulating means 37.

Upon reception of the feedback message by the receiving means 30, the source equipment 10 checks if duplicated coded symbols were received by the destination equipment 20, i.e. if $D \neq 0$ using checking means 38.

If $D \neq 0$, then the source equipment 10 checks if the value of the coded index ln_i associated to the duplicated coded symbols corresponds to a coded symbol it processed.

If it is the case, the source equipment 10 updated the value of the coding index ln_i corresponding to the destination equipment 20 as follow :

$$ln_{i_{new}} = ln_i + SF$$

where SF is an adjustment factor randomly chosen, using the calculating means 33.

The source equipment 10 comprises means for reducing 39 the number $W_{i_{new}}$ of coded symbols to be transmitted to the destination equipment 20 during the next round.

Figure 6 represents a destination equipment 20 capable of running the method object of the invention.

The destination equipment 20 comprise means for requesting 40 a data content to a source equipment 10.

The destination equipment 20 comprises receiving means 41 for receiving the data packets constituting the data content transmitted by the source equipment 10.

The destination equipment 20 comprises counting means 42 for counting the number of received coded symbols N and stores this number N in a database DB.

5 The destination equipment comprises checking means 43 for checking if the coded symbols received from a given source equipment 10 have already been received from another source equipment. If it is the case, the value of the coding index ln_i corresponding to the source equipment 10 is stored in the database DB in a list ESI list and the number D of duplicated coded symbols is stored in the database DB.

10 The destination equipment 20 comprises means for generating 44 a feedback message intended to be sent to the source equipment 10.

Then the feedback message is encapsulated in a UDP packet or a DCCP packet prior its transmission to the source equipment 10 using encapsulating means 45.

CLAIMS

1. Method for transmitting a data content between at least a first equipment, called source
5 equipment, and at least a second equipment, called destination equipment, the first and the
second equipments being part of a content centric network, the data content to be transmitted
being constituted of at least one symbol, the method comprising, executed by the source
equipment, the following steps of :

- calculating a value of a coding index to be used when coding the symbol
10 constituting the data content, as a function of an identifier of the destination equipment, a
number of symbols constituting the data content and an identifier of the source equipment,

- transmitting the symbol coded using the calculated value of the coding index to the
destination equipment,

- upon reception of a feedback message sent by the destination equipment indicating
15 that the destination equipment has already received the coded symbol from another source
equipment, calculating an updated value of the coding index.

2. Method for transmitting a data content according to claim 1 wherein the updated value of
the coding index is the sum of the calculated value of the coding index and a randomly chosen
factor

3. Method for transmitting a data content according to claim 1, further comprising a step of
20 determining a number of coded symbols to be transmitted to the destination equipment, the
number of coded symbols to be transmitted being the minimum between a number of coded
symbols capable of being transmitted by the source equipment and a number of coded
symbols capable of being received by the destination source.

4. Method for transmitting a data content according to claim 3, wherein the number of coded
25 symbols capable of being received by the destination source is comprised in the feedback
message.

5. Method for transmitting a data content according to claim 3, wherein when no feedback
message received when a timer expires, the number of coded symbols to be transmitted to the
30 destination equipment is set to a minimum value.

6. Method for transmitting a data content according to claim 1, wherein the coded symbols
being encapsulated in at least one data packet of a limited size, the method comprises a step
of fragmenting the coded symbols in portions the maximum size of which corresponding to the
size of the data packet.

7. Method for transmitting a data content according to claim 6, wherein the data packet
35 further comprises a first parameter representing the number of coded symbols constituting the
data content to be transmitted, a second parameter representing the calculated value of the
coding index, and a third parameter representing a position of the portions of the fragmented
coded symbols.

8. Method for transmitting a data content according to claim 3, wherein the feedback message comprises a first parameter representing the number of coded symbols capable of being received by the destination source, a second parameter representing the number of coded symbols received by the destination equipment, a third parameter representing the number of coded symbols already from another source equipment, and a fourth parameter representing the calculated values of the coding indexes associated with the coded symbols already received from another source equipment.

9. Method of communication between at least a first equipment, called destination equipment, and at least a second equipment, called source equipment, the first and the second equipments being part of a content centric network, the method comprising, executed by the destination equipment, the following steps of :

- receiving at least one coded symbol constituting a data content transmitted from the source equipment,
- determining if the destination equipment has already received the coded symbol from another source equipment,
- if so, sending a feedback message to the source equipment indicating that the destination equipment has already received the coded symbol from another source equipment.

10. Equipment, called source equipment, capable of transmitting a data content to at least another equipment, called destination equipment, the source and destination equipments being part of a content centric network, the data content to be transmitted being constituted of at least one symbol, the source equipment comprising means for :

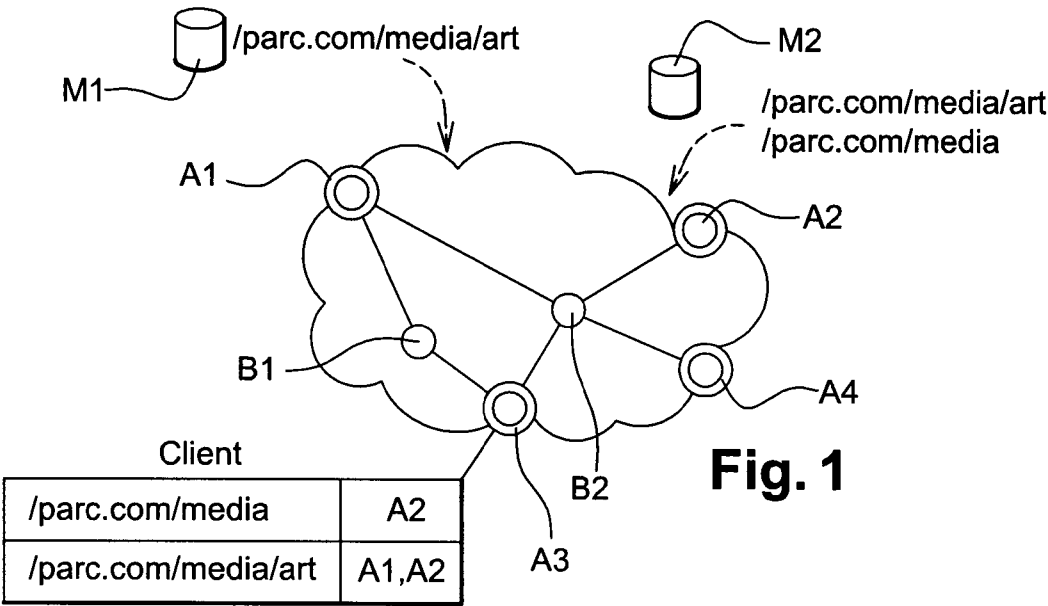
- calculating a value of a coding index to be used when coding the symbol constituting the data content, as a function of an identifier of the destination equipment, a number of symbols constituting the data content and an identifier of the source equipment,
- transmitting the symbol coded using the calculated value of the coding index to the destination equipment,
- upon reception of a feedback message sent by the destination equipment indicating that the destination equipment has already received the coded symbol from another source equipment, calculating an updated value of the coding index.

11. Equipment, called destination equipment, capable of communicating with at least a second equipment, called source equipment, the destination and source equipments being part of a content centric network, the destination equipment comprising means for :

- receiving at least one coded symbol constituting a data content transmitted from the source equipment,
- determining if the destination equipment has already received the coded symbol from another source equipment,
- if so, sending a feedback message to the source equipment indicating that the destination equipment has already received the coded symbol from another source equipment.

12. Computer program characterized in that it comprises program code instructions for the implementation of the steps of the method for transmitting a data content as claimed in claim 1 when the program is executed by a processor.

5 13. Computer program characterized in that it comprises program code instructions for the implementation of the steps of the method of communication as claimed in claim 9 when the program is executed by a processor.



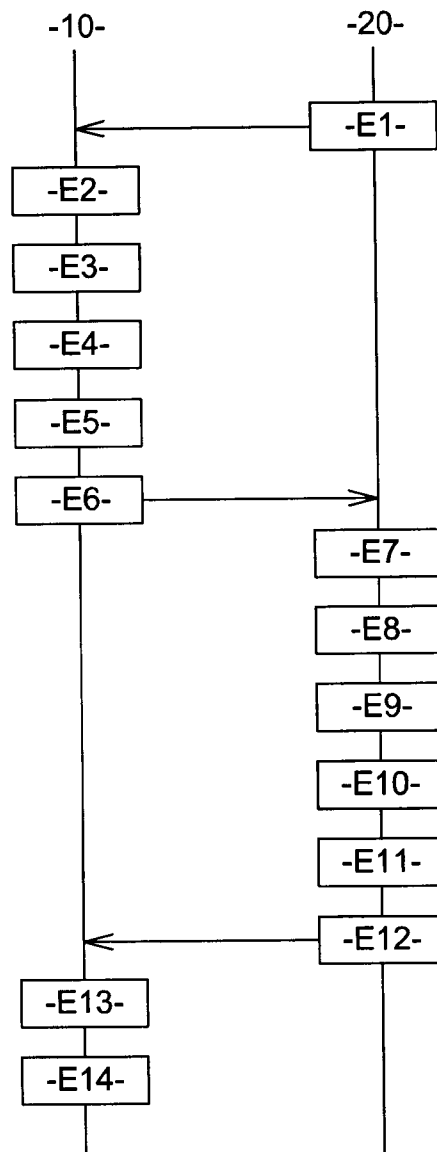
I	K	S
---	---	---

Fig. 3

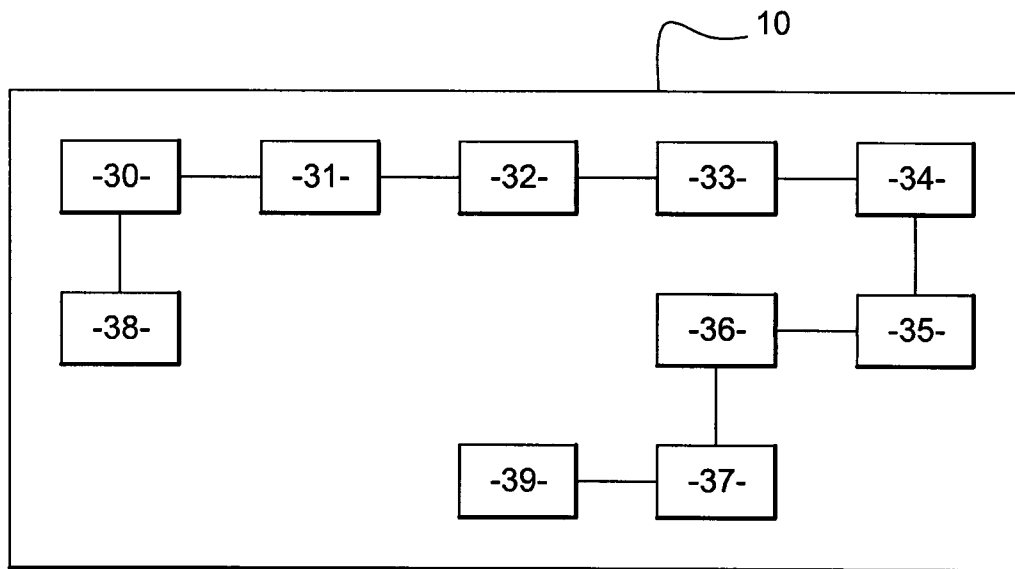
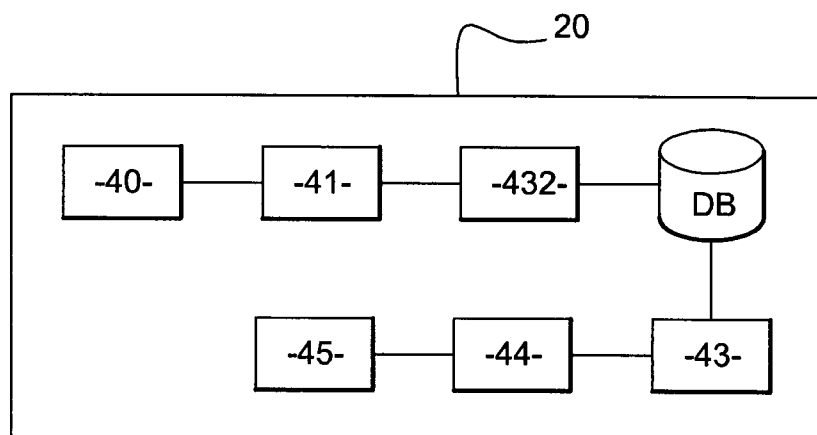
WS	N	D	ESI List
----	---	---	-------------

Fig. 4

2 / 3

**Fig. 2**

3 / 3

**Fig. 5****Fig. 6**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/082324

A. CLASSIFICATION OF SUBJECT MATTER

H04L 12/00 (2006.01) 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)

IPC: H04L, H04W

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)

EPODOC, WPI, CNPAT, CNKI, GOOGLE, IEEE : CONTENT, CENTRIC, NETWORK, TRANSMIT+, DATA, INTEREST, CNN, SYMBOL+, INDEX+, COD+ AND IDENTIFIER, NUMBER, ENCODE, SAFETY, SECRECY, REQUEST, FEEDBACK, VALUE, RESPONSE, RETURN, NOTIFY, MESSAGE, RECEIVE, ORIENTED, BASED, CALCULATE, FUNCTION, UPDATE, ANOTHER

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20120166806 A1(FUTUREWEI TECHNOLOGIES, INC.) 28 June 2012(28.06.2012) see	1-13
A	EP 2120419 A2(PALO ALTO RESEARCH CENTER INCORPORATED) 18 November 2009(18.11.2009) see the whole document	1-13
A	US 2005219070 A1(DIGITAL FOUNTAIN INC) 06 October 2005(06.10.2005) see the whole document	1-13
A	US 2012096136 A1(SAMSUNG ELECTRONICS CO LTD) 19 April 2012(19.04.2012) see the whole document	1-13

☐ 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

28 June 2013(28.06.2013)

Date of mailing of the international search report

11 Jul. 2013 (11.07.2013)

Name and mailing address of the ISA/CN

The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088

Facsimile No. (86-10)62019451

Authorized officer

ZHANG Guihua

Telephone No. (86-10)62411839

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/082324

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
US 20120166806 A1	28.06.2012	WO 2012089004 A1	05.07.2012
EP 2120419 A2	18.11.2009	US 2009287835 A1	19.11.2009
		JP 2009277234 A	26.11.2009
		EP 2120419 A3	09.06.2010
		US 8386622 B2	26.02.2013
US 2005219070 A1	06.10.2005	WO 2005055016 A2	16.06.2005
		EP 1706946 A2	04.10.2006
		KR 20060096156 A	07.09.2006
		CN 1886898 A	27.12.2006
		JP 2007513549 A	24.05.2007
		INCHENP 200602115 E	06.07.2007
		US 7412641 B2	12.08.2008
		CN 100505552 C	24.06.2009
		CN 101582698 A	18.11.2009
		KR 100041762 B1	17.06.2011
		JP 4787167 B2	05.10.2011
		WO 2005055016 A3	04.05.2006
US 2012096136 A1	19.04.2012	WO 2012050293 A1	19.04.2012
		KR 20120038187 A	23.04.2012