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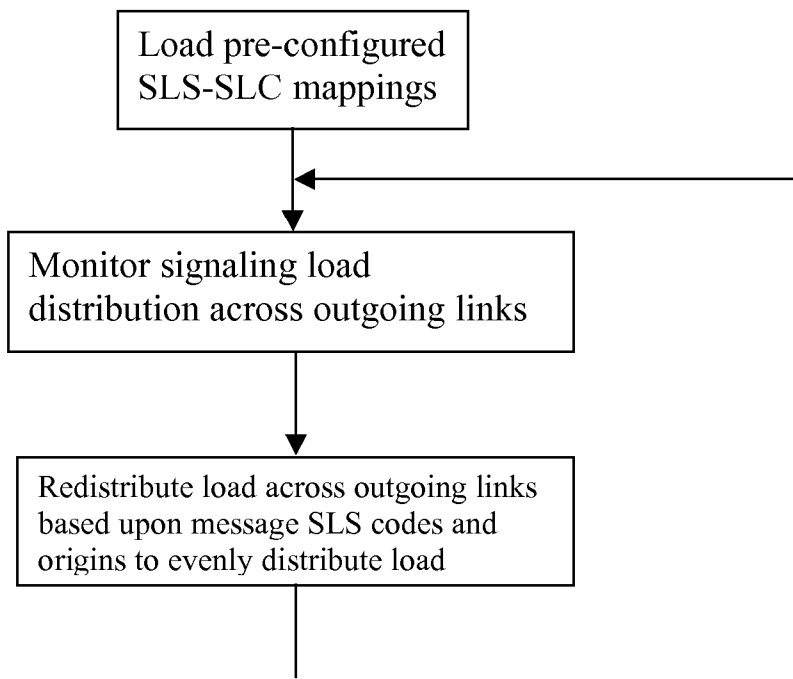
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(54) Title: LOAD SHARING IN SS7 OR SCTP SIGNALLING NETWORKS



(57) Abstract: A method of operating a signaling transfer point in order to distribute signaling message load across a plurality of outgoing links coupled to the signaling transfer point. The method comprises distributing received signaling messages across said plurality of outgoing links according to a mapping of signaling link selection codes to outgoing links, maintained at the signaling transfer point, and monitoring the relative signaling loads placed on the outgoing links. Based upon the monitored results, said mapping is modified in order to more evenly share the message load across said plurality of outgoing links.

Figure 7

WO 2009/043384 A1

LOAD SHARING IN SS7 OR SCTP SIGNALLING NETWORKS

Technical Field

- 5 The present invention relates to network load sharing and in particular to methods and apparatus for achieving efficient load sharing within a Signaling System number 7 (SS7) network.

Background

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Signaling System number 7 (SS7) is a common channel signaling system defined by the International Telecommunications Union (ITU). SS7 is in fact a suite of protocols which allow for the routing of circuit and non-circuit information to be routed within and between networks. The most important SS7 protocols are MTP (Message Transfer Part), SCCP (Signaling Connection Control Part) and ISUP (ISDN User Part).

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An elementary signaling network can be said to consist of originating, intermediate, and destination signaling points (SPs) connected by signaling links. For each SP, outgoing signaling links are identified by a signaling link code (SLC). Intermediate signaling points, which only transfer messages from one link to another, serve as signaling transfer points (STPs). SPs are allocated a 14 bit identification code according to ITU Recommendation Q.708. Figure 1 illustrates a very simple signaling network comprising, for the purpose of illustration, an originating SP A, a destination SP F, and four STPs B to E. SP A has a single link to each of STPs B and C, each of STPs B and C has a single link to each of STPs D and E, and each of STPs D and E has a single link to SP F. It will be readily apparent from Figure 1 that messages sent from SP A to SP F can follow a number of different routes. However, it is important to ensure that the message traffic is shared as evenly as possible between the different routes to avoid certain links from becoming congested, and to maximise message transfer speed.

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ITU Recommendation Q.705 provides for a signaling link selection field within the MTP message header. This field contains a signaling link selection (SLS) code,

generated at the originating SP. The SLS code provides a means for achieving load sharing whilst at the same time ensuring that messages relating to the same session follow the same route (in order to satisfy the requirement that SS7 messages relating to the same session arrive at a destination SP in sequence).

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The SLS code is a four bit code allowing for 16 different possible values. Code values are allocated, at the originating SP, to message sessions using some appropriate algorithm, e.g. on a round-robin basis. Within the network, each signaling point, including the originating SP and STPs, is configured with a mapping of SLS codes to SLCs. In the example of Figure 1, at SP A, SLS codes having a “0” as the second lsb (having the format XX0X) are allocated to link A→B, whilst SLS codes having a “1” as the second lsb (having the format XX1X) are allocated to link A→C. That is half the SLS codes are allocated to link A→B, and half to link A→C. This mechanism is illustrated further in US6,965,567.

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Continuing with the example of Figure 1, it will be appreciated that if the SLS to SLC mapping applied at SP A were to be implemented at STPs B and C, only one of the two outgoing links for each STP will be utilised. In order to allow load sharing also at the STPs therefore, a different SLC to SLS mapping should be used at the STPs B and C than is used at SP A. As illustrated in Figure 1, such a mapping could be based on the lsb of the SLS code such that, for STP B, SLS codes having a “0” as the lsb (XXX0) are mapped to link B→D, whilst SLS codes having a “1” as the lsb (XXX1) are mapped to link B→E.

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Figure 1 illustrates the case where SPs are connected via only a single link. Of course, in a real network, to provide for sufficient capacity and link redundancy, any two SPs may be connected via multiple links. However, for the purpose of load sharing, such multiple links are treated as just another link towards the destination. The fact that the SLS code has 16 possible values means that the total number of outgoing links from a given SP, including links to the same STP, should not exceed 16.

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Whilst in a simple network it is relatively straightforward to preconfigure SLS to SLC

mappings at network SPs so as to ensure load balancing throughout the network, this becomes difficult or even impossible to achieve in large and complex networks. In any case, even if a network can be configured to redistribute SLS codes from one node to the next, outgoing links of a given STP will only be used efficiently if a full range of SLS values is received on the incoming links to that STP. For example, in the network of Figure 1, if STP B receives messages containing only SLS codes having a “0” as the lsb, only link B→D will be utilised.

This problem can be further illustrated with reference to Figure 2 which contains SPs A to H. Considering SP A as the originating SP, SLS codes 0,1,4,5,8,9,13 (corresponding to codes having a “0” as the second lsb) are mapped to link A→B, whilst codes 2,3,6,7,10,11,14,15 (corresponding to codes having a “1” as the second lsb) are mapped to link A→C. STP B has four outgoing links to SP D, which is the destination SP for this example. SLS codes 0,4,8,12 (corresponding to “00” as the two lsb’s) are mapped to a first link, 1,5,9,13 (corresponding to “01” as the two lsb’s) are mapped to a second link; SLS codes 2,6,10,14 (corresponding to “10” as the two lsb’s) are mapped to a third link; and SLS codes 3,7,11,15 (corresponding to “11” as the two lsb’s) are mapped to a fourth link. Thus, the mapping used at SP A collides with the mapping used at SP B in that, for messages sent from SP A to STP B, only the first and second links between STP B and SP D will be used. Similarly, the mapping used at G will collide with that used at B. Messages containing the SLS codes mapped to the third and fourth links between B and D will never be received at B. Furthermore, if the traffic volumes arriving at B from A and E differ, SLS values that are used on the first and second outgoing links will arrive with different frequencies, further unbalancing the outgoing loads. The skilled person will appreciate that it is not always possible to coordinate mappings between different nodes as networks are not always symmetrical, and different vendors may support different mapping algorithms.

US20040015964 describes a mechanism for load sharing signaling messages amongst signaling links in a network, based upon the generation of signaling link selection parameters. US6,002,693 also describes a mechanism for load sharing and which

allows 5-bit SLS codes to be expanded to provide 8-bit SLS codes. US5,848,069 describes a mechanism for assigning SLS codes to outgoing links.

5 An analogous problem arises in the case of SIGTRAN based signalling networks, where messages streams are carried between signaling points across an IP network. SIGTRAN specifies the use of Streaming Control Transmission Protocol (SCTP) in IETF RFC2960 to create and control message streams. SIGTRAN also specifies an M3UA layer in RFC 3332 which sits on top of the SCTP layer. M3UA is able to distribute messages across multiple SCTP streams within one or more M3UA/SCTP
10 associations, where an association is defined by the network interfaces at respective signaling points. Multiple associations exist where two signaling points each have two or more network interfaces. M3US/SCTP associations are analogous to SS7 signaling links.

15 Summary

It is an object of the present invention to provide for more effective load sharing across links of a large and complex signaling network, be they SS7 or SCTP. This is achieved by monitoring, at a given signaling point, the distribution of SLS codes of routed
20 messages and adjusting the used load sharing algorithm based upon SLS code to more evenly load the outgoing links.

According to a first aspect of the present invention there is provided a method of operating a signaling transfer point in order to distribute signaling message load across a
25 plurality of outgoing links coupled to the signaling transfer point. The method comprises distributing received signaling messages across said plurality of outgoing links according to a mapping of signaling link selection codes to outgoing links, maintained at the signaling transfer point, and monitoring the relative signaling loads placed on the outgoing links. Based upon the monitored results, said mapping is
30 modified in order to more evenly share the message load across said plurality of outgoing links.

Embodiments of the present invention provide for the dynamic redistribution of signaling loads across the outgoing links at a signaling transfer point, thus avoiding the need to synchronise SLS code use and allocation across different signaling points of a network whilst at the same time maintaining in-sequence delivery where necessary.

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The invention is applicable in particular to signaling points configured for use within a Signaling System No. 7 signaling network, where said signaling link selection codes are included within a Message Transfer Part header of signaling messages. However, the invention is also applicable to other signaling networks including SIGTRAN signaling networks, wherein said links corresponding to M3UA/SCTP associations.

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According to a particularly advantageous embodiment of the invention, said mapping additionally takes into account an origin of received signaling messages. Thus, messages having the same SLS code but different origins may be mapped to different outgoing links.

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According to a second aspect of the present invention there is provided apparatus for distributing signaling messages received via one or more incoming signaling links, across a plurality of outgoing links. The apparatus comprises a first interface for coupling to said incoming signaling link(s) and a second interface for coupling to said outgoing signaling links. A memory is provided for maintaining a mapping of signaling link selection codes to outgoing links. A signaling message distributor is provided for distributing received signaling messages across said plurality of outgoing links according to said mapping, and a processor is provided for monitoring the relative signaling loads placed on the outgoing links, and for modifying said mapping based upon the monitored distribution to more evenly share the message load across said plurality of outgoing links.

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Brief Description of the Drawings

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Figure 1 illustrates schematically a simple signaling network utilising a prior art SLS-based load sharing scheme;

Figure 2 illustrates, within the context of a more complex network, SLS to SLC mapping collisions;

Figure 3 presents an example signaling message load distribution across a set of signaling link selection codes, also indicating message origin and destination outgoing link;

Figure 4 presents the data of Figure 3 as a mapping between signaling link selection code and destination outgoing link;

Figure 5 illustrates a load distribution resulting from a remapping of the signaling link selection codes to outgoing links;

Figure 6 illustrates schematically the functional components of a signaling transfer point according to an embodiment of the present invention; and

Figure 7 is a flow diagram illustrating a method of operating the signaling transfer point of Figure 5.

15 Detailed Description

In order to illustrate an improved mechanism for sharing load between links of a signaling network, reference will be made once again to the example SS7 network of Figure 2. Assume that the network is preconfigured with the SLS to SLC mappings illustrated. In the following discussion, the four outgoing links from STP B to SP D are identified as L₁, L₂, L₃, and L₄. A function is implemented at each of the STPs of the network, and in particular at STP B, to monitor the load placed on the different outgoing links. More particularly, the function monitors both the load attributed to each SLS code and the origin of that load (as identified by the originating point code contained within the MTP header).

Considering again Figure 2 and the initial preconfigured load sharing mappings illustrated, assume that STP B receives traffic originating only from SP A and from SP E (via SP G acting as STP), and that all traffic is destined for SP D, i.e. the MTP message headers identify D as the destination point code. Assume further that the traffic originating from SP E is three times that originating from SP A and that, for each originating SP, the message traffic is evenly distributed across the SLS codes arriving at

B, i.e. 1,5,9,13 for E, and 0,1,4,5,8,9,12,13 for A. Figure 3 shows the load share across the four outgoing links for B, broken down according to SLS codes and assuming that the sum total of the traffic arriving at B is 100%. Each of the eight SLS codes arriving from SP A carries 6.25% of the total load, whilst each of the four SLS codes arriving from SP G, via STP G, carries 18.75% of the total load. [NB. It should be assumed that routes exist between F, H and D, other than via B, although these are not shown.]

Figure 4 shows the monitored data on a per outgoing link basis and illustrating the originating SP for messages on each link.

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The monitoring function implemented at each STP provides the monitored statistics to a load balancing function. The load balancing function detects imbalances in the load across the outgoing links, and performs a redistribution of the SLS codes to these links in order to correct any such imbalances. Considering again Figures 2 to 4, the load balancing function implemented at STP B will determine that the preconfigured SLS to SLC has resulted in a greater relative load being placed on outgoing link L₂, with no load being placed on links L₃ and L₄. The redistribution function aims to achieve a 25% loading on each link (+ or – some allowed amount, e.g. 5%). Figure 5 illustrates a possible redistributed SLS to SLC mapping. It can be seen for example that SLS 2 has been reallocated from SLC L₃ to SLC L₁, whilst SLS 4 has been reallocated from L₁ to L₂.

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It is important to note that the redistribution illustrated in Figure 5 allows signaling traffic associated with the same SLS code to be distributed to different outgoing links depending upon the origin of the traffic. It can be seen for example that traffic having an SLS code of 13 and originating from node A is sent out on link L₁, whilst traffic having an SLS code of 13 and originating from node E is sent out on link L₃ (previously both traffic streams were sent out on link L₂). This redistribution based upon both SLS code and origin allows a 25% load to be placed on each outgoing link.

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It is of course important to consider the effect of an SLS code redistribution on the requirement for in-sequence delivery of messages. If a redistribution were to be

5 effected too quickly, there is a danger that messages relating to a given session and being sent across a “new” link will arrive before messages sent across the “old” link. This is easily avoided by introducing a time-controlled changeover at the STP, whereby messages are buffered at the STP for some appropriate time, sufficient to allow delivery of messages via the old links to be completed, before recommencing sending over the new links.

10 Figure 6 illustrates schematically a STP 1 having a set of interfaces 2 which are coupled in use to a corresponding set of incoming links from other SPs and STPs. The STP 1 is also provided with a second set of interfaces 3 coupled in use to a corresponding set of outgoing links to other SPs and STPs. The STP 1 comprises one or more processing and memory components which provide, in functional terms, a dynamic SLS to STC mapping table (in respect of the outgoing interface) 4, a monitoring function 5, and a load balancing function 6. The various components are interconnected via some appropriate communication network 7. Figure 7 is a flow diagram illustrating the load monitoring and redistribution mechanism implemented at the STP of Figure 6.

20 The procedure described above is implemented automatically at each STP and provides for load sharing in a dynamic fashion. Apart from the initial configuration of the SLS to SLC mappings, manual intervention is not normally required. Thus, the management and efficiency of large and complex networks is greatly improved, and the frequency with which link overloads occur can be greatly reduced.

25 It will be appreciated by the person of skill in the art that various modifications may be made to the above described embodiments without departing from the scope of the present invention. For example, the invention may be employed to achieve load sharing within an SCTP signaling network, where M3UA/SCTP associations are analogous to MTP signaling links. In this case, the M3UA layer maintains a mapping between SLS codes (carried within the M3US header) and SCTP streams and associations. The load distribution across the multiple associations is monitored, and SLS codes redistributed in a dynamic fashion in order to achieve a more even load share.

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Claims

1. A method of operating a signaling transfer point in order to distribute signaling message load across a plurality of outgoing links coupled to the signaling transfer point,
5 the method comprising:
distributing received signaling messages across said plurality of outgoing links according to a mapping of signaling link selection codes to outgoing links, maintained at the signaling transfer point;
monitoring the relative signaling loads placed on the outgoing links; and
10 modifying said mapping based upon the monitored relative loads in order to more evenly share the message load across said plurality of outgoing links.
2. A method according to claim 1, wherein said signaling transfer point is operated within a Signaling System No. 7 signaling network, and said signaling link selection
15 codes are included within a Message Transfer Part header of signaling messages.
3. A method according to claim 1, wherein said signaling transfer point is operated within a SIGTRAN signaling network, and said outgoing links correspond to M3UA/SCTP associations.
20
4. A method according to any one of the preceding claims, wherein said step of modifying said mappings additionally takes into account an origin of received signaling messages.
- 25 5. A method according to claim 4, said origin being identified by an originating point code of a message.
6. A method according to any one of the preceding claims, the method further comprising buffering messages for a predefined time period, immediately prior to
30 modifying said mappings in order to ensure in-sequence delivery of associated messages.

7. Apparatus for distributing signaling messages received via one or more incoming signaling links, across a plurality of outgoing links, the apparatus comprising:
a first interface for coupling to said incoming signaling link(s)
a second interface for coupling to said outgoing signaling links;
5 a memory for maintaining a mapping of signaling link selection codes to outgoing links;
a signaling message distributor for distributing received signaling messages across said plurality of outgoing links according to said mapping; and
a processor for monitoring the relative signaling loads placed on the outgoing
10 links, and for modifying said mapping based upon the monitored distribution to more evenly share the message load across said plurality of outgoing links.
8. Apparatus according to claim 7, the apparatus being configured for use within a Signaling System No.7 signaling network.
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9. Apparatus according to claim 7, the apparatus being configured for use within a SIGTRAN signaling network, where said signaling links correspond to SCTP message streams.
- 20 10. Apparatus according to any one of claims 7 to 9, wherein said mapping maps signaling link selection codes and message origins to outgoing links.

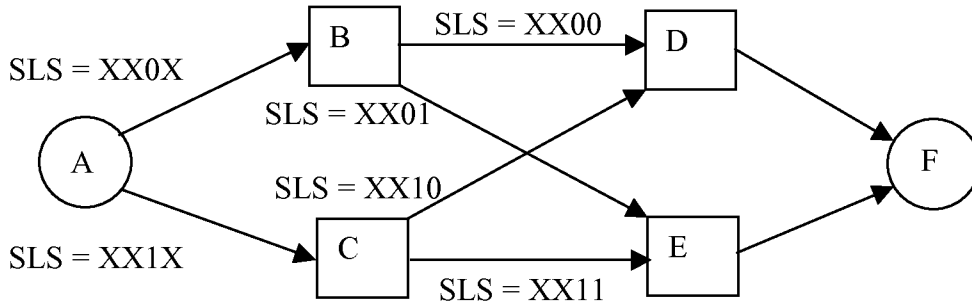


Figure 1

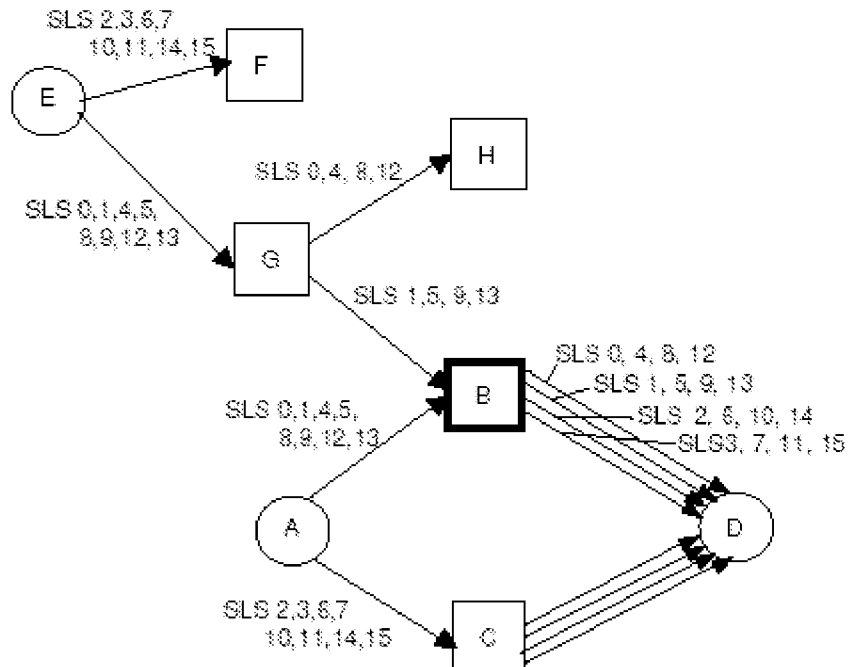


Figure 2

SLS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
link	L1	L2	L3	L4	L1	L2	L3	L4	L1	L2	L3	L4	L1	L2	L3	L4
Frequency from A (in %)	5	5	0	0	5	5	0	0	5	5	0	0	5	5	0	0
Frequency from E (in %)	0	15	0	0	0	15	0	0	0	15	0	0	0	15	0	0
Total (in %)	5	20	0	0	5	20	0	0	5	20	0	0	5	20	0	0

Figure 3

SLS \ frequency	Link L1	Link L2	Link L3	Link L4
0	Node A: 5			
1		Node A: 5 Node E: 15		
2			0	
3				0
4	Node A: 5			
5		Node A: 5 Node E: 15		
6			0	
7				0
8	Node A: 5			
9		Node A: 5 Node E: 15		
10			0	
11				0
12	Node A: 5			
13		Node A: 5 Node E: 15		
14			0	
15				0
Total:	20%	80%	0%	0%

Figure 4

SLS \ frequency	Link L1	Link L2	Link L3	Link L4
0	Node A: 5			
1		Node A: 5 Node E: 15		
2	0			
3		0		
4		Node A: 5		
5			Node A: 5 Node E: 15	
6			0	
7				0
8				Node A: 5
9				Node A: 5 Node E: 15
10	0			
11		0		
12	Node A: 5			
13	Node E: 15		Node A: 5	
14			0	
15				0
Total:	25%	25%	25%	25%

FIGURE 5

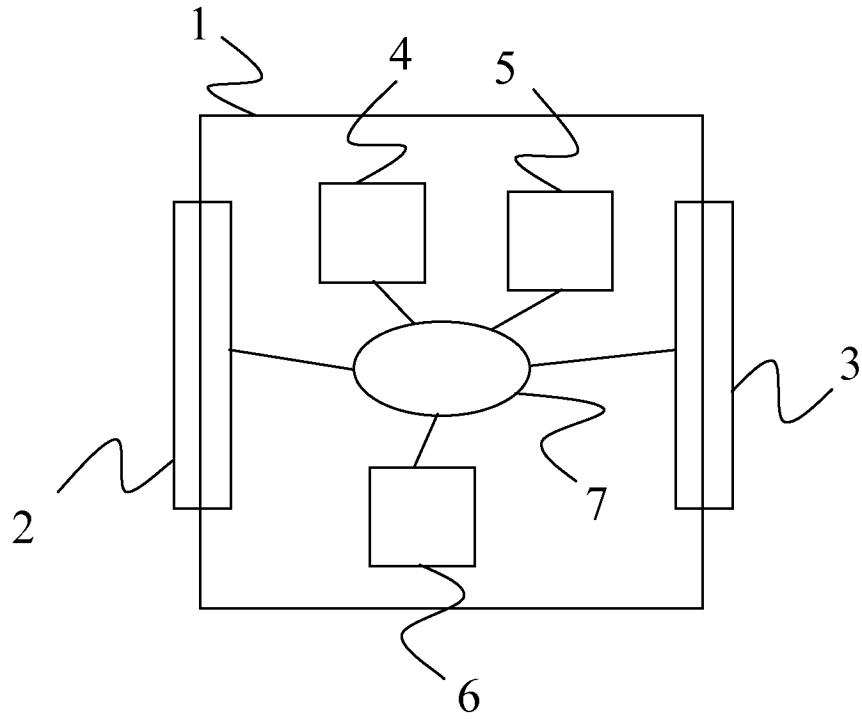


Figure 6

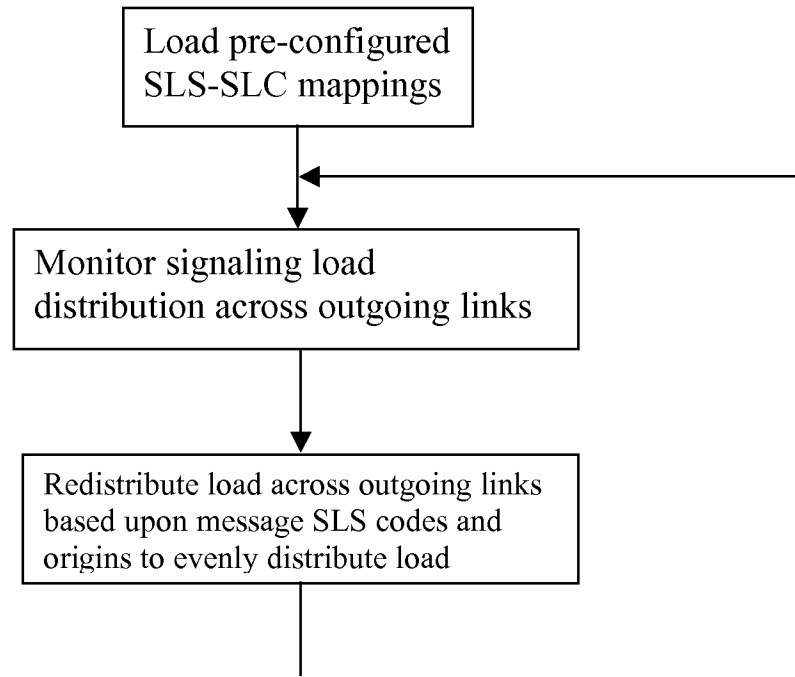


Figure 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/060607

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04Q3/00

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)
H04Q

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 practical, search terms used)

EPO-Internal, WPI Data, IBM-TDB, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/078007 A1 (ANGERMAYR M ET AL) 13 April 2006 (2006-04-13) paragraphs [0013] - [0020], [0023] paragraphs [0032] - [0044]	1-10
X	WO 03/013157 A (SIEMENS AG) 13 February 2003 (2003-02-13) page 11, lines 22-36 page 13	1-10
A	WO 2004/107774 A (UT-STARCOM KOREA LTD) 9 December 2004 (2004-12-09) page 4, line 25 - page 5, line 24	1-10

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006078007 A1	13-04-2006	DE 102004049465 A1	20-04-2006
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