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(54)

SYSTEM AND A METHOD IMPLEMENTING A DIRECTED ACYCLIC GRAPH (DAG) CONSENSUS ALGORITHM VIA A GOSSIP PROTOCOL

(57)

The invention relates to a computer-implemented method for exchanging information, through a DAG/Hashgraph consensus algorithm via a gossip protocol, the method comprising steps for

- making a first given node (N₁) select a second given node (N₄) randomly and send reference information (8);
- determining based on the reference information (8) which node events are in front of that of the others;
- If the reference information (8) implies that the events of the first given node (N₁) is in front of that of the second given node (N₄),

- then sending a cancellation information (9) to the first given node (N₁), preventing, in consequence, the first given node (N₁) from sending DAG-event information to the second given node (N₄);
- If the reference information (8) implies that the events of the second given node (N₄) is in front of that of the first given node (N₁),
- then making the first given node (N₁) send DAG-event information (6) to the second given node (N₄); and soon through the network.

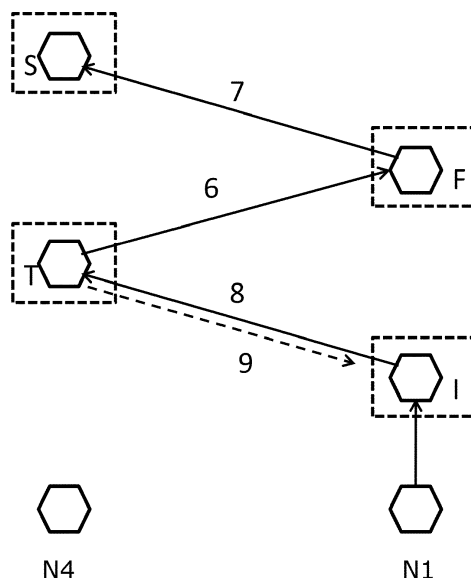


FIG. 5

Description

[0001] The present invention relates to the field of exchanging information relating in particular to a list of actions or transactions, among distributed computer nodes connected in a specific network.

[0002] The invention relates to a system and a method implementing a Directed Acyclic Graph (DAG) consensus algorithm such as a Hashgraph consensus algorithm via a gossip protocol.

[0003] The Hashgraph is known in the art as a new way of reaching consensus in a decentralised network. It is often referred to as a voting algorithm. The Hashgraph is a specific Directed Acyclic Graph (DAG).

[0004] The goal of Hashgraph is primarily to reach consensus between nodes in distributed system. The Hashgraph algorithm is a way to solve Byzantine Generals' Problem.

[0005] In addition, Hashgraph algorithms may stop an attacker from shutting down the network or freezing the network, thereby stopping it from reaching consensus.

[0006] One idea with this invention is to have an efficient way to exchange information between nodes, as well as a support method and support system for the Hashgraph or other DAG systems which need to exchange DAG information.

[0007] Figure 1 illustrates a Hashgraph schematically as developed in the art. The Hashgraph is based on a network of computer nodes (N_A , N_B , N_C , N_D , N_E) arranged vertically in figure 1. Each computer node (N_A , N_B , N_C , N_D , N_E) can record what is called an event 1 represented as a circled, and more detailed in figure 2. The event is generally a sequence of information/bytes and memory, that is then hashed. The event will be recorded by the node. The event comprises a piece of information to be distributed to the network. The information is generally hashed to have it secured. The Hashgraph thus enables to distribute secured information that is distributed in the network.

[0008] The event is signed by the node.

[0009] In the implementation of a Hashgraph, a node will then randomly select another node and transmit him all the information it hashed about the communication. This is repeated until the information is propagated throughout the network.

[0010] The Hashgraph implies infinite numbers of transmissions of information in the network. In addition, in the Hashgraph algorithm, an event always includes a timestamp to reach a consensus timestamp in the network.

[0011] Referring to figure 2, the information of the event includes

- a hash from the self-parent 2 received from the self-parent node represented vertically in figure 2. The hash from the self-parent 2 relates to previous events in the memory of the self-parent node;
- a hash from the "other" parent 3 received from the

- other parent node represented diagonally in figure 2. The hash from the other parent 3 relates to previous events in the memory of the other parent node;
- information of the current event 1_i; and
- a timestamp 4 of the current event.

[0012] An objective of the invention is to limit/reduce the number of transmissions of information and to decrease the use of computer resources in the calculations, storing and transmission of the information.

[0013] Another general objective of the invention is to efficiently exchange information between computer nodes and to prevent nodes from going into an infinity echo where they forever send information back and forth.

[0014] Another objective is to secure the nodes and easily determine what information needs to be shared between nodes, without sending unnecessary information between them.

[0015] In order to meet these objectives, the invention relates to a computer-implemented method for exchanging information among distributed computer nodes connected in a specific network, the method implementing a Directed Acyclic Graph (DAG) consensus algorithm such as a Hashgraph consensus algorithm via using a gossip about gossip protocol, the method comprising steps for

-making a first given node select a second given node randomly and send reference information; the method being preferably characterized by

- determining based on the reference information which node events are in front of the others;
- If the reference information implies that the events of the first given node is in front of the events of the second given node,
 - then sending a cancellation information to the first given node, preventing, in consequence, the first given node from sending DAG-event information to the second given node;
- If the reference information implies that the events of the second given node is in front of the events of the first given node,
 - then making the first given node send DAG-event information to the second given node;
 - and preferably, then making the second given node send DAG-event information to the first given node;
- and so on for other nodes, so as to synchronise and propagate the DAG-event information through the network.

[0016] More precisely, according to an aspect, the method comprises a step for

- making the second given node send a cancellation information to the first given node,

when the second given node receives the reference in-

formation from the first given node,
if the second given node previously sent a reference in-
formation to the first given node,
such that the first given node does not send DAG-event
information to the second given node.

[0017] The "DAG-event information" refers to the in-
formation which is exchanged relating to an event of the
DAG. In particular, the pieces of information are in con-
nection via hash pointers. It means the hash of an event
is a unique hash (fingerprint), and the self-parent and the
other-parent hash fingerprints are contained in the event,
which acts as unique identifiers/pointers between events
in the DAG.

[0018] Advantageously, the method enables to limit
the number of transmissions of information via the can-
cellation information such that the node stops the com-
munication of the information. That implies decreasing
the use of computer resources in the calculations, storing
and transmission of the information.

[0019] The idea with this invention is to have an effi-
cient way to exchange information between nodes (gos-
sip about gossip). So the Wavefront method is used as
a support system for the Hashgraph or other DAG sys-
tems which need to exchange DAG information.

[0020] Furthermore, it limits the number of information
by sending the state of each node's chain of events,
which is indicated by the reference/altitude number. By
this way, the node can decide if the last event in a chain
of events is behind or in front of the other node event
chain.

[0021] In addition, the cancellation enables to prevent
infinity echo between two nodes.

[0022] In addition, the Wavefront method enables to
secure the nodes easily and to determine what informa-
tion needs to be shared between to nodes by sharing the
"wave-front" state (further detailed below) without send-
ing unnecessary information between them.

[0023] According to other aspects of the method taken
individually or combined in any technically possible com-
bination:

- the reference information relates to the order of node
events; and/or
- the order of node events is determined by keeping
track of an ordinate value of every event; and/or
- the order of node events is determined by making
each node keep track of an integer value called Al-
titude, which increases for each event created in a
node; and/or
- the reference information is sent via a Tidal-wave;
and/or
- the cancellation information is sent via a Breaking-
wave; and/or
- the second sending of DAG-event information from
the second given node to the first given node is the
second and last wave of DAG-event information;
and/or
- the method comprises a step for sending another

cancellation information if a node receives informa-
tion that is not in a predetermined sequence of ex-
change of information and/or if a node receives in-
formation from a node with which it already ex-
changed information.

[0024] The invention further relates to a system for ex-
changing information, comprising means for carrying out
the steps of the method according to the invention.

[0025] More generally, the invention further relates to
a system for exchanging information among distributed
computer nodes connected in a specific network, the sys-
tem implementing a Directed Acyclic Graph consensus
algorithm such as a Hashgraph consensus algorithm via
using a gossip about gossip protocol, the system com-
prising

- means for making a first given node select a second
given node randomly and send reference informa-
tion;
the system being preferably characterized by
- means for determining based on the reference infor-
mation which node events are in front of the others;
- means for sending a cancellation information to the
first given node if the reference information implies
that the events of the first given node are in front of
that of the second given node,
preventing, in consequence, the first given node from
sending DAG-event information to the second given
node; and
- means for making the first given node send DAG-
event information to the second given node
if the reference information implies that the events
of the second given node are in front of the events
of the first given node,
- and preferably, means for making then the second
given node send DAG-event information to the first
given node;
- and so on for other nodes, so as to synchronise and
propagate the DAG-event information through the
network.

[0026] The advantages mentioned above for the meth-
od also apply to the system implementing the method.

[0027] According to other aspects of the system taken
individually or combined in any technically possible com-
bination:

- the reference information relates to the order of node
events; and/or
- the system comprises means for keeping track of an
ordinate value of every event to determine the order
of node events; and/or
- the system comprises means for making each node
keep track of an integer value called Altitude, which
increases for each event created in a node to deter-
mine the order of node events; and/or
- the system comprises means for sending wherein

the reference information via a Tidal-wave, and means for sending the cancellation information via a Breaking-wave; and/or

- the system comprises means for limiting the number of transmissions of DAG-event information between the first given node and the second given node; and/or
- the system comprises means for sending another cancellation information if a node receives information that is not in a predetermined sequence of exchange of information.

[0028] Another object of the invention is a network comprising one or more central unit, in particular, one or more computerised central unit, and connection(s) to additional command units implementing transactions, in particular, computerised command units, the central unit(s) comprising a system according to the invention.

[0029] The invention will now be presented in details via the description of non-limitative embodiments of the invention and based on the enclosed drawings, among which:

- figure 1 is a schematic illustration of a Hashgraph in a method according to the prior art;
- figure 2 is a schematic illustration of an event in the Hashgraph of figure 1;
- figure 3 is a schematic illustration of a system according to an embodiment of the invention;
- figure 4 is a schematic illustration of a Hashgraph in a method according to an embodiment of the invention; and
- figure 5 is a detailed illustration of exchanges of information between two nodes in the invention.

[0030] The invention relates to exchanging information.

[0031] The invention includes implementing a DAG consensus algorithm via a gossip about gossip protocol, such as a Hashgraph consensus algorithm via a gossip about gossip protocol.

[0032] The means of the invention distribute the information via a gossip protocol, sending information about the data received from the other nodes in a specific network 5.

[0033] The invention concerns a computer-implemented method, and also the corresponding system 5a and network 5. The method of the invention enables to process and exchange information, such as what is needed regarding blockchain transaction and applications of Hashgraphs.

[0034] The DAG, such as a Hashgraph, is used to exchange information among distributed computer nodes connected in a specific network. The information is secured and hashed. The information of the DAG/Hashgraph transmitted will be called the "DAG-event information".

[0035] A gossip protocol implies that computer nodes

transmit to one another, the information that they have in memory.

[0036] The method of the invention comprises a step for determining an order of node events to determine node events that are in front and node events that are behind.

[0037] In the embodiment, the order front and behind is not based on time. This embodiment does not need time consensus. Advantageously, this avoids the problem of having echo computer node to agree on the same time.

[0038] Determining the order of events enable to know which event is in front, and which event is behind. Thus the information on the event is more precise. This determination is preferably not limited to having a timestamp of the node in the event.

[0039] According to an embodiment of the invention, the order of node events is determined by keeping track of an ordinate value of every event. Advantageously, using an ordinate value avoids the problem of having echo computer nodes to agree on the same time.

[0040] In particular, the order of node events is determined by making each node keep track of an integer value called Altitude, which increases for each event created in a node. The altitudes play a role in the processing of the information.

[0041] In another step of the method of the invention, a first given node N_1 randomly selects a second given node N_4 and may send it DAG-event information 6, 7 in network 5. More generally, the system is made such as making the first node N_1 selecting a second given node N_4 randomly and if applicable, sending DAG-event information (6, 7).

[0042] All the nodes $N_0, N_1, \dots, N_5, \dots$ of the network 5 proceed so until the DAG-event information (6, 7) is propagated in the network 5.

[0043] The invention aims at preventing some transmissions of DAG-event information and yet having the relevant information propagated in the network 5.

[0044] According to the invention, the method comprises a step for, when the first given node N_1 randomly selects the second given node N_4 , making the first given node N_1 send the second given node N_4 a specific reference information (8) before sending any DAG-event information (6, 7). The sending of the reference information may be called a Tidal-wave. The Tidal-wave is a flow of information.

[0045] The "Tidal-wave" may define an altitude value for each node. Each node keeps track of the event-DAG; this means that each node has the current altitude known by the node for each node.

[0046] In particular, the reference information (8) relates to the order of node events. More particularly, the reference information 8 comprises the previous altitudes, here, a list of all Altitudes for each node.

[0047] Furthermore, according to the invention, the method comprises a step for sending a cancellation information (9) to the first given node N_1 under certain con-

ditions to avoid further transmission of DAG-event information 6, 7 from the first given node N_1 to the second given node N_4 . The sending of the cancellation information 9 may be called a Breaking-wave. The Breaking-wave is a flow of information sent as a response, in order for the node to return to the initial state.

[0048] Cancellation information 9 is sent when the second given node N_4 receives the reference information 8 from the first given node N_1 if in view of the reference information 8, the events of the second given node N_4 are not in front of that of the first given node N_1 . This is easily done when analysing the altitudes.

[0049] Cancellation information 9 may go directly from the second node N_4 to the first node N_1 in the preferred embodiment.

[0050] The method further comprises a step for, in consequence of the cancellation information, preventing the first given node N_1 from sending DAG-event information to the second given node N_4 .

[0051] In other words: the second given node N_4 sends a cancellation information to the first given node N_1 , such that the first given node N_1 does not send DAG-event information to the second given node N_4 .

[0052] Advantageously, the method enables to limit the number of transactions via the cancellation information such that the node stops the communication of the information. This implies decreasing the use of computer resources in the calculations, storing and transmission of the information.

[0053] If, in view of the reference information (8), the events of the second given node N_4 is in front of that of the first given node N_1 , then the transmission of DAG-event information continues.

[0054] In particular, the second given node N_4 sends the DAG-event information, including the events it has in memory to the first given node N_1 . This first sending of DAG-event information may be called a First-wave 6. The First-wave is a flow of information known as such by the skilled person in the art. The DAG-event information of the First-wave 6 includes a list of all the events the second given nodes N_4 has in memory.

[0055] Moreover, in particular, after the first given node N_1 receives the DAG-event information from the second given node N_4 , the first given node N_1 may send the DAG-event information, including the events it has in memory to the second given node N_4 . This second sending of DAG-event information may be called a Second-wave (7). The Second-wave is a flow of information known as such by the skilled person in the art.

[0056] After the first and second waves, the exchanges of information between the first given node N_1 the second given node N_4 are stopped.

[0057] This is a second way of avoiding the infinite echo of information transmitted. In other words, when the second-wave is received/send the wave state for this node-id is returned to the initial state.

[0058] According to a preferred embodiment, the method includes a step of sending another (second) can-

cellation information if a node receives information that is not in a predetermined sequence of exchange of information, in particular the sequence of first the reference information (8), then the first wave (6) and then the second wave (7) of the DAG-event information. The cancellation information is in particular of the same type as previously, but is triggered if for example the second given node N_4 receives at first, a second wave.

[0059] According to another embodiment, the method includes a step of sending another (third) cancellation information if a node receives information from a node with which it already exchanged information. The cancellation information is in particular of the same type as previously, but is triggered if for example the second given node N_4 receives later another reference information 8 from the first Node N_1 . Advantageously, these steps limit further the redundancy/echo regarding the transmission of information.

[0060] The invention further concerns a system 5a for implementing the method as described above. The system 5a is a computerised system and comprises inherent hardware and software modules configured to implement the method described above. It may be called a Wave-front system 5a.

[0061] The system 5a enables to exchange information among distributed computer nodes connected in a specific network, implementing a DAG/Hashgraph consensus algorithm via a gossip about gossip protocol.

[0062] The system 5a comprises means for determining an order of node events to determine node events that are in front and node events that are behind;

- means for making a first given node N_1 select a second given node N_4 randomly and sending a reference information (8) and, where applicable, DAG-event information (6, 7),
- means for propagating the DAG-event information (6, 7) in the network 5.

[0063] According to one aspect, the system 5a comprises

- means for making the second given node N_4 send a cancellation information to the first given node N_1 ,

when the second given node N_1 receives the reference information from the first given node N_1 , if the second given node N_4 previously sent the reference information to the first given node N_1 ,

- means for preventing, in consequence, the first given node N_1 from sending DAG-event information to the second given node N_4 .

[0064] The system 5a further preferably comprises means for sending another cancellation information if a node receives information that is not in a predetermined

sequence of exchange of information; and/or if a node receives information from a node with which it already exchanged information.

[0065] The advantages mentioned above for the method also apply to the system implementing the method.

[0066] Another object of the invention is a network comprising one or more central unit(s) 10, in particular, one or more computerised central unit, and connection(s) 12 to additional command units 11 implementing transactions, in particular, computerised command units, the central unit(s) comprising a system 5a as described above. This may be called a Wavefront network. The network may be connected via the internet to the additional command units.

[0067] The advantages mentioned above for the method and the system 5a also apply to the network 5 including the corresponding system 5a. Example

[0068] An example is described in detail in figures 4 and 5.

[0069] Figure 4 shows a Hashgraph of gossip information representing the information flow between network nodes $N_0, N_1, N_2, \dots, N_5$. Other nodes are preferably in the same network but are not represented.

[0070] In finite time all nodes in the network will be able to build the same event-DAG.

[0071] Each vertical line represents a compute node and each circle an event. The lines between the events represent the communication of the events between the nodes.

[0072] The events only seen by the respective Nodes are in white circles with unbroken lines. The events seen by two or more Nodes are in white circles with broken lines. The last events of the respective Node are in plain coloured circles.

[0073] The last event to create is a dotted circle.

[0074] The Hashgraph algorithm uses a gossip protocol called "gossip about gossip" to propagate information between the nodes. This means a first given node N_1 sends all the information of the communication that it knows to a randomly selected second given node N_4 . This enables node N_4 to construct the same Hashgraph as node N_1 .

[0075] In the network of the invention 5, a protocol called Wavefront is used to exchange information between two nodes, ensuring that node N_1 and N_4 only needs to communicate three times to exchange the state of the graph.

[0076] Each node keeps track of an integer value called Altitude. Altitude is increased by one for each event created by the node. Each node stores its current view of Altitude for each node in the network.

[0077] By exchanging information about the Altitude between two nodes, both are able to figure out which of the events are in front.

[0078] To determine which event is in the current event and the received event is subtracted this value is greater than 0 it means that the current event is in front of the received event and vice versa.

$$a_{current} - a_{received} < 0$$

if the received event is in front of the current event.

[0079] The Wavefront information exchange has four states:

1. Node N_1 randomly selects Node N_4 and sends a list of last known Altitudes for each node. This state is called a Tidal-wave.
2. Node N_4 receives a Tidal-wave from Node N_1 . If based on the Tidal wave, the events of Node N_4 are not in front of the events of Node N_1 then Node N_4 will send which is called a Breaking-wave to Node N_1 . Otherwise, Node N_4 will return a list of all events which are in front of the Tidal-wave of Node N_1 . This state is called first-wave.
3. If Node N_1 receives a First-wave from Node N_4 , it returns a list of all the events which are in front of Node N_4 . When this state has been reached the wave-front exchange ends.
4. If Node N_1 or Node N_4 receives a Breaking-wave, the wave-front communication is dropped.

[0080] Regarding state 2, alternatively or in combination, if Node N_4 already exchanged information with node N_1 through a previous Tidal wave, then Node N_4 would send a Breaking wave. In addition, alternatively or in combination, if Node N_4 received at first a second wave from node N_1 , then Node N_4 would send a breaking wave.

[0081] This prevents both nodes from going into an infinity echo where they forever send information back and forth.

[0082] In the network, a node will often have many simultaneous wave-front connections, so it will sometimes receive the same event package from other nodes. It will simply drop any duplicated events it receives.

[0083] The examples in Figures 4 and 5 illustrate events and altitude values are shown.

[0084] Node 1 synchronizes to Node N_4 . The event b5 (coloured) is the last event generated by Node N_1 and all the previous events which are known by b5 are under the dotted dash line.

[0085] The event e5 (coloured) is the last event generated by Node N_4 and all previous events know by this event is under the dashed line.

[0086] All the events know by both b5 and e5 is drawn as dashed circles.

[0087] The Wavefront from Node N_1 (marked with the dotted dash line) is the list of all altitudes of the latest known events.

[0088] This means the Wavefront Node Niis.

$$W_{1,b5} = [-3, -2, 1, -1, 0, 2]$$

[0089] The same for Node N_4 marked with blue dashed-line

$$W_{4,e5} = [-4, -6, -1, -2, 3, 4]$$

[0090] The steps of communication are as follows:

The first node N_1 is first in an idle state at the bottom of the figure. The first node N_1 initiates a gossip towards the second node N_4 and goes to an initial state /

1. Initial Wavefront:

Node N_1 connects to Node N_4 and sends the Wavefront $W_{1,b5}$ to Node N_4 .

This message is marked as a Tidal-wave type. This makes Node 4 go from an idle state to a Tidal-wave state T .

2. If a message marked as Tidal-wave type is received:

Node N_4 receives the Wavefront and compares with its Wavefront $W_{4,e5}$ and collects all the events which are in front of the $W_{1,b5}$ this means the events $e3$, $e4$, $e5$, $f3$ and $f4$ are returned to Node N_1 .

This message is marked as a first-wave type. It makes Node N_1 go to a First-wave state F .

3. If a message marked First-wave are received:

Node N_1 receives the Wavefront from Node N_4 and stores the events which are unknown by Node N_1 .

The received Wavefront is compared to its Wavefront and the events in front of the received Wavefront are collected and returned to Node N_1 .

The collected in this example is $a1$, $b1$, $b2$, $b4$, $b5$, $c2$, $c3$ and $d3$.

This message is marked as a second-wave type. It makes Node N_4 go to a Second-wave state S .

If the Node N_4 already has sent and a message of the First-wave to Node N_1 , Node N_4 will send a message marked as a Breaking-wave type to Node 1 and it must set the state for the communication to Node N_1 to none.

4. If a message marked second-wave is received:

The events are stored if the events are unknown to Node N_4 .

5. If a message marked Breaking-wave are received:

[0091] This communication state of the received channel is set to none.

[0092] The communication flow of the example is shown in Figure 5.

[0093] In this example, the Tidal-wave 8 includes the list of altitudes $W_{1,b5} = [-3, -2, 1, -10, 2]$.

[0094] The First-wave 6 includes the list of altitudes $W_{4,e5} = [-4, -6, -1, -2, 3, 4]$, and also the list of events 1: $\{e3, e4, e5, f3, f4\}$.

[0095] The Second-wave 7 includes the list of events 1: $\{a1, b1, b2, b4, b5, c2, c3, d3\}$.

Claims

1. Computer-implemented method for exchanging in-

formation among distributed computer nodes connected in a specific network, the method implementing a Directed Acyclic Graph consensus algorithm such as a Hashgraph consensus algorithm via using a gossip about gossip protocol, the method comprising steps for

- making a first given node (N_1) select a second given node (N_4) randomly and send reference information (8);

the method being **characterized by**

- determining based on the reference information (8) which node events are in front of the other (N_1);

- If the reference information (8) implies that the events of the first given node (N_1) are in front of the events of the second given node (N_4),

--then sending a cancellation information (9) to the first given node (N_1), preventing, in consequence, the first given node (N_1) from sending DAG-event information to the second given node (N_4);

- If the reference information (8) implies that the events of the second given node (N_4) is in front of the events of the first given node (N_1),

--then making the first given node (N_1) send DAG-event information (6) to the second given node (N_4);

-- and preferably, then making the second given node (N_4) send DAG-event information (7) to the first given node (N_1);

- and so on for other nodes, so as to synchronise and propagate the DAG-event information (6, 7) through the network.

2. Computer-implemented method according to the preceding claim, wherein the reference information relates to the order of node events.

3. Computer-implemented method according to any of the preceding claims, wherein the order of node events is determined by keeping track of an ordinate value of every event.

4. Computer-implemented method according to the preceding claim, wherein the order of node events is determined by making each node keep track of an integer value called Altitude, which increases for each event created in a node.

5. Computer-implemented method according to any of the preceding claims, wherein the reference information is sent via a Tidal-wave (8), and/or the cancellation information is sent via a Breaking-wave (9).

6. Computer-implemented method according to any of the preceding claims, **characterized in that** the second sending of DAG-event information from the second given node to the first given node is the second and last wave of DAG-event information. 5
7. Computer-implemented method according to any of the preceding claims, comprising a step for sending another cancellation information if a node receives information that is not in a predetermined sequence of exchange of information and/or if a node receives information from a node with which it already exchanged information. 10
8. System for exchanging information among distributed computer nodes connected in a specific network, the method implementing a Directed Acyclic Graph consensus algorithm such as a Hashgraph consensus algorithm via using a gossip about gossip protocol, the system comprising 15
- means for making a first given node (N_1) select a second given node (N_4) randomly and send reference information (8);
 - the system being preferably **characterized by** 25
 - means for determining based on the reference information (8) which node events are in front of the others;
 - means for sending a cancellation information (8) to the first given node (N_1) if the reference information (8) implies that the events of the first given node (N_1) are in front of the events of the second given node (N_4), 30
 - preventing, in consequence, the first given node (N_1) from sending DAG-event information (6, 7) to the second given node (N_4); and 35
 - means for making the first given node send DAG-event information (6) to the second given node (N_4) 40
 - if the reference information (8) implies that the events of the second given node (N_4) are in front of the events of the first given node (N_1), 45
 - and preferably, means for making then the second given node (N_4) send DAG-event information (7) to the first given node (N_1);
 - and so on for other nodes, so as to synchronise and propagate the DAG-event information (6, 7) through the network.
9. System according to the preceding claim, wherein the reference information relates to the order of node events. 50
10. System according to claim 8 or 9, comprising means for keeping track of an ordinate value of every event to determine the order of node events. 55
11. System according to the preceding claim, comprising means for making each node keeps track of an integer value called Altitude, which increases for each event created in a node to determine the order of node events.
12. System according to any of claims 8 to 11, comprising means for sending wherein the reference information via a Tidal-wave (8), and means for sending the cancellation information via a Breaking-wave (9).
13. System according to any of claims 8 to 12, **characterised by** means for limiting the number of transmissions of DAG-event information between the first given node (N_1) and the second given node (N_4).
14. System according to any of claims 8 to 13, comprising means for sending another cancellation information if a node receives information that is not in a predetermined sequence of exchange of information; and/or if a node receives information from a node with which it already exchanged information.
15. Network comprising one or more central unit, in particular, one or more computerised central unit (10), and connection(s) (12) to additional command units (11) implementing transactions, in particular, computerised command units, the central unit(s) (10) comprising a system (5a) according to any of claims 8 to 14.

FIG. 1
(Prior art)

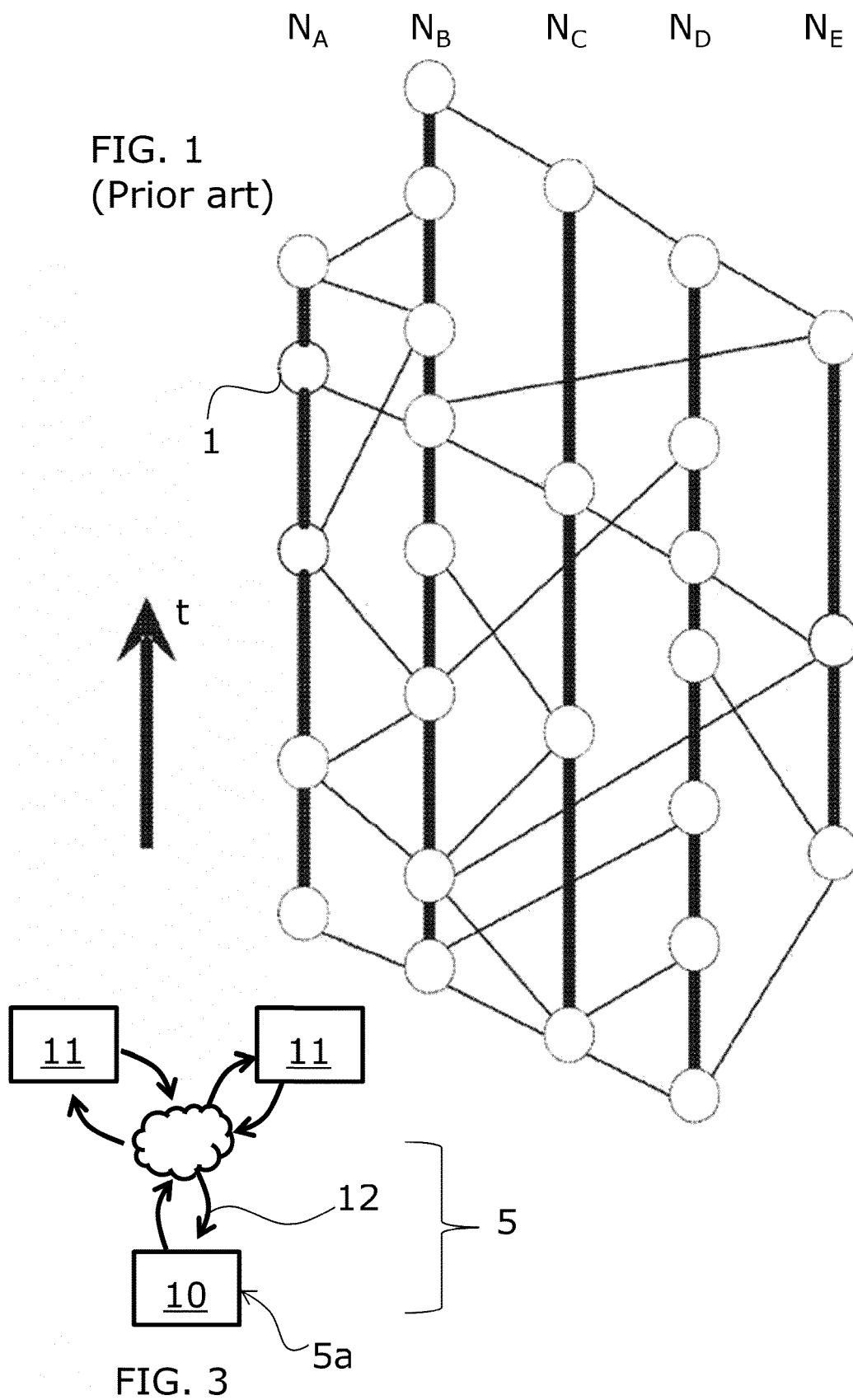


FIG. 2
(Prior art)

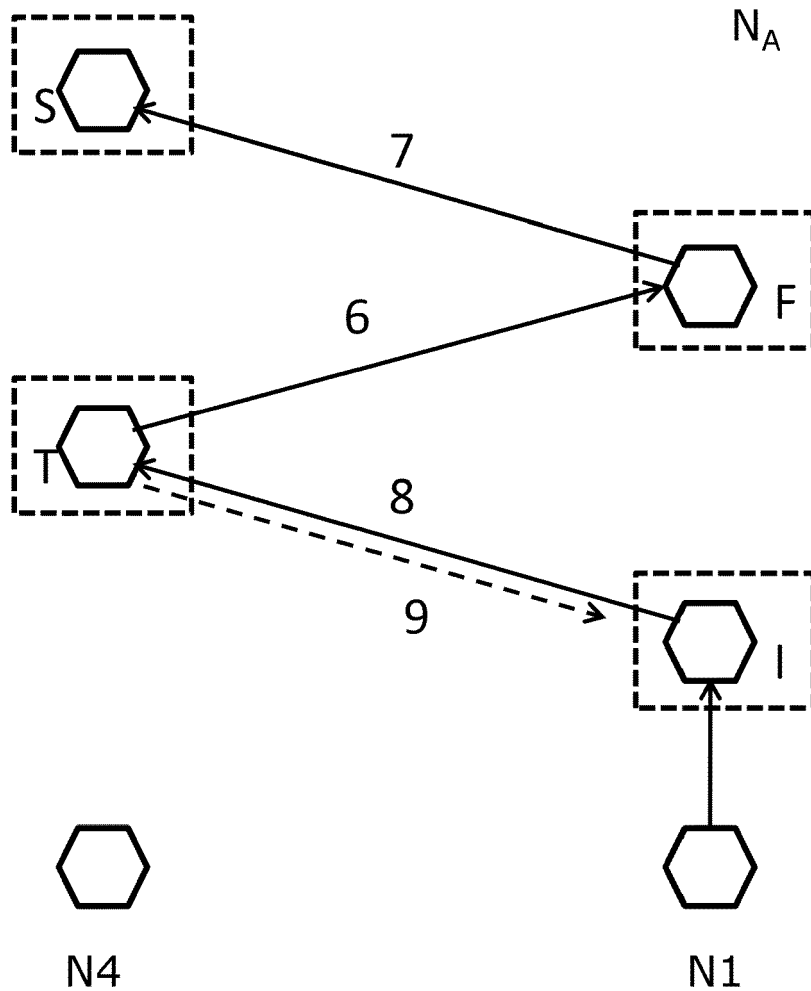
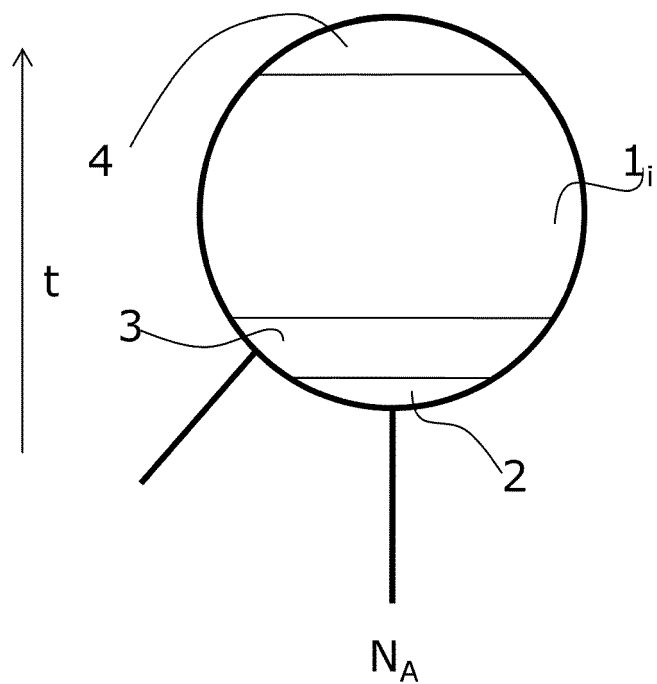


FIG. 5

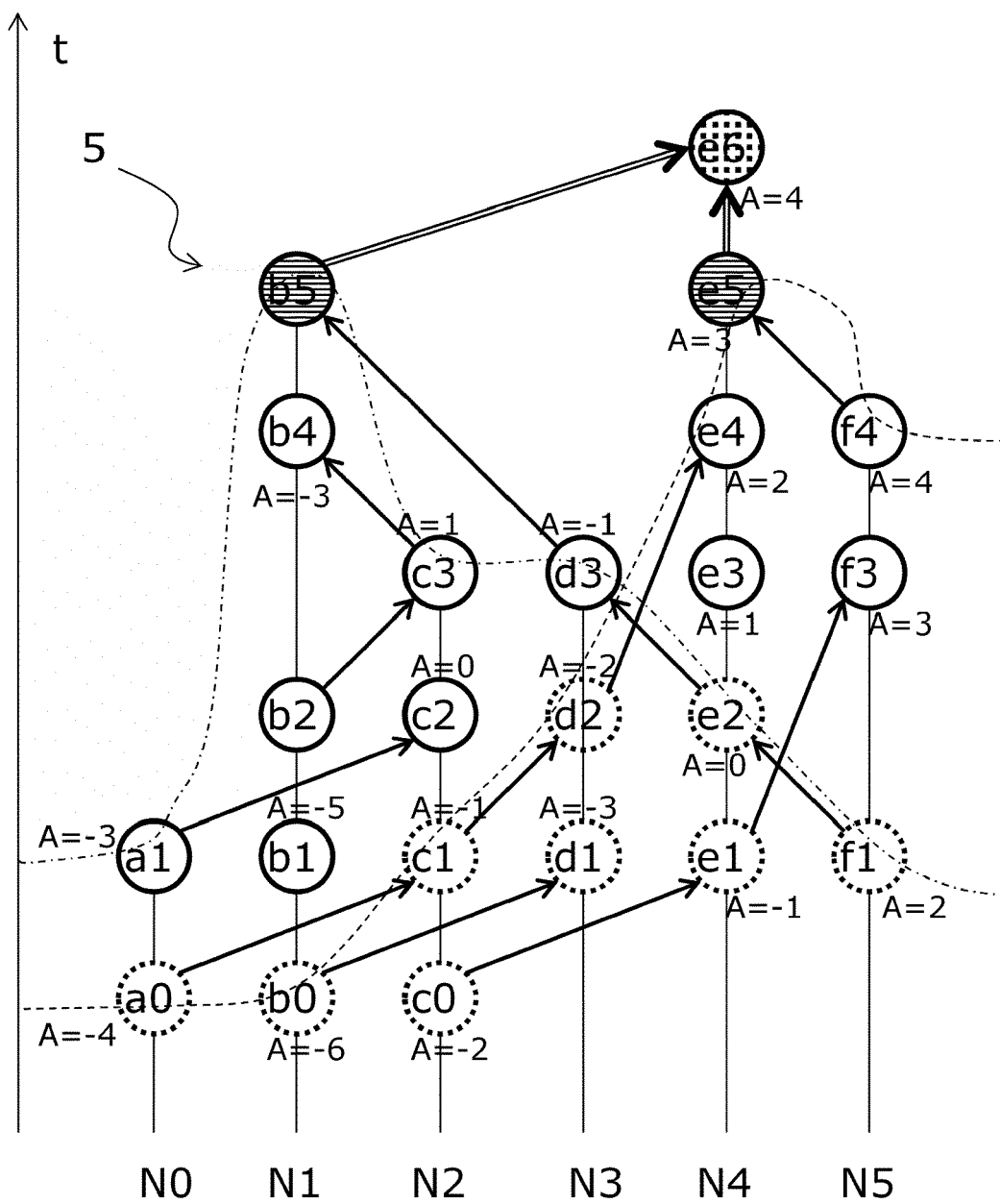


FIG. 4



EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search Berlin		Date of completion of the search 11 May 2020	Examiner Nazzaro, Antonio
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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