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(12) (19) (CA) **Demande-Application**

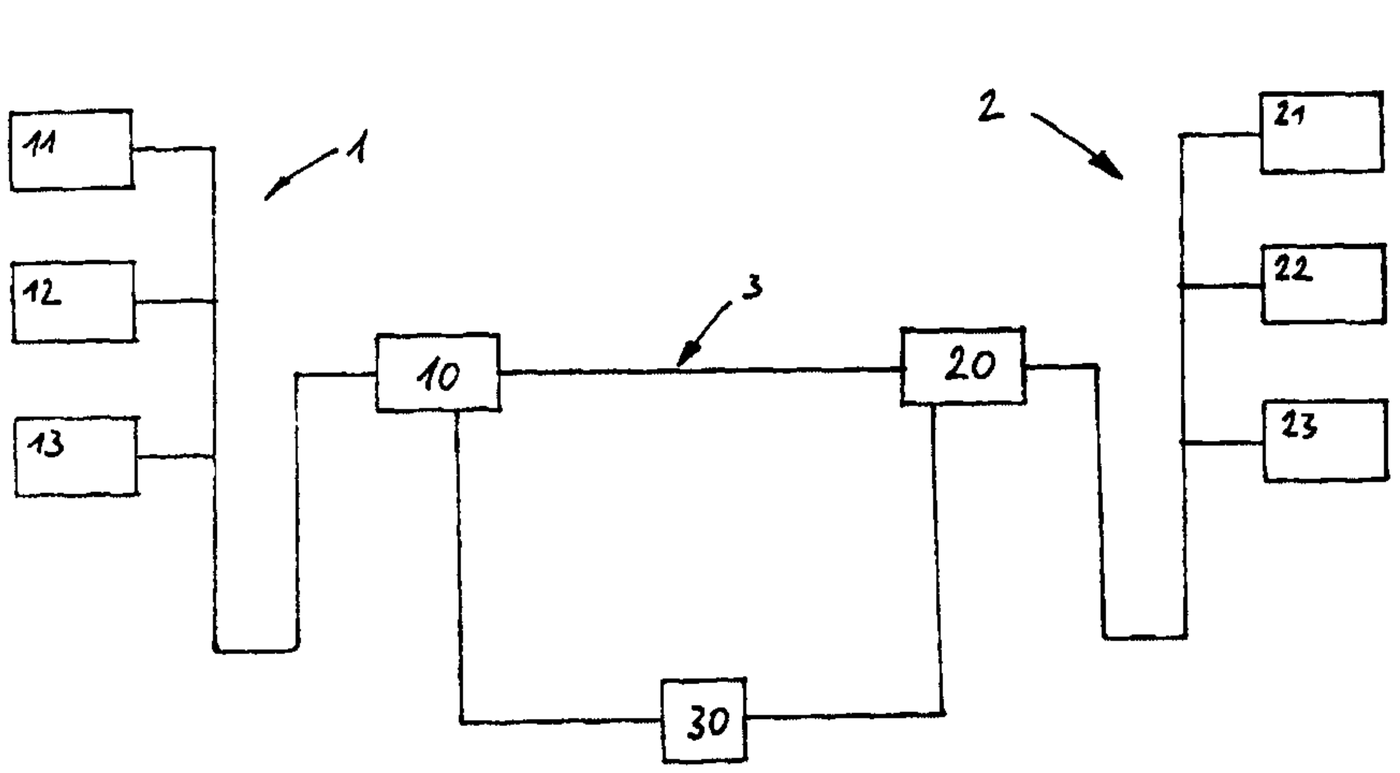
(21) (A1) **2,296,481**
(86) 1999/05/17
(87) 1999/11/25

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(51) Int.Cl.[7] G06F 17/17
(30) 1998/05/18 (198 22 211.4) DE

(54) **PROCEDE POUR REDUIRE LE DEBIT BINAIRE LORS DE LA TRANSMISSION DE DONNEES OBJET ENTRE DES ELEMENTS DE CALCUL COMMUNIQUANT A L'INTERIEUR DE CONDITIONS TEMPORELLES**

(54) **METHOD FOR REDUCING DATA RATE DURING TRANSMISSION OF OBJECT-RELATED DATA BETWEEN TWO COMPUTER ELEMENTS COMMUNICATING WITHIN TIME LIMITS**



(57) L'invention concerne un procédé pour réduire le débit binaire lors de la transmission de données orientées objet entre des zones utilisateur (1, 2) communiquant à l'intérieur de conditions temporelles, notamment en temps réel, par l'intermédiaire d'une unité de

(57) The invention relates to a method for reducing data rate during transmission of object-oriented data between two user areas (1, 2) having at least one communication module (10, 11) to which at least one external unit (11, 12, 13; 21, 22, 23) has been allocated and

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transmission de données (3), avec respectivement au moins un module de communication (10, 11) auquel est associée au moins une unité externe (11, 12, 13; 21, 22, 23). Selon ce procédé, une extrapolation des données à émettre est effectuée dans chaque module de communication émetteur, et les données sont émises à destination de chaque module de communication récepteur, lorsqu'une valeur de comparaison formée à partir des données actuelles et des données extrapolées atteint au moins une valeur de consigne. Selon ce procédé, une extrapolation des données reçues est effectuée dans le module de communication récepteur, et les unités externes de ce dernier fonctionnent sur la base des données extrapolées par ledit module jusqu'à la réception des données actuelles.

communicating within time limits, especially in real time mode, by means of a data transmission device (3), whereby the data to be transmitted is extrapolated in the transmitting communication module and data is transmitted to the corresponding receiving communication module once a comparative value formed on the basis of the actual data and the extrapolated data reaches at least a set value and whereby the received data is extrapolated in the receiving communication module whose external units operate on the basis of data extrapolated by said communication module until actual data is received.

ABSTRACT:

Process for reducing the data throughput when transmitting object-oriented data between user areas (1, 2) communicating within time conditions, particularly in real time, by way of a data transmission device (3) and having at least one communication module (10, 11) respectively, to which in each case at least one external unit (11, 12, 13; 21, 22, 23) is assigned, an extrapolation of the data to be sent taking place in the respective sending communication module, and a sending of the data taking place to the respective receiving communication module when a comparison value formed of the respective current data and the extrapolated data at least reaches a desired quantity, and an extrapolation of the received data taking place in the receiving communication module and its external units operating on the basis of the data extrapolated by it until current data are received.

(Figure 1)

PROCESS FOR REDUCING THE DATA THROUGHPUT WHEN TRANSMITTING OBJECT-RELATED DATA BETWEEN COMPUTING ELEMENTS COMMUNICATING WITHIN TIME CONDITIONS

The invention relates to a process for reducing the data throughput when transmitting object-related data between computing elements communicating within time conditions, particularly communicating in real time, as well as to a device for implementing this process.

In the case of computer units which communicate with one another in real time, the maximal bandwidths or transmission rates of the data transmission devices used for the communication, including the protocol provided for this purpose, represent a bottleneck in the data interchange between these computer units. Usually, data quantities which exceed these maximal bandwidth are deleted or delayed during the transmission, in which case the sending computer has no information concerning the cutting-off or the delay of data quantities and as to which portion of the data quantity has not been transmitted. As the result, the sending computer unit itself has no control over which data the receiving computer unit has received. It is therefore a disadvantage that in the state of the art it is essentially only possible to either tolerate this uncertainty or to accept additional management expenditures with respect to data transmission reliability in order to achieve a control over

the data transmitted to the receiving computer unit. According to the state of the art, these advantages are overcome in that relatively high-expenditure and therefore high-cost data transmission devices with a large transmission bandwidth are used.

It is therefore an object of the invention to provide a process for transmitting data between computer units communicating under time conditions, by means of which the data quantities to be exchanged between the computer units become minimal, while simultaneously the information concerning the respective connected computer units, which is present in the interchanging computer units, is to be preserved.

This object is achieved by means of the characteristics of Claim 1. Additional embodiments are indicated in the subclaims.

In order to decide whether, in a transmission interval, the sending communication computer should send data with respect to an object to another communication computer in a different user area, at least one extrapolation process is used which is running on both data-interchanging communication computers. In the respective sending communication computer, the current data, with respect to whose sending a decision has to be made and with which the respective sending communication computer is supplied by the external units assigned to it, are compared with the data

extrapolated by the latter. Since data extrapolated in the same manner are also present in the receiving communication computer and are used in the external units assigned to it, the sending communication computer, taking into account the respective occurring transmission path, has information as to which data are present in the receiving user area. On this basis and as the result of the comparison of extrapolated data with current data, the respective sending communication computer makes a decision concerning a sending of data to the receiving user area. In order to design these extrapolation processes efficiently, the characteristics of objects, by means of which the data to be transmitted are described, are structured in corresponding formats such that, on the one hand, the objects to be described are described by means of as few data expenditures as possible and, on the other hand, the extrapolation processes to be used are as efficient as possible with respect to the computing time. As a result, the data quantities to be transmitted per time unit are clearly reduced. Furthermore, the quality of the objects processed by the system and thus the complexity or precision of the system or the number of described objects can be increased when the same data quantities as in the state of the art are transmitted.

The comparison values from the current and the extrapolated data sets are compared with threshold values for the decision concerning the transmission. Together with a continuously

updated list of priorities, by means of which a sequence and thus a transmission point in time of the data to be transmitted is defined, these threshold values determine a maximal transmission error.

The system according to the invention for the transmission of data particularly also has the advantage that, for the communication between computer systems producing large quantities of data, it is possible to use data transmission devices which are reasonable in cost with relatively low transmission bandwidths.

In the following, the invention will be described by means of the attached figures.

Figure 1 is a view of the computer system according to the invention with two user areas and a data transmission line;

Figure 2 is a view of a simulation system also with two user areas as an application example of the invention.

Figure 1 illustrates a computer system with a first user area 1 and a second user area 2, which are connected with one another by way of a data transmission device 3, in which case the data processing device 3 may also comprise storage media. In the first user area 1, a communication module or a communication

computer 10 is connected to the data transmission device 3. The communication module or communication computer 10 is connected by way of corresponding signal or data transmission lines with external units 11, 12, 13, which may be computer units or a tape recorder. Likewise, a communication module or communication computer 20 connected to the data transmission device 3 is provided in the second user area 2. This communication module or communication computer 20 is also connected by way of corresponding signal or data transmission lines with external units 21, 22, 23 of the second user area 2. The external units 11, 12, 13 and 21, 22, 23 continuously generate data which they transmit to the respective communication computers 10 and 20, in which case the generating of data may be independent of the communication computers 10 and 20. The communication computers 10, 20 communicate with one another under time conditions; that is, they mutually exchange data which they received from the respective assigned external units 11, 12, 13 and 21, 22, 23. The communication computers 10, 20 being connected with a timer 30. Furthermore, the communication computers 10, 20 may have functions which control at least parts of the communication between external units.

If, for example, the communication computer 10 receives data from the external units 11, 12, 13 connected with it, which are to be transmitted to the communication computer 20 by way of the data transmission device 3, these data are transmitted by way of

the data transmission device 3 on the basis of a defined data transmission protocol in the form of data sets or data set packets of a defined transmission format. The data transmission device 3 has a limited bandwidth. This limited bandwidth may be the result of the maximal data throughput of the respective transmission channel, for example, of a data line or of a radio connection, of the memory size of an assigned storage unit or of the data processing speed of the data processing devices provided for the data transmission, for example, of a crypter (encrypter? translator). The generated and interchanged data preferably are object-oriented data, that is, data which describe objects or characteristics of objects.

According to the invention, a differentiation is made in the case of these transmission formats between data which can be changed by way of the transmission steps and data which cannot be changed by way of these transmission steps or are quasi-static. These may be numerical values as well as logic values. The quasi-static data comprise, for example, data which describe the characteristics of objects which remain the same over time, while the data which can be changed by way of the transmission steps describe, for example, the time-variable behavior of these objects. The quasi-static data must be transmitted only at the beginning of the whole transmission process and at the relatively rare points in time at which these change. A device or function is therefore provided in the respective sending communication

computers 10, 20, which determines whether a type of quasi-static data has changed and which, in this case, provides the transmission of corresponding quasi-static data. Furthermore, the respective sending communication computer 10, 20 can initiate and cause the transmission of quasi-static data if this communication computer 10, 20 has determined that a sufficient amount of transmission bandwidth is still available for the corresponding transmission step in the data transmission device 3.

The changeable data are described in application-specific or object-specific formats for the data sets. For the data to be transmitted, extrapolation processes exist in the interchanging communication computers 10, 20. These may represent an estimate of the functions implemented in the external units assigned to these, or represent an extrapolation of new values with respect to the time on the basis of old values. Analogous to the functions provided in the external units, these extrapolation processes may be mathematical or logic functions, such as data bank functions. By means of the extrapolation processes, the data which are present at the time of a transmission step in a communication computer 10, 20 may be determined for the time of a later point in time. The extrapolation processes provided in a communication computer 10, 20 depend on the number and type of the functions which are implemented in the external units 11, 12, 13 and 21, 22, 23 assigned to this communication computer.

However, they may also be designed independently of the functions of the external units 11, 12, 13 and 21, 22, 23 according to general principles. The extrapolation processes in each case implemented in a communication computer of a user area have the purpose of calculating, for the external units in the respective receiving user area, in parallel to the generating of current data, on the basis of specific functions in the external units of the sending user area, values for the external units of the receiving user area. As the result of the extrapolations in the receiving user area, values or data are determined for points in time for which the respective current data are determined on the basis of specific functions in the external units of the sending user area.

In the case of the time value on which the extrapolation is based, the transmission time of the data from the sending communication computer 10 to the receiving communication computer 20 is taken into account. In the case of the sending communication computer, for example, a transmission time is used which is determined ahead of time. In the case of the receiving communication computer 20, the transmission time occurring in the case of the respective data set is determined by a time stamp with which the sending communication computer 10 has provided the data set to be sent on the basis of a corresponding signal of the timer 30 for the sending point in time , and by means of the absolute time defined by the timer 30 for the receiving point in

time. This actual transmission time is preferably in turn transmitted to the communication computer which has sent the data and is used later for the estimation of the transmission time by the sending communication computer. The extrapolation processes are optimized or adapted to the data or to the corresponding data set formats of the application or their objects and vice-versa with respect to the computing time. The extrapolation processes are constantly, that is, for the respective operating time of the computer system according to the invention, active in the corresponding communication computers 10, 20. In the respective sending communication computer, the same extrapolation process is active which runs in the receiving communication computer and is used for generating the same data and therefore information as to on the basis of which data the operation takes place in the respective receiving user area. The current data sent to the receiving communication computer or the data extrapolated there are preferably used as input data for the functions which are implemented in the external units of the respective receiving user area.

For example, the communication computer 10 in each case sends current data of the corresponding specific data set format, that is, a group of data types by means of which the objects to be described by the data can be efficiently described, to the receiving communication computer 20. These current data are generated by the external units which are assigned to the sending

communication computer and on which specific application programs or functions run preferably for the, among other things, time-variable description of objects and are generally required at least partially by the functions which run on external units in the respective receiving user area. Then the sending communication computer 10 as well as the receiving communication computer 20 independently of one another determine, by means of the same specific extrapolation processes which are applied to data with the same time basis defined by the timer 30, data for a later point in time, for example, for a later transmission step. The data obtained by the receiving communication computer 20 by extrapolation as well as the data received from time to time by the respective receiving communication computer 20 are used as input quantities for the object-oriented functions which run in the external units of the receiving user area. Independently thereof, the sending communication computer 10 receives from the external units 11, 12, 13 assigned to it, on which units the function or object-oriented application programs run, additional current data which, for the respective point in time, correspond to the respective data which were obtained or are obtained by the corresponding extrapolation.

The current data are compared in the communication computer 10 with the extrapolated data. In parallel thereto, the application programs or functions, which run in the receiving user area, operate on the basis of the data last generated by the

sending user area or communication computer 10 and transmitted to the receiving communication computer 20 or on the basis of the data obtained by the receiving communication computer 20 by extrapolation. If, during the comparison taking place in the sending communication computer 10 the resulting comparison values exceed a threshold value, at which the transmission time determined by the sending communication computer 10 is taken into account and which is determined for each object described by the respective data set or an object related thereto specifically before or during the operation of the computer system, a transmission of the data set formed of these data is initiated, that is, its transmission is noted down. On the basis of the transmission time concretely determined by means of the timer 30, the receiving communication computer 20 relates the respective received current data to the point in time at which they were generated in the sending user area or its external units or to which they relate. By taking into account the transmission path, the respective sending communication computer 10 can carry out a comparison of the respective current data with the data by means of which the application programs of the external units 21, 22, 23 operate in the receiving user area 2. On the basis of this comparison, information can also be obtained concerning the precision with which the functions of the external units 21, 22, 23 are running.

For the decision as to which data are actually sent by the

sending communication computer 10 to the respectively receiving communication computer 20, a list of priorities is provided which is constantly updated by the sending communication computer 10. This list of priorities represents an evaluation of a variable number of entries which refer to the data sets to be sent. In this case, the data and the contents themselves are preferably not entered into the list of priorities, the entries only being references to the respective data sets. By means of the list of priorities which is to be updated constantly, it is determined that the data to which the entries refer in each case are sent to the receiving communication computer 20. The sending takes place in the order or sequence in which the entries are listed in the list of priorities.

The order or sequence and thus the significance of the entries and of the pertaining data sets in the list of priorities required with respect to the operational reliability is defined by given criteria, in which case it is relevant, for example, for which time period the data of a certain data type were no longer updated by the communication computer 20 or were sent irrespective of an updating, or which meaning and significance attributed with respect to the functionality of the whole computer system is assigned to the data sets pertaining to the entries, or what size the data sets have. In the order or sequence of the entries of the priority list, the data sets, to which the respective entries refer, are sent by the respective

sending communication computer 10 to the respective receiving communication computer 20.

From the sum of the entries listed in the list of priorities, the respective sending communication computer 10 determines the transmission bandwidth which is required for ensuring the operational reliability of the entire computer system. In the event that this required transmission bandwidth exceeds the bandwidth defined by the data transmission device 30, the respective sending communication computer 10 can take appropriate countermeasures. These may comprise the following; Increase of the physical bandwidth of the data transmission device 30, for example, by connecting another transmission line, or the temporary reduction of the bandwidth required for the functionality of the entire computer system by the temporary change of the criteria for the determination of the list of priorities, for example, by a raising of the tolerance limit defined by the threshold values.

The function of the data transmission was described above for a case in which the communication computer 10 is the sending unit and the communication computer 20 is the receiving unit. This operation can simultaneously also take place in the reverse direction. In addition, the described sequences can also be used when data are to be sent for the description of different objects in one or the other direction.

The computer system according to the invention may also have more than two user areas. In this case, one or several user area(s) may comprise one or several communication computer(s). In addition, only one communication computer may be provided for several user areas. Also, one or several additional communication computer(s) may be connected to a first communication computer, which additional communication computer(s) may also be subordinate to the first communication computer.

The timer 30 has the function of indicating to the communication computers connected to it an absolute time; that is, a time which is independent of the sequence in the communicating computers. This function can be carried out by means of other devices available in the state of the art, for example, by standard-time clocks.

By separating data into static and dynamic data, the advantage is achieved that the data set to be sent frequently contains only the very time-variable or dynamic data, so that the data set size is smaller than the data set sent in the state of the art with each transmission step and provided with the same contents. As a result, the data quantity to be transmitted is reduced.

In an alternative embodiment, several objects may also be

described by means of one data set.

As an alternative to the described embodiments, the extrapolation processes in the communication modules 10, 20 or computers may differ. However, they must be suitable for building up and having available within the respective communication module 10, 20 a knowledge of the information present in the respective assigned communication module 10, 20.

The transmission times for the transmission of the data from the sending to the respective receiving communication computer or module 10, 20 estimated or determined during the extrapolation in the preferred embodiment may also be omitted if permitted by the required overall precision of the system according to the invention.

In the respective receiving communication module, an estimated transmission time can also be used when defining the extrapolation time.

Another advantage is the fact that data sets are generated which are specific of the simulated objects. These data sets contain data by means of which a particularly efficient extrapolation can be carried out with a minimal number of data, whereby again a reduction of the transmission bandwidth requirements is achieved.

By establishing a constantly updated list of priorities and controlling the utilization of the transmission system, its bandwidth can be optimally utilized because a selection can be made of the data sets to be transmitted. The updating of the priority list can be carried out at predetermined time intervals or automatically according to known processes.

In the following, the invention will be described by means of the simulation system illustrated in Figure 2.

Figure 2 illustrates a simulation system 100 in which several locally mutually separated flight simulators operate in a predetermined air space, for example, in groups, with or against one another. Figure 2 shows a first simulation center 101 and a second simulation center 102. The two simulation centers 101, 102 each have a communication module or a communication computer 111, 112, to which several simulation devices 133, 134 respectively are connected by means of the corresponding interfaces (I/F). In the first simulation center 101, a first flight simulator 121 and a second flight simulator 122 are connected to the simulation devices 133 assigned to these interfaces, which flight simulator may in each case comprise an airplane simulation, a weapons system simulation, a cockpit simulation, an outside-view simulation, and others. Two airplane simulators 123, 124 are also connected as simulation devices to the communication computer 112 of the second simulation center

102. One shared memory 131 and 132 respectively is provided in the two simulation centers 101, 102, which shared memory 131, 132 is in each case connected with the communication computer 111, 112 and with the pertaining flight simulators 121, 122 and 123, 124, 125. By way of the shared memory 131, 132, the data interchange is carried out within the simulation devices 133 and 134 as well as between the simulation devices 113 and the assigned communication computer 111. Between the first simulation center 101 and the second simulation center 102, a data transmission device or a transmission system 130 is provided which, by means of at least one transmission medium, transmits data from one communication computer to another.

The communication computers 111, 112 are connected with a timer 140.

In the following, the method of operation of the simulation system according to Figure 2 is described:

The two simulation centers 101 and 102 operate in real time and may possibly be constructed spatially far away from one another. As a result, for example, by means of the simulation system 100, tactical air combat maneuvers of two hostile groups of flight simulators can be carried out in a predetermined scenario, in which case the respective flight-related or tactical decision can be made in each simulation center 101, 102

independently of one another.

The flight simulators 121, 122 and 123, 124, 125 normally continuously or at a defined updating or iteration rate, supply data changing by way of the iteration steps concerning their condition and the values calculated by their functions to the shaped memory 131, 132. Thus, the flight simulation supplies, for example, information concerning the momentary position, velocity, acceleration, angular velocities, angular accelerations of the airplane model as well as concerning its attitude and direction. At the updating rate, the cockpit devices 121, 122, 123, 124 also supply data to their assigned communication computers 111, 112 concerning the condition of the respective plane which is flown by means of the corresponding cockpit device in a simulation.

Furthermore, the flight simulators 121, 122 and 123, 124, 125 supply quasi-static data concerning the airplane type, possibly its subtypes, status, affiliation with a formation as well as flight-technical and tactical parameters.

The weapons system simulation sends quasi-static data of guided missiles, for example, with respect to the type, possible subtypes, status, such as the flight condition or achieved hits, affiliation with a formation or with a selected target. As dynamic data, on the one hand, guided-missile-specific data are

sent to the shared memory 131, 132, specifically preferably the position and speed of the missile. On the other hand, the weapons system simulation sends emission data, for example, radar data or interference data (jammers) and simulation data for defense measures to the respective shared memories 131, 132.

By way of the respective shared memory 131, 132, the communication computers have access to the data of the flight simulators 121, 122 and 123, 124, 125.

Those data which are relevant, for example, to the cockpit simulations of the flight simulators 123, 124, 125 of the second simulation center 102 with respect to the first simulation center 101 are sent by the first communication computer 111 to the second communication computer 112.

For a further illustration of the method of operation, in the following, the communication computer 111 will be considered to be the sending communication computer.

The receiving communication computer 112 receives the quasi-static and dynamic data sent by the communication computer 111 and extrapolates from these dynamic data, by means of application-specific extrapolation algorithms, these to defined later points in time until it receives a new data set from the communication computer 111. During this extrapolation, the time

duration of a possible transmission of the data to simulation devices 134 of another simulation center 102 is taken into account. The communication computer 112 provides the quasi-static data by way of the shared memory 132 to the simulation devices 123, 124, 125.

Both communication computers 111, 112, which are part of the respective assigned simulation centers 101, 102, have implemented the same specific extrapolation algorithms and extrapolate by means of these in parallel based on the sent and received data, data for later points in time, the transmission time for the respective transmission between the respective simulation computers being taken into account. The sending communication computer 111 compares the data obtained by the extrapolation with the current data generated by the assigned flight simulators 121, 122 and data present in the shared memory 131. In the event that this comparison results in differential values which are larger than predetermined threshold values, the communication computer 111 initiates the sending of the current data of the flight simulators 121, 122 by way of the data transmission system 130 to the communication computer 112. These current transmitted data form the new starting point for a new extrapolation.

The actual sending takes place on the basis of the list of priorities described by means of Figure 1 and continuously updated in the operation by the communication computer 111, in

which entries with references to corresponding data sets on the basis of concrete criteria, which may also change in the course of the process, are arranged in a priority sequence corresponding to the transmission sequence.

In the present application, the positions of the corresponding entries of the respective simulation computer 121, 122 in the list of priorities are defined according to the amount by which the differential values between the current and the extrapolated data have exceeded a predetermined threshold value; the importance of the current data; and/or a possibly defined minimal updating rate. The importance of data is determined, for example, on the basis of the required computing precision of the functions of the flight simulators 121, 122. For example, airplanes within the range of a gun are assigned a higher precision and thus a higher importance than those objects which cannot yet be detected by radar. Airplane data which are generated by the airplane simulation may also have a greater importance than missile data because a higher precision is normally required for the description of the flight path of an airplane.

In order to control and direct the quantity of the data sent by the communication computer 111 by way of the transmission system 130, the threshold values for the comparison between the extrapolated and the updated data can be modified by the

respective communication computer 111. For this purpose, for example, for missiles, a lower and an upper limit of threshold values with respect to the position vector and the speed vector are used as initialization parameters.

The data sent to the communication computer 112 are transmitted in the form of defined data sets, which depends on the function of the flight simulators 121, 122 which these data sets generate, thus, for example, on the flight simulation or the weapons system simulation. For example, the following data sets are provided in the described application: a data set with the above-mentioned quasi-static data in each case for a simulated airplane and in each case for a missile which is generated and sent at least once in the course of the life cycle of the corresponding object; a data set with the dynamic data for one airplane simulation respectively which is to be sent as a function of the predetermined threshold values and which preferably comprises the position, the speed, the acceleration, the orientation (in quaternions), the angular velocity and the angular acceleration; a data set with the dynamic data for one missile respectively controlled by the weapons system simulation, which preferably contains its position and speed; a data set with data, for example, for objects, such as radar emissions, jammer simulations of defense measures, these data being transmitted in the form of the corresponding data set either always as soon as they were generated or being sent in a fixed

time pattern.

When the data sets of the quasi-static as well as of the dynamic or of the other data are sent, these data sets are provided with an identification of the generating flight simulator 121, 122. In addition, the data sets of the dynamic data receive a time stamp.

By the use of quaternions for describing the orientation of simulated objects, a particularly efficient extrapolation of these data can be carried out. This permits, on the one hand, a data reduction while simultaneously maintaining predetermined error tolerance limits. On the other hand, during the transmission of the same data quantity as transmitted without the process according to the invention in the case of the state of the art, a better quality of the values is achieved because of the values transmitted by the application programs within the respective system.

It is stressed that the structures of the data sets are designed specifically for the description of the simulated objects and simultaneously permit an efficient extrapolation, that is, an extrapolation caused by means of relatively few data. As a result, in the event of a corresponding deviation of the extrapolated data from the current data, only a few data must be transmitted to the receiving simulation center.

An above-described data set packet is sent per transmission step to the second communication computer 112. The transmission of all interchanged data must not take place in a timed manner in the case of the process according to the invention. A transmission step in this case is only a single transmission step. In order to take into account the transmission time which occurs only in a simulation system but not in reality, the data to be sent are precomputed to the receiving point in time. In this case, the transmission time is used as the basis which was determined in the preceding transmission steps by means of the timer 140. thus on the basis of time stamp added to the respective data set when sending it off and the absolute times transmitted by the timer to the corresponding communication computers.

The above statements refer to the method of operation of the simulation system for the transmission from the communication computer 111 to the communication computer 112. Analogously, they also apply to the reverse transmission operation.

In an alternative embodiment of the air space simulation system 100, each simulation center 101, 102 may comprise more than two communication computers 111, 112. The air space simulation system 100 according to the invention may also comprise more than two simulation centers which each have at least one communication computer 111, 112.

The relationship of functions described by means of the first communication computer 101 is preferably also implemented in the second communication computer 112 as well as optionally in the additional communication computers.

The system according to the invention can, for example, also be provided for the alignment of simulations with the corresponding real systems, instruments or vehicles, in which case the same time base must always be used for the measurement data to be fed into the system to be aligned as well as for the measurement data to be fed into the simulated system.

NEW CLAIMS:

1. Process for reducing the data throughput when transmitting at least partially variable, object-related data by means of a protocol between communication modules (10, 20; 111, 112) communicating within time conditions by way of a data transmission device (3; 130), to which communication modules (10, 20; 11, 112) at least one external unit (11, 12, 13; 21, 22; 23; 121, 122; 123, 124, 125) respectively is assigned for providing and utilizing the object related data, and which are connected with a timer (130, 140),

wherein, in the respective sending communication module (10, 20; 111, 112), a time-related extrapolation takes place of the data to be sent while taking into account the transmission time, and a sending of the data takes place to the respective receiving communication module (10, 20; 111, 112) when a comparison value formed from the respective current data and the extrapolated data reaches or exceeds a desired quantity,

wherein, in the communication module (10, 20; 111, 112) which has received the sent data, a time-related extrapolation of these data takes place in parallel and the external unit (11, 12, 13; 21, 22, 23; 121, 122; 123, 124, 125) assigned to the respective receiving communication module utilizes the extrapolated data until the respective receiving communication module (10, 20; 111, 112) has received newer data with respect to time, the respective receiving communication module (10, 20; 111,

112) during the extrapolation of the received data using an extrapolation time, in the case of which the transmission time for the transmission of the data from the respective sending to the respective receiving communication module (10, 20; 111, 112) is taken into account, the extrapolation being specific for at least one time-variable object described by means of the data, and the data being defined such in the form of data sets that they reflect characteristics of the object to be described which can be extrapolated.

2. Process according to Claim 1,
characterized in that, for the comparison between the current and the extrapolated data, the desired quantity can be set during the process, the data quantity to be sent for the respective point in time being relevant relative to the available data transmission bandwidth.

3. Process according to one of the preceding claims,
characterized in that, for defining the sequence in which the data are sent in the form of data sets, a continuously updated list of priorities is provided which comprises an arrangement of references to the data sets, according to which the sending of the data sets takes place, the sequence, on the one hand, being determined by a weighting of the respective data set with respect to its significance for the functionality at least of the sending user area, and, on the other hand, by the time duration in which

the data set has no longer been sent until the point in time of the updating of the list of priorities.

4. Process according to one of the preceding claims, characterized in that the data-generating communication module (10, 20; 111, 112) formats the data to be sent with respect to an object in each case in a data set with data which are invariable for a relatively long time, and in a data set with data which are variable in the course of a small number of iteration steps, the data set with the invariable data being sent according to time intervals which are several times larger than the time intervals according to which the variable data are sent, and the data set with the variable data being used during the extrapolations.

5. Process according to one of the preceding claims, characterized in that the extrapolations are mathematical extrapolations.

6. Process according to one of the preceding claims, characterized in that the comparison value is a differential value and the desired quantity is a threshold value.

7. Device for implementing the process according to one of Claims 1 to 5.

8. Device according to Claim 7,

characterized in that the device is a simulation device.

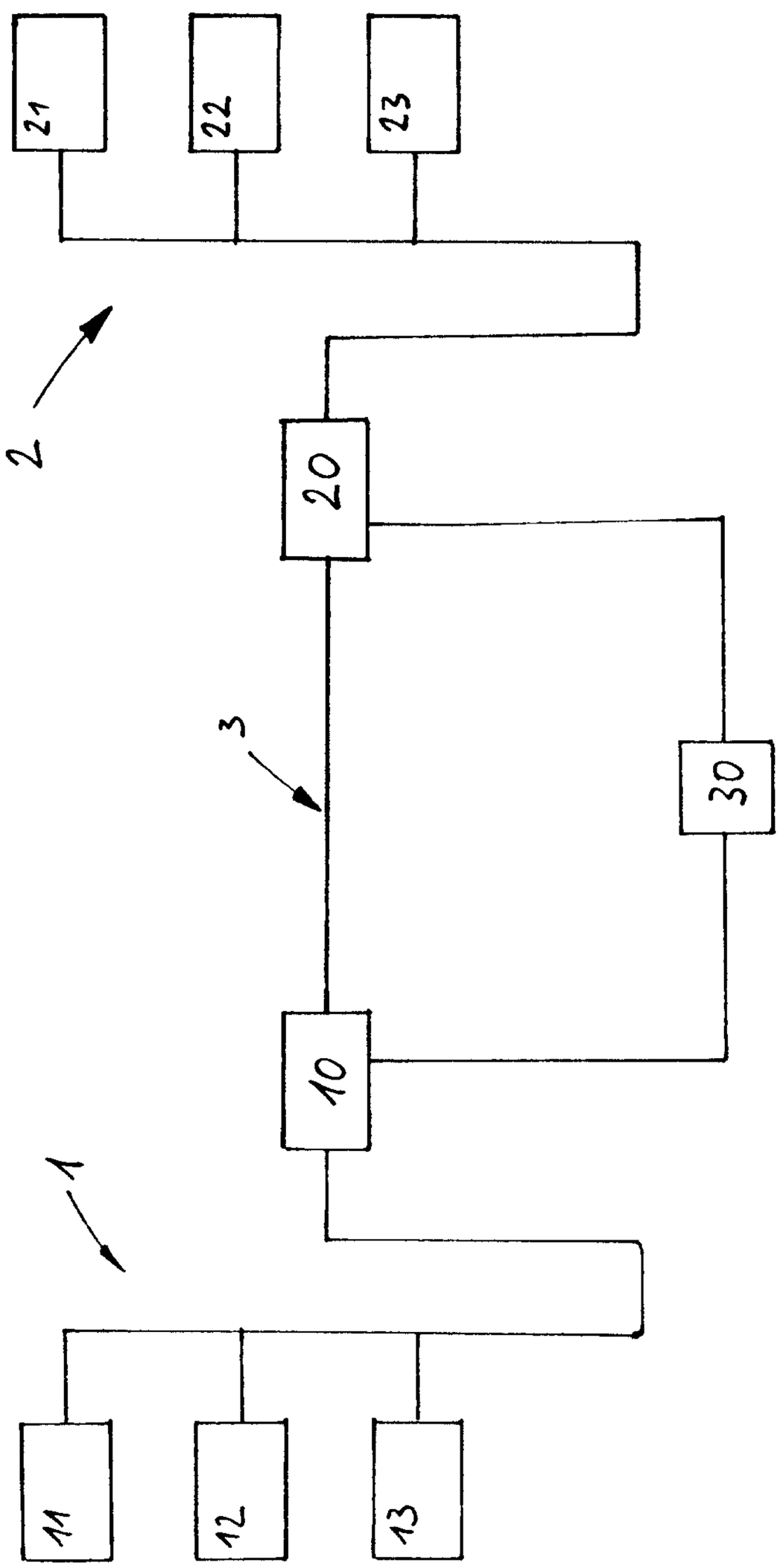


Fig. 1

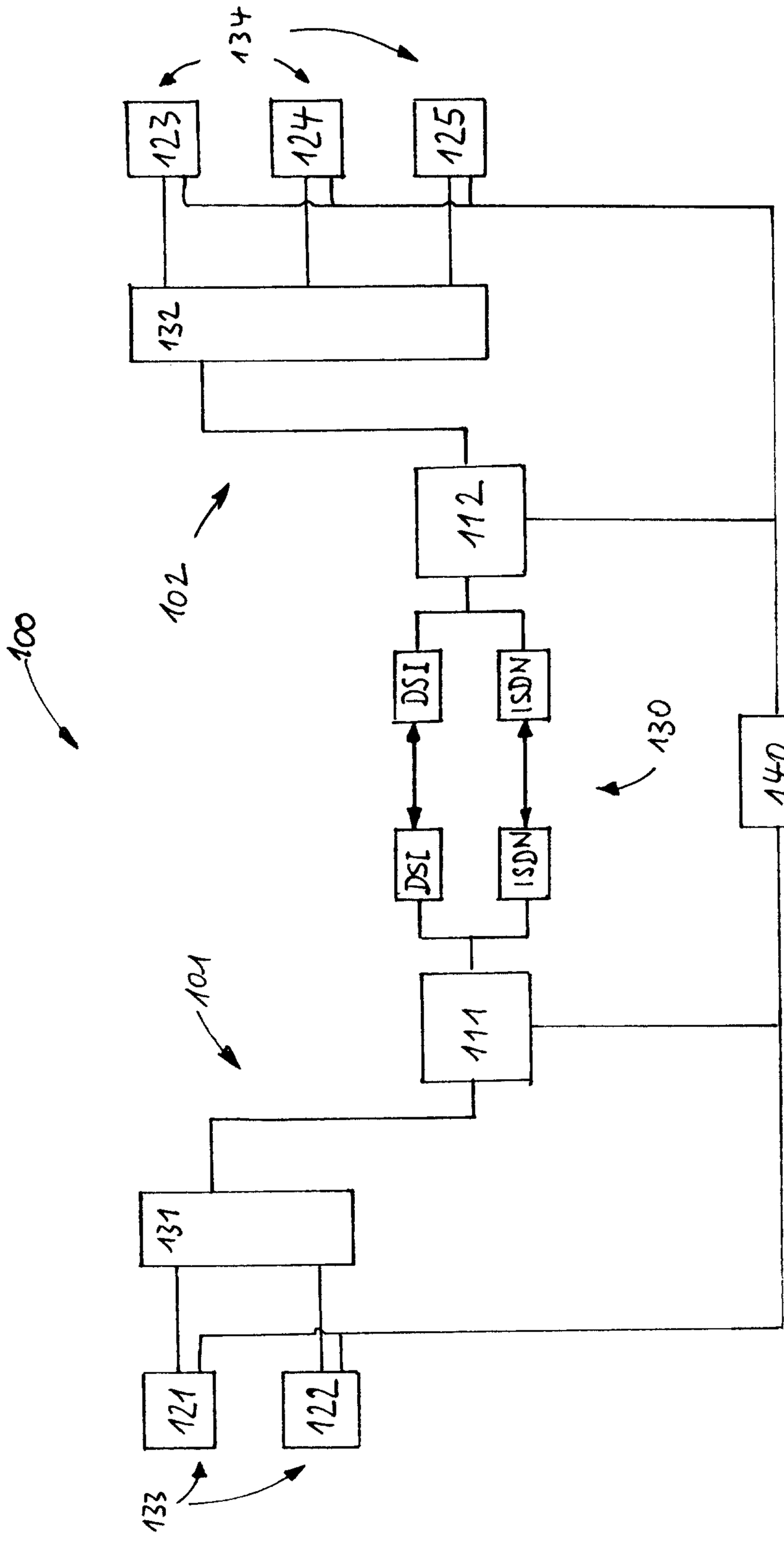

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Fig. 2