



CLAIMS

- 5 1. A communications network management system, for managing a network which comprises a plurality of nodes connected by traffic links and wherein communication services can be provided to customers according to predetermined service parameters by allocating selected links and nodes to said services on a priority basis, the management system comprising a distributed control system
- 10 which in turn comprises co-operating intelligent software agents, said software agents individually having control over the configuration of one or more allocated nodes of said plurality of nodes, and thereby having control with respect to communications services provided via said allocated node or nodes,
- wherein at least two of said agents are each provided with:
- 15 a) communication means for communicating with other agents;
- b) associated data storage for holding data which is local to the agent, in respect of the network;
- c) updating means for updating data in the data storage;
- d) decision-making intelligence; and
- 20 e) a control output for issuing control signals to an allocated node or nodes, the distributed control system providing reconfiguration of the network by means of said control signals in response to a customer request, by reconfiguration of one or more of said plurality of nodes subsequent to a decision-making process initiated amongst said agents, using said decision-making intelligence and
- 25 communication means, and based on parameters of said customer request modified in accordance with said priority basis.
2. A system according to Claim 1 wherein the communication means comprises message handlers for queuing messages received by the agent.
- 30 3. A system according to either one of the preceding Claims wherein the data storage is also for holding data which is global to the network.

AMENDED SHEET

CLAIMS

1. A communications network management system, for managing a network which comprises a plurality of nodes connected by traffic links and wherein communication services can be provided to customers according to predetermined service parameters by allocating selected links and nodes to said services on a priority basis, the management system comprising a distributed control system based on which in turn comprises co-operating intelligent software agents, said software agents individually having control over the configuration of one or more allocated nodes of said plurality of nodes, and thereby having control with respect to communications services provided via said allocated node or nodes,

wherein a change in communications services provided by said network can be established at least two of said agents are each provided with:

- a) communication means for communicating with other agents;
- b) associated data storage for holding data which is local to the agent, in respect of the network;
- c) updating means for updating data in the data storage;
- d) decision-making intelligence; and
- e) a control output for issuing control signals to an allocated node or nodes.

the distributed control system providing reconfiguration of the network by means of said control signals in response to a customer request, by reconfiguration of one or more of said plurality of nodes subsequent to a decision-making process initiated amongst said agents, using said decision-making intelligence and communication means, and based on parameters of said customer request modified in accordance with said priority basis.

2. A system according to Claim 1 wherein the communication means comprises message handlers for queuing messages received by the agent.

3. A system according to either one of the preceding Claims wherein the data storage is also for holding data which is global to the network.

4. A system according to any one of the preceding Claims wherein the decision-making intelligence is provided by generic agent code, incorporating one or more algorithms.

5. A system according to Claim 4 wherein at least one of the algorithms is a distributed routing algorithm.

26. A communications network management system, for managing a network which comprises a plurality of nodes connected by traffic links, wherein communication services can be provided to customers according to predetermined service parameters by allocating selected links and nodes to said services on a priority basis, the management system comprising a distributed control system based on which in turn comprises co-operating intelligent software agents, said software agents individually having control over the configuration of one or more allocated nodes of said plurality of nodes, and thereby having control with respect to communication services provided via said allocated node or nodes,

wherein at least two of said agents are each provided with:

- a) communication means for communicating with other agents;
- b) associated data storage for holding data which is local to the agent, in respect of the network;
- c) updating means for updating data in the data storage;
- d) decision-making intelligence;
- e) failure detection means for detecting failure of a neighbouring agent; and
- f) means for outputting a bid value.

the distributed control system being such that, on failure of an agent, one or more neighbouring agents are alerted to detects said failure and initiates a bidding process, each of said the neighbouring agents putting forward a outputting bid values based on parameters weighted so as to give, in combination, an estimate of each agent's suitability to take over some or all responsibilities of said failed agent, the neighbouring agent putting forward outputting a winning bid value thereafter asserting said responsibilities.

37. A network management system according to either any one of the preceding claims, wherein there is more than one type of software agent, there being provided

service management agents which have direct control outputs to one or more of said nodes of the network, and customer agents, each of which customer agents is associated with at least one service management agent, but has no direct control output to a node of the network.

48. A network management system according to ~~claims 2 and 3~~ 6 and according to claim 7 insofar as it is dependent on claim 6, wherein the bid value "F" for a neighbouring agent is calculated according to the function:

$$F = w_1 C + w_2 R + w_3 O + w_4 M$$

where C, R, O and M are parameters computed in respect of connectivity, service responsibility, occupancy and management load for that neighbouring agent, and w_1 , w_2 , w_3 and w_4 are weighting factors, w_3 and w_4 being negative.

59. A network management system according to claim 48, wherein connectivity is allocated the greatest weighting factor.

610. A method of reconfiguring a communications network in response to a requirement for a change in communications services available by means of said network, wherein the network comprises a plurality of reconfigurable nodes connected by links for carrying traffic, and wherein there is provided a management system comprising a community of co-operating software agents having management control over the configuration of allocated nodes of said network, wherein at least two of said agents are each provided with:

- a) communication means for communicating with other agents;
 - b) associated data storage for holding data which is local to the agent, in respect of the network;
 - c) updating means for updating data in the data storage;
 - d) decision-making intelligence; and
 - e) a control output for issuing control signals to an allocated node or nodes.
- the method comprising the steps of:
- i) receiving said requirement for a change at the management system;
 - ii) initiation of a negotiation process negotiating amongst at least some of said software agents, the negotiation process being based on by means of said communication means, to determine a node or nodes for reconfiguration to provide said

change, taking into account constraints including relative priorities allocated to said communication services; and

iii) outputting a reconfiguration control output from one or more of said software agents to one or more nodes of the network in accordance with the outcome of said negotiation process signal to the node or nodes so determined, from the control output of the agent or agents to which the node or nodes are allocated, to provide said change.

711. A method according to claim 610, wherein said change in communication services comprises new service provision.

812. A method according to claim 610, wherein said change in communication services comprises reconfiguration of said network in order to reinstate services subsequent to failure of one or more elements of said network.

913. A method of managing a communications network, said network comprising a plurality of nodes connected by links for carrying communications traffic, and wherein there is being provided with a management system comprising a community of software agents, individual ones of which control outputs to one or more allocated nodes of the network, at least two of said agents being provided with:

wherein, on failure of a software agent, a bidding process is initiated in said community of software agents, at least one agent outputting a bid function F representing weighted values of parameters relevant to that agent in respect of taking over the responsibility of the failed agent, and, on completion of said bidding process, the agent which has output the most favourable bid function F assumes one or more responsibilities of said failed agent.

a) communication means for communicating with other agents;

b) associated data storage for holding data which is local to the agent, in respect of the network;

c) updating means for updating data in the data storage;

d) decision-making intelligence;

e) failure detection means for detecting failure of a neighbouring agent; and

f) means for outputting a bid value.

which method comprises the steps of:

i) detecting failure of a software agent by means of said failure detection means;

ii) responding to said failure by initiating a bidding process in said community of software agents, at least one agent outputting a bid value F representing weighted values of parameters relevant to that agent in respect of taking over the responsibility of the failed agent;

iii) on completion of said bidding process, identifying the agent which has output the most favourable bid value F; and

iv) transferring one or more responsibilities of said failed agent to the identified agent.

104. A network management system according to any one of claims 1, 2, 3, 4 or 5 1 to 9 wherein each software agent having control over the configuration of one or more nodes of the network has an associated database data storage comprising data which is incomplete with respect of to the network as a whole, but complete in respect of local data enabling the agent to exercise said control.

145. A method according to claim 913, wherein the agent which assumes the responsibilities of said failed agent downloads data from said failed agent as an initial step in said assumption of responsibilities. step iv) includes the downloading of data from said failed agent to the identified agent.