

NODE APPARATUS HAVING AN ALTERNATIVE

SUBSYSTEM FOR DATA TRANSMISSION

1 The present invention relates to a node
apparatus contained in a local area network.

 A local area network (LAN) is utilized as a
network for making high speed data transfer in a middle
5 distance (several tens km at its maximum) range. In
general, this local area network is composed of node
apparatuses for performing reproduction, repeating and
processing of signals; transmission paths for connecting
these node apparatuses with each other; and terminal
10 devices connected to the respective node apparatuses.

 Some of the LANs employ duplicated communication
paths, and the node apparatuses employed therein comprise
duplicated subsystems.

 Fig. 1 is a functional block diagram showing an
15 arrangement of a conventional node apparatus as a first
example thereof. In a node apparatus 8 shown in Fig. 1,
reference numeral 1 indicates a first subsystem and
reference numeral 2 denotes a second subsystem. With such
first and second subsystems, this node apparatus 8 has a
20 structure of a duplicated internal module. Reference
numeral 3 indicates a switching control section for
switching the operating/waiting conditions between the
first and second subsystems 1 and 2. In the first and
second subsystems 1 and 2, reference numerals 4 and 5
25 denote control sections, and reference numerals 6 and 7

1 represent shared memories, respectively. Then, the
writing of the operation management information is
performed commonly via these shared memories 6 and 7 under
the control of the control sections 4 and 5 between the
5 first and second subsystems.

The operations of the conventional node
apparatus 8 shown in Fig. 1 will be described. In Fig. 1,
when a state change occurs in the conventional network,
for instance, the control section 4 employed in the first
10 subsystem 1 in operation recognizes this state change and
then writes this state change into the shared memory 6.
This state change is simultaneously written into the
shared memory 7 employed in the second subsystem 2 which
is in the waiting condition. The control section 5 in the
15 second subsystem 2, which is in the waiting condition,
reads the operation management information of the control
section 4 in the first subsystem 1 from the shared memory
7, so that both of the first and second subsystems 1 and 2
are allowed always to share the same operation management
20 information.

Next, another operation of the conventional node
apparatus 8 in which a failure or fault happens to occur
will be described. When a failure or fault happens to
occur in the first subsystem 1 in an operation condition,
25 the control section 4 in the first subsystem 1 informs the
occurrence of the failure or fault to the switching
control section 3, otherwise, the switching control
section 3 detects a failure informing signal from the

1 control section 4 in the first subsystem 1. Then, the
switching control section 3 operates to stop the operation
of the control section 4 in the first subsystem 1 in order
to remove it from the redundant arrangement and, at the
5 same time, to switch the control section 5 of the second
subsystem 2 to be put into operation. With such a
processing operation, the operation of the node apparatus
8 can be continued so that the operation of the network
can be executed without any interruption.

10 As described above, even when one of the
duplicated subsystems happens to fail in the conventional
node apparatus 8, the operation of the network may be
continued without any interruption by virtue of the
duplication switching function of the switching control
15 section, namely, such a function that an operation
condition of one subsystem in an operating condition, in
which a failure has happened to occur, is switched to the
other subsystem in a waiting condition.

However, in the above described conventional
20 node apparatus 8, if a failure happens to occur in the
switching control section 3 itself which is not
duplicated, there is a problem that the intended
duplication switching function cannot be performed.

Next, Fig. 2 is a schematic block diagram
25 showing a conventional node apparatus 9 having the
above-described duplicated subsystems, as a second example
of the conventional node apparatus.

In Fig. 2, the node apparatus 9 comprises a

1 first subsystem 21a, a second subsystem 21b and a
switching control section 22 commonly used therefor.
Thus, this node apparatus 9 is duplicated by the first
subsystem 21a and second subsystem 21b. The switching
5 control section 22 switches the operating/waiting
conditions between the first subsystem 21a and second
subsystem 21b. The first subsystem 21a comprises a
control section CTa and a shared memory MRa. Similarly,
the second subsystem comprises a control section CTb and a
10 shared memory MRb. Reference numeral 23 indicates a
central monitoring control apparatus which transmits/
receives connection information and monitoring information
via the duplicated communication paths 24a and 24b between
the control section CTa and control section CTb employed
15 in this node apparatus 9.

Then, the operation of the above-described
conventional node apparatus 9 with the above-explained
functional arrangement, upon occurrence of a fault, will
now be explained.

20 Fig. 3 illustrates an operation sequence of this
node apparatus 9 when a fault or failure happens to occur
therein.

When a failure or fault happens to occur in the
first subsystem 21a (time point ta), the first subsystem
25 21a sends a duplication switching instruction to the
switching control section 22 as far as the first subsystem
21a can do so (time point tb). Otherwise, if this
procedure of the first subsystem 21a can not be performed

1 appropriately, the switching control section 22 detects a
factor which requires the duplication switching operation
(time point tb'). Then the switching control section 22
sends an interruption instruction informing a duplication
5 state change to the second subsystem 21b (time point tc).
Then, the second subsystem 21b, which have recognized this
interruption instruction, informs this state change to the
central monitoring control apparatus 23 (time point td).

As described above, it is possible for the
10 above-described conventional node apparatus 9 having such
a functional arrangement to inform a change of the
duplicated condition, upon occurrence of a failure.

However, in the conventional node apparatus 9,
there is another problem that, although the occurrence of
15 a failure is reported to the central monitoring control
apparatus 23, the details of the failure and the place,
where the failure has actually occurred, cannot be
determined.

The present invention has been made in an
20 attempt to solve the above-described problems.

Thus, the present invention proposes to provide
such a node apparatus capable of dealing with a failure or
fault occurring in a switching control section having a
duplication switching function.

25 According to the present invention, there is
provided a node apparatus in a local area network
including duplicated communication paths, which node
apparatus has duplicated subsystems, each thereof

1 monitoring an operating condition of its own, said
duplicated subsystems comprising:

storage means for storing therein operating
condition monitoring information obtained by the monitor-
5 ing operation of each of the duplicated subsystems, and
for simultaneously causing the monitoring information to
be stored in an opposite subsystem continuously; and

duplicated switching means having an operation
switching function to switch an operating condition from a
10 failed subsystem to the other subsystem when one of the
duplicated subsystems happens to fail,
whereby one subsystem in normal operation in the
duplicated subsystems is continuously kept in operation
without interrupting the operation switching function.

15 The present invention will now be further
described by way of example with reference to the
accompanying drawings, in which:

Fig. 1 is a schematic block diagram showing an
arrangement of a conventional node apparatus as a first
20 example thereof;

Fig. 2 is a schematic block diagram showing an
arrangement of a conventional node apparatus as a second
example thereof;

Fig. 3 schematically illustrates an operation
25 sequence of the second conventional node apparatus; and

Fig. 4 is a schematic block diagram showing an
arrangement of a node apparatus according to an
embodiment of the present invention;

Fig. 4 shows an arrangement of a node apparatus 10 according to the first embodiment of the present invention. In the node apparatus 10 shown in Fig. 4, reference numeral 11 indicates a first subsystem, and reference numeral 12 represents a second subsystem, each of which has a form of a duplicated internal structure module. In each of the first and second subsystems, reference numerals 13 and 14 indicate control sections, and reference numerals 15 and 16 designate switching control sections both of which function as sections capable of switching the operating/waiting conditions between the first and second subsystems 11 and 12, respectively. Reference numerals 17 and 18 indicate shared memories disposed in the first subsystem 11 and second subsystem 12, respectively, through which operation management information is made available commonly to the control sections 13 and 14. Reference numerals 19 and 20 indicate power supply sections used to commonly feed the switching control sections 15 and 16, respectively. These power supply sections supply power to both of the

1 switching control sections 15 and 16 in a parallel mode.
It should be noted that, although the shared memories 17
and 18 and also the control sections 13 and 14 in the
first and second subsystems 11 and 12 are energized by the
5 other power supply systems, respectively, which are
different from the above-described power supply sections
19 and 20, said power supply systems are not shown.

There is a master/slave relationship between the
switching control section 15 of the first subsystem 11 and
10 the switching control section 16 of the second subsystem
12, so that one of these switching control sections 15 and
16 becomes the master to take the initiative in the
switching control, and a control section on the same side
with the switching control section of the slave side is
15 subordinate to an instruction from the switching control
section in the subsystem on the master side, and further
the switching control section on the slave side keeps the
states of its instructions to the respective control
sections always identical with those of the switching
20 control section on the master side. Furthermore, since
the respective switching control sections 15 and 16 are
always fed by both of the power supply sections 19 and 20,
both the switching control sections 15 and 16 can operate
even when one of the power supply sections 19 and 20
25 happens to fail.

The operation of the node apparatus 10 according
to the first embodiment of the present invention will be
described. In the node apparatus 10 of the first

1 embodiment, it is assumed that the first subsystem 11 is
in an operating condition, while the second subsystem 12
is in a waiting condition, and the switching control
section 15 of the first subsystem 11 functions as the
5 master, while the switching control section 16 of the
second subsystem 12 functions as the slave.

Firstly, a description will be made of a case
where the switching control section 15 of the first
subsystem 11 happens to fail. Upon occurrence of a
10 failure in the switching control section 15 functioning as
the master, the switching control section 16 functioning
as the slave in the second subsystem 12, which is always
monitoring the state of the switching control section 15
in the opposite subsystem 11, detects this failure with
15 higher priority as compared with other failure factors,
and becomes a master switching control section by itself.
At the same time this new master switching control section
16 instructs the old master switching control section 15
to become a new slave switching control section, and
20 further sends an information of the master/slave change of
the switching control sections to the control section 14
of the second subsystem 12. As a result, when such a
failure happens to occur in the duplicated subsystems, the
control section 13 of the first subsystem 11 receives an
25 instruction of the change of the operating/waiting
conditions from the old slave switching control section 16
of the second subsystem 12, whereby the operation of the
node apparatus 10 can be continued.

1 Next, a description will be made of operations
at the time when a power supply section for a switching
control section happens to fail.

 As explained before, even when the switching
5 control sections are duplicated, if power supply sections
therefor happen to fail, a satisfactory operation thereof
cannot be expected. Therefore, the operation reliability
of the subsystems may be improved by employing duplicated
power sources belonging to a power system different from
10 that of the other power supply sections for other
component units in the subsystems. These duplicated power
sources may be constructed to supply power to the above-
described duplication switching control sections in a
parallel mode to thereby elevate the reliability of the
15 operation of the subsystems. Even when the power supply
section 19 for supplying power to the switching control
section 15 in the first subsystem 11 happens to fail, for
instance, when power supply is interrupted or a voltage
drop occurs, since this switching control section 15 is
20 also fed by the power supply section 20 in the second
subsystem 12, the setting of the operating/waiting
conditions of the first and second subsystems 11 and 12
and the master/slave relationship between the switching
control sections 15 and 16 may be maintained in the same
25 state.

 Thus, in accordance with the above-described
first embodiment, even when one of the switching control
sections 15 and 16 happens to fail, the switching to the

1 other switching control section can be performed
smoothly. Furthermore, since it is so constructed that
each of the power supply sections supplies power to both
of the switching control sections 15 and 16 in a parallel
5 mode, even if any one of the power supply sections 19 and
20 for feeding the switching control sections 15 and 16,
respectively happens to fail, the operations of the
switching control sections are not put into disorder.

As is apparent from the foregoing explanation of the embodiment, there is obtained a particular advantage that, since the switching control sections, which control the switching operations for the operating/ waiting conditions between the duplicated subsystems in the node apparatus, are also duplicated, even when one of the switching control sections fails, the duplication switching function may be maintained. Furthermore, since the power supply sections for the respective duplicated switching control sections are disposed independently and separately from power supply sections for other component units and besides they are duplicated to be able to supply power to both of the duplicated switching control sections in a parallel mode, an overall normal operation of the node apparatus can be assured even when a failure occurs, and furthermore the reliability of the network system against various failures or malfunctions can be elevated.

CLAIMS:

1. A node apparatus in a local area network including duplicated communication paths, which node apparatus has duplicated subsystems, each thereof monitoring an operating condition of its own, said duplicated subsystems comprising:

storage means each for storing therein operating condition monitoring information obtained by said monitoring operation of each of said duplicated subsystems and simultaneously for always making the operating condition monitoring information be stored in said storage means of opposite one of said duplicated subsystems; and

duplicated switching control means each thereof having an operation switching function to switch the operation of said duplicated subsystems from failed one of said duplicated subsystems to the other normally operable one of said duplicated subsystems when either one of said duplicated subsystems happens to fail, whereby said node apparatus continuously maintains normally operable one of said duplicated subsystems in an operating condition, without interrupting the operation switching function of said node apparatus.

2. A node apparatus as claimed in Claim 1, wherein each of said duplicated switching control means



is simultaneously fed by duplicated power supplies which are provided independently from power supplies for circuit portions other than said duplicated switching control means in said duplicated subsystems.

3. A node apparatus as claimed in Claim 1, wherein each of said duplicated subsystems comprises a control section for performing at least one of a condition monitoring operation for monitoring a condition of a communication path connected to said duplicated subsystem itself, a communication control operation for controlling communication with other node apparatuses, and a condition monitoring operation for monitoring operating conditions of respective portions of said node apparatus, and

wherein:

each of said storage means is arranged to be shared by said duplicated subsystems, respectively, and to continuously store therein operation management information of said duplicated subsystem of its own under the control of said control section;

said control section is constructed to continuously have the operation management information of said duplicated subsystem of its own stored in said shared storage means of said duplicated subsystem of its own and to simultaneously have the same operation management information stored in said shared storage



means of the opposite duplicated subsystem under a normally operating condition, and, on the other hand, to have failure information of said duplicated subsystem, in which a failure has happened to occur, stored in both of said shared storage means of said duplicated subsystems in addition to the operation management information, upon occurrence of the failure of said duplicated subsystem; and

each of said duplicated switching control means is constructed to instruct operation switching to said control section of normally operable one of said duplicated subsystems, upon receipt of at least one of an operation switching instruction from opposite failed one of said duplicated subsystems and a failure detection signal from the failed duplicated subsystem.

4. A node apparatus as claimed in Claim 3, wherein each of said duplicated switching control means is constructed to execute an interruption processing to send duplicated condition change information which instructs the operation switching to said control section of the normally operable one of said duplicated subsystems, upon receipt of at least one of the operation switching instruction and the failure detection signal from said control section of the opposite failed duplicated subsystem, whereby said control section of the normally operable duplicated



subsystem reads, from said shared storage means of said duplicated subsystem of its own, the operation management information and the information about the content of the failure, when the interruption processing has been executed by said duplicated switching control means.

5. A node apparatus substantially as hereinbefore described with reference to and as shown in Figure 4 of the accompanying drawings.