Stability of the SpaceWire Network's Time-Code Mechanism to Various Failure Types

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Abstract

The time-code mechanism uses for synchronization of SpaceWire networks components.

There are a special auxiliary characters which are used in the time-code mechanism. Its name is Time-codes. The time-code mechanism is subject to a number of errors. In this article these errors and time of restoration of system after failure are considered.

INDEX TERMS: SPACEWIRE, TIME-CODE, REALTIME

I. INTRODUCTION

The Time-codes are a symbol with highest priority that allows them to pass through a network with minimum delays, even under strong congestion.

For Time-code are using 6 bits, that allows to encode 64 different values (from 0 to 63).

Time-code source is a terminal node (source-node). After sending Time-codes in network, devices which will received them, should handle them. Sending Time-codes is broadcasted.

When device receives a Time-code, it compares new value with old. If new value is correct (value greater than 1), the device should write it over the old value and broadcast this Time-code further in network. Each device which is accepting Time-code, should pass it to all ports, besides the port through which it are received. If new Time-code value is not correct (value greater more than 1 or less old value), then device rewrites value of Time-code in itself, but doesn't broadcast it further in network. (See Fig. 1).

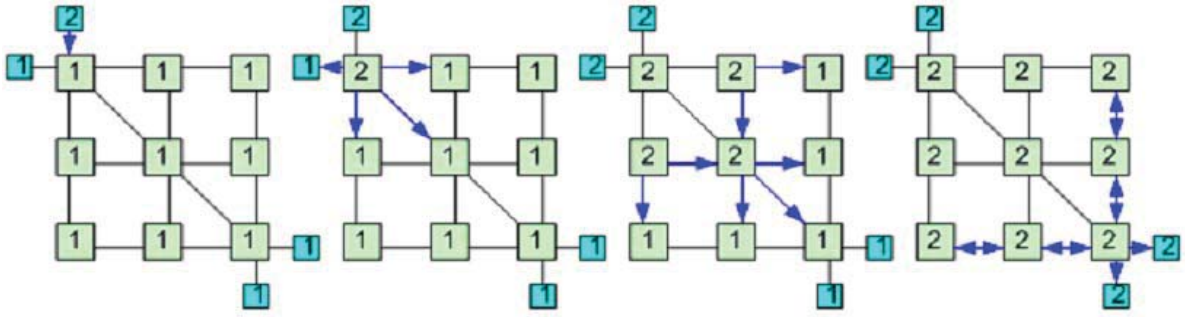

Fig. 1: Time-code broadcast

II. MAIN PART

Stability of the Time-code mechanism depends on success of time-codes spreading. But the mechanism is not insured from the errors occurring at a time - codes transmission. It is important to know possible types of errors and time after error occurrence for which in system transmission of correct codes will be restored.

There are 3 possible type of error in Time-code mechanism:

A. Loss Time-code

Loss of Time-code can be the result of transmission failure on data link. (See Fig. 2)

Loss of Time-code leads to the following results:

- is temporarily disrupting mechanism of transmission of time-codes,
- the subsequent devices will receive an invalid value.

Let's consider parameters of this error in more details for determine the time of restoring after failure.

All parameters depend on topology of a network, a speed and a length of information transfer channel. The grid type topology without links between levels requires sending the same quantity Time-codes as the tree type topology.

After loss Time-code it is necessary to send quantity of time-codes equal quantity of transitions of the shortest path from the source-node to most remote from it node ($N_{tc} = P_{Max}$).

System restoring time will be:

$$T_{recovery} = (N_{tc} - 1) * T_{gener} + P_{Max} * T_{trans},$$

T_{gener} - the period of generation Time-codes

T_{trans} - time of passing a signal between devices.

Number of necessary to sending the codes is reduced by adding to the topology of the network of additional links between levels. $N_{tc} = P_{Max} - K$, where K – a number of “skip” levels.

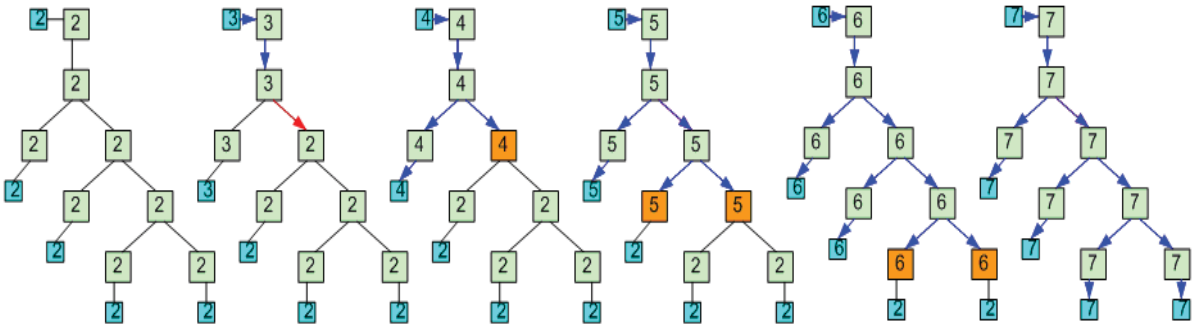

Fig. 2: Loss Time-code

B. Not expected appearance of Time-code

There are two types of codes which not expected:

- The value greater than expected
- The value less than expected

The value less than expected can appear after an error in the time-code source, after signal distortion of transmission through a data link.

The code greater than expected can appear after an error in the time-code source, after signal distortion of transmission through a data link or after loss signal in transfer (then a expected signal greater than 1).

If device receives not expected time-code (it is greater or less expected code) is the same situation with the loss time-code. (See Fig. 3)

The number of correct time-codes which is necessary for sending after receiving of an invalid code is $N_{tc} = P_{Max}$.

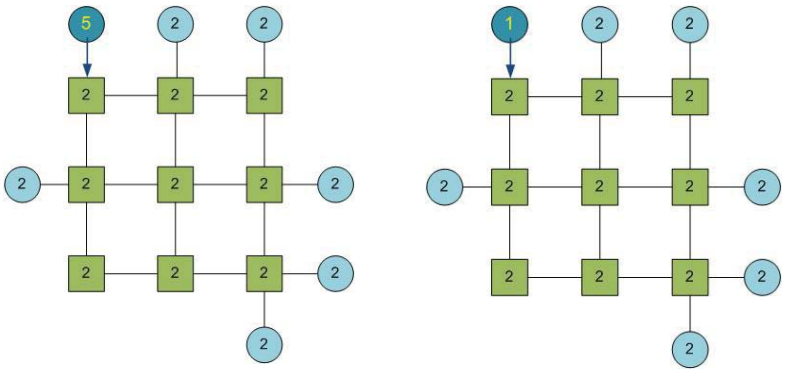

Fig. 3: Not expected appearance of Time-code

3. Appearance Second Time-code source

The reason of this error is the node, which was started broadcast time-codes, without being the main source-node in a network.

In this case we have two waves of time-codes spread which aimed each other. (See Fig. 4)

Restoring after this error is reduced to restoring after error not expected appearance time-code.

In case of appearance the second source of time-codes (device) at grid topology type it is necessary to transmit 2 valid codes for restoring system.

In a case if source #1 and a source #2 are connected to one router the task is reduced to restoring after recieving not expected time-code. $N_{tc} = P_{Max}$.

In a case if the second source of time-codes is the router, duration of restoring depends on presence links between levels and number of the nodes which are linked to the given device. At worst this task reduced to restoring after reception of not expected time-code. $N_{tc} = P_{Max}$.

At the tree type topology (without links between levels and cycles) problem is reduced to the task of not expected code appearance. In this case P_{Max} will be equal to path from the last node containing a correct time-code, to the node most remote from it.

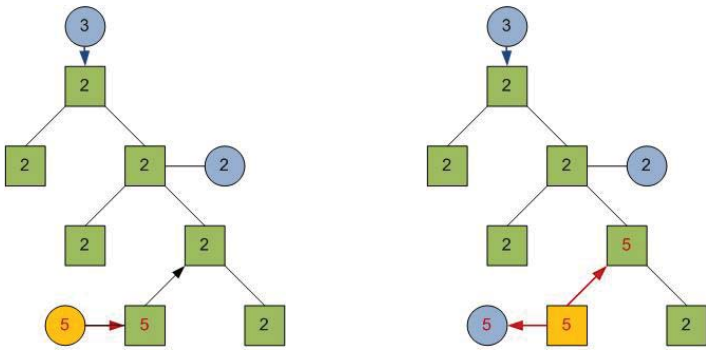

Fig. 4: Second Time-code source appearance

III. CONCLUSION

After considering different Time-code propagation error types and different network structure we can make a conclusion that then higher the connectivity of the network then faster it recovers from transmission erroneous time-codes.