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MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS (ANALOGUE)

FUNCTIONAL ORGANIZATION FOR AUTOMATIC TRANSMISSION RESTORATION

ITU-T Recommendation M.496

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation M.496 was published in Fascicle IV.1 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Recommendation M.496

FUNCTIONAL ORGANIZATION FOR AUTOMATIC TRANSMISSION RESTORATION

This Recommendation is a description of the functional organization for three general types of automatic transmission restoration systems:

- 1+1 transmission restoration;
- N+M direct transmission restoration (protection link switching);
- N+M automatic rerouting (protection network switching).

The terminology and general principles of transmission restoration are described in Recommendation M.495. Specifications for equipment of the 1+1 restoration system type can be found in Recommendation G.181 [1]. Specifications for equipment of the N+M direct transmission restoration or automatic rerouting system type can be found in Recommendation G.180 [2].

1 1+1 transmission restoration

1.1 *Purpose of 1+1 transmission restoration*

1.1.1 1 + 1 restoration is used for the restoration of one group or digital block or link on one restoration link that is dedicated to its transmission restoration.

1.1.2 This type of restoration is generally reserved for specific services with a need for a very high availability.

1.1.3 As this method of restoration is rather expensive (duplication of transmission links), it is often effected, at the present time, at low hierarchichal levels (for example, group or primary digital block). This is a preventive protection, adapted to specific services, whereas restoration at the highest order group or digital block is a corrective protection for part of the network.

Figure 3/M.495 illustrates such a configuration.

1.2 *Method of transmission restoration*

1.2.1 The transmission signal is sent on the normal link and generally also on the restoration link at the same time.

1.2.2 In order to ensure the best availability of transmission, it is recommended to have the restoration link routed on a transmission route different from the route of the normal link.

1.2.3 Control equipment or a control function implemented in equipment with other functions, at both ends of the link, ensures link supervision and control and detects the occurrence of such conditions that may need a restoration action. Generally, there is no control circuit in such a transmission restoration system: control and switching can be done at both receive ends of the signal.

When a fault has been detected and confirmed, the switching equipment receives a command for a switching action.

1.2.4 If a switchback function is provided, when the normal link becomes available again for transmission, it is advisable to perform the switchback at a time when there is the least impact on the traffic concerned. At that time, a switching command is sent by the control equipment. The switching equipment switches back the transmission to the normal link.

This switching is normally effected in such a way that it has minimal impact on transmission quality and availability.

1.3 *Restoration time*

Restoration time should be kept as short as possible, in order to have minimal impact on service availability.

2 N+M direct transmission restoration (protection link switching)

2.1 *Purpose of N+M direct transmission restoration*

N+M direct transmission restoration systems provide M restoration links for N normal links. All the links have their terminal equipments located at the same locations.

Figure 1/M.495 illustrates such a configuration.

2.2 *Method of transmission restoration*

2.2.1 The M restoration links may be routed on the same transmission route as all, or part, of the N normal link; but preferably, some restoration links may be routed over a different route, so that a fault of a whole transmission route allows the restoration of some links.

2.2.2 This type of transmission restoration can be effected at all hierarchical levels. It is often used at the transmission system level.

2.2.3 At both ends of the links, control equipment (or a control function implemented in equipment) ensures link supervision and control, and detects the occurrence of a failure. The control circuits for this function might be on a restoration link, or on another link which is not one of the N normal links, or duplicated on at least 2 of the N normal links.

2.2.4 Some of the N normal links might have a higher priority. In this case, when one of them is in fault, it is restored in priority and can use a restoration link on a preemptive basis. This means that:

- in case of a simultaneous fault of several links, and if a complete restoration is not possible, only the highest priority links are restored;
- if all restoration links are in use and if a normal link having a priority of one of the restored links has a failure, the lower priority restored link is interrupted so that the link in fault can be restored.

2.2.5 When a restoration action has been detected, confirmed and accepted (restoration link available or priority link in fault), the switching equipment receives a command for a switching action. Switching might be effected at both ends systematically, but it is also possible to switch only the faulty direction, if necessary.

2.2.6 In the case of automatic switchback, after the normal link is available again for a normal transmission, the control equipment sends a switchback command. In this case, the switching equipment switches back the signal transmitted from the restoration link to the normal link. This switching is normally effected in such a way that it has a minimal impact on transmission quality and availability.

2.3 *Restoration time*

N+M direct transmission restoration is characterized by a requirement to detect a degraded or faulty normal link and switch to a restoration link in a time interval that is short enough not to cause established telephone calls to be released.

2.4 *Other considerations*

2.4.1 A restoration link might be used, when a restoration is not needed, for other purposes such as planned outages or non- priority traffic. In this case, it can be preferable that the N normal links have a preemption of the restoration link when they are in fault.

2.4.2 The maximum number N of normal links for one restoration has to be dimensioned correctly to avoid a too large number of non-restored faults. When a large number of links have to be restored, N+M direct transmission restoration (with $M > 1$) is necessary; in this case M restoration links can be used for the restoration of N normal ones.

2.4.3 The N+M direct transmission restoration is an automatic system, but it should also allow manual or semi-automatic (remote manual) actions, in order to force switching or inhibit restoration.

3 N+M automatic rerouting (protection network switching)

3.1 *Purpose of N+M automatic rerouting*

N+M automatic rerouting systems provide, on a single switching equipment, M restoration links to N normal ones. The restoration of 1 normal link is effected by a certain number of restoration links that are assembled together.

The restoration systems belong to a restoration network.

Figure 2/M.495 illustrates such a configuration.

3.2 *Method of transmission restoration*

3.2.1 At the present time, this type of restoration is generally effected at high hierarchical levels.

3.2.2 The organization of N+M automatic rerouting systems is generally complex: a network of normal links is protected by a network of restoration links.

There is a supervision and control of every link that can be done by or under the control of one or several restoration control centres. Restoration can be a specific function of a more general control centre.

3.2.3 After a failure is detected on a normal link, the restoration is normally effected according to certain preestablished restoration plans, if the restoration links are available. It is also possible to have a restoration plan computed after failure detection.

A certain number of restoration links are assembled together through switches located at the nodes of the network and connected to the faulty link through switches located at its ends.

3.2.4 It should also be possible to have manual or semi-automatic (remote-manual) action or inhibition of N+M automatic rerouting systems.

3.2.5 If a restoration plan fails or a restoration link used for a restoration has a failure, all restoration links involved in the restoration plan should be released.

3.2.6 After the fault of the normal link is removed, there can be a switchback to the normal link which should have a minimal impact on transmission quality and availability.

3.2.7 Certain equipment, such as automatic digital distribution frames, might have a function of N+M automatic rerouting but might not be dedicated to it.

3.3 *Restoration time*

As the operations of N+M automatic rerouting take network conditions into account, they can involve considerable data processing; they may entail all calls being claired or lost before the operations are completed. Restoration times can be in the order of seconds, minutes, or even hours, depending on the complexity of the network and its state at that moment.

3.4 *Other considerations*

3.4.1 Restoration links might be used under normal conditions by low-priority traffic. In this case, there is generally a preemption by normal traffic in case of normal link failure.

3.4.2 As the restoration network might not be dimensioned for the total restoration of all transmission route interruptions and multiple failures, it might be necessary to define certain priorities among normal links. In this case, certain links might be restored in priority with preemption of restoration links used by non-priority links.

References

[1] CCITT Recommendation, *Characteristics of 1+1 type restoration systems for use on digital transmission links,* Rec. G.181.

[2] CCITT Recommendation, *Characteristics of N+M type direct transmission restoration systems for use on digital sections, links or equipments,* Rec. G. 180.