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Traffic engineering – Determination of the number of circuits in automatic and semi-automatic operation

SERVICE PROTECTION METHODS

Reedition of CCITT Recommendation E.525 published in the Blue Book, Fascicle II.3 (1988)

NOTES

1 CCITT Recommendation E.525 was published in Fascicle II.3 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 E.525

SERVICE PROTECTION METHODS

1 Introduction

The objective of service protection methods is to control the grade of service for certain streams of traffic by restricting the access to circuit groups. Several methods are available, with the common feature that they may reject certain call attempts when the considered circuit group has little spare capacity. Service protection is generally used in alternative routing networks to restrict overflow traffic, but can also be used to give priority service to one class of traffic over another.

Failure or overload conditions may require temporary changes to service protection parameters. This is considered to be network management action which is described in the E.400 Series Recommendations.

Applications of service protection methods are described in § 2, and the available methods are described in § 3.

The use of service protection generally increases the complexity of dimensioning algorithms. Appropriate dimensioning algorithms are presented in § 4.

The choice between available methods will generally depend on performance characteristics and ease of implementation. These are discussed in §§ 5 and 6.

2 Applications

2.1 *Traffic routing*

2.1.1 *Overflow routing strategies – General principles*

Routing strategies that involve overflow often have direct first-choice (high-usage) routes, and indirect alternative routes. In conditions of traffic overload the proportion of alternatively-routed traffic increases rapidly, with the risk of severe degradation of network performance. Service protection methods should be used to prevent calls overflowing from a direct route to an alternative route when circuit groups on the alternative route are heavily loaded. In Figure 1/E.525, which shows a hierarchical case only for the sake of simplification, calls from A to B have a direct first-choice route and an alternative route via D. Exchange A should apply service protection on the circuit group AD. When AD is occupied over a certain limit, overflow calls (e.g. from AB) are rejected and priority is given to first-choice traffic (e.g. from A to C).

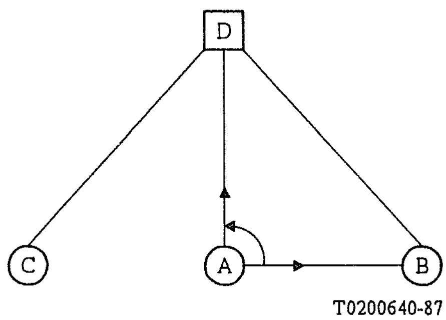

FIGURE 1/E.525

In Figure 1/E.525 traffic from A to B has access to two possible routes but traffic from A to C has only one. In this situation traffic from A to B is likely to experience a much better end-to-end grade of service unless service protection is used to restrict its access to AD. This control of grade of service allows optimal (minimum cost) dimensioning for planned traffic loads in addition to giving protection against heavy overloads.

2.1.2 *Fixed hierarchical alternative routing*

An example of fixed hierarchical alternative routing is illustrated in Figure 1/E.525. Here exchange D is a tandem exchange at a higher hierarchical level than A, B and C. Direct routes at the lower level (e.g. AB) overflow via the hierarchical route (ADB). This hierarchical route is always the final alternative routing. In such networks it is highly recommended to apply service protection to restrict traffic overflowing to final choice routes.

2.1.3 *Fixed non-hierarchical alternative routing*

This term describes routing strategies which are based on fixed sequences of alternative routes (as in hierarchical alternative routing) but which do not have a hierarchical final-choice route for all overflow traffic. Figure 2/E.525 may be used to illustrate some simple but common cases. Traffic from A to B has a first-choice route AB and an alternative ACB which is final to this traffic, while traffic from A to C may use AC as a first choice and then overflow to ADC. Traffic from D to B is either first offered to the route DAB and then overflowing to DCB or vice versa. The latter routing principle is commonly known as mutual overflow.

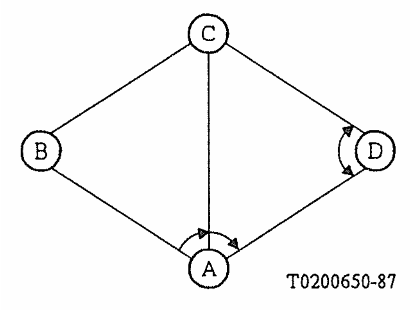

FIGURE 2/E.525

In both routing schemes a certain hierarchy is distinguishable. They are however non-hierarchical, in the sense that no hierarchical trunk group that is final to all its carried traffic can be found. The application of service protection methods may be less simple than for hierarchical routing, but the general principles presented in § 2.1.1 still apply.

2.1.4 *Dynamic routing*

Many different forms of preplanned or adaptive dynamic routing are possible, with either centralized or distributed control (see Recommendation E.170). One feature that is common to most dynamic routing schemes is the availability of a large number of potential alternative routes for any given connection. With this type of routing scheme, service protection is of crucial importance and has several special features:

– Protection should be stronger than with other overflow routing schemes (i.e. larger reservation parameters should be used).

– If possible, service protection should be applied on all circuit groups in an alternative route. This requires a certain amount of information-passing between exchanges or to a central processor.

– In connection with adaptive routing, the service protection concept can be used not only to block overflow calls but also in the selection of a good alternative route (generally this will be a route on which all circuit groups have at least a requested number of free circuits).

2.2 *Priority service*

Service protection methods can also be used to give priority service to one type of traffic, for example in a multiservice network, e.g. ISDN.

2.3 *Stability*

In order to provide stability in networks with non-hierarchical routing schemes, service protection should be used to restrict overflow traffic if that traffic overflows to an alternative route which is shared with first-choice traffic.

3 Available methods

3.1 *Split circuit group*

A straightforward technique is to divide a circuit group into two components. Priority traffic is allowed access to the whole circuit group, while non-priority (usually overflow) traffic is only allowed access to one component. Normally the priority traffic is offered first to the reserved component – this is then equivalent to a separate high usage group.

3.2 *Trunk reservation*

This method is also known as priority reservation system. Non-priority calls are accepted on the considered circuit group only when the momentary number of free circuits in that group observed at the arrival of a non-priority call exceeds a specified lower limit (irrespective of which particular circuits are free). Priority calls are always accepted if any circuits are free.

Trunk reservation may also be applied selectively, for example, to restrict call attempts to hard-to-reach destinations. This method is known as selective trunk reservation.

4 Evaluation and dimensioning

4.1 *Cluster engineering concept*

In hierarchical automatic alternative routing (AAR) a cluster consists of a final-choice circuit group together with those high usage groups from which traffic overflows to the final group. This cluster should be engineered as a whole. This implies firstly that grade-of-service (GOS) criteria should be applied to the whole cluster rather than separately to final groups. Secondly, the question of high-load dimensioning must be considered for the whole cluster. In order to meet normal and high load cluster GOS criteria in the most efficient way, the parameters of service protection methods must be determined appropriately as a part of the dimensioning process.

4.2 *Split circuit group*

With hierarchical AAR, the split final circuit group creates a separate high-usage group for first-choice traffic. This should be dimensioned so as to achieve the cluster GOS criteria. Standard evaluation methods that can be used include the Wilkinson Equivalent Random Traffic theory [1]. Interrupted Poisson Process methods can be used to give more precise evaluation [2], [3] and to evaluate network performance [4].

Split circuit groups may be useful to control GOS in non-hierarchical routing. The precise dimensioning and evaluation depends on the individual situation and it is generally more practical to use 1-moment methods of analysis [5], [6].

4.3 *Trunk reservation*

With hierarchical AAR, a trunk reservation parameter should be applied to the final group so as to achieve the cluster GOS criteria optimally for all traffic offered to the cluster. In most situations a small value of this parameter is appropriate. For evaluation of Poisson streams a recursion method is available which may be extended, using equivalent random traffic (ERT) techniques, into overflow situations [7]. Interrupted Poisson Process [3] methods can be used to give a more precise evaluation and to evaluate network performance [8].

For non-hierarchical strategies, 1-moment evaluation methods are again recommended. Simple recursion formulas are available for a circuit group using trunk reservation and offered Poisson traffics. 1-moment [7] methods can also be extended to give better accuracy by taking account of downstream blocking and traffic correlations [6] and [8].

5 Performance characteristics

5.1 *Efficiency*

Efficiency can be measured by traffic capacity at normal load subject to GOS criteria. In this respect there is little to choose between trunk reservation and split circuit group methods, provided each is correctly dimensioned.

5.2 *Overload protection*

The two service protection methods, trunk reservation and split final with a reserved high usage group, provide considerably better overload protection for first-choice-final traffic in cases of general and overflow overload than does the less usual method, split final with reserved final group.

5.3 *Robustness*

A significant advantage of trunk reservation is that it provides a robust performance profile with respect to traffic load variations (decreasing high priority traffic in combination with increasing low priority traffic) and reservation parameter settings. Independent of the trunk group size, traffic variations (which have not been forecasted) are relatively well carried.

With trunk reservation the same parameter value is likely to be optimal for a wide range of configurations at both normal load and overloads.

In contrast, the reserved section of a split circuit group should be redimensioned for different configurations and (when dimensioned according to the normal traffic load pattern) will not give optimal values at overload.

5.4 *Peakedness*

Changes in the peakedness of overflowing traffic have a slightly greater impact on the blocking probabilities within split circuit group arrangements in comparison with trunk reservation.

6 Implementation consequences

6.1 *Dimensioning methods*

Methods for the calculation of a split circuit group or a trunk reservation parameter are available [7], [9], [10].

6.2 *Traffic measurements*

Both service protection methods require the estimates of the first-choice-final traffic which is to be protected and the overflowing traffic from the high-usage trunk group(s) (i.e. measurements on a per destination basis).

With the split circuit group method, first routed traffic can be easily measured on a trunk group basis. With the trunk reservation method, measurements other than traditional are required to identify the first offered traffic.

6.3 *Operational aspects*

Since trunk reservation is a software controlled technique, protection for different traffic streams can easily be changed by changing parameters in the software. This allows temporary changes to be made under network management control. Precautions should be taken in such situations to restore design parameter values.

6.4 *Technology requirements*

Split circuit group methods can be installed in both electromechanical and processor controlled exchanges.

Trunk reservation may, in practice, only be realized in software as a conditional overflow facility and consequently only be installed in SPC exchanges.

Both methods require that the exchange have the ability to distinguish between priority and non-priority traffic.

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