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**Route Merging Problem found during Validation**

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SUMMARY

During the testing of TAR Release D, unexpected behaviour was observed during a test of the route merging algorithm. This problem was reported by Telegenics to Eurocontrol, where it was confirmed that the problem was due to errors in the SARPs specification for Route Merging. This paper has been prepared in order to record the problem found and the proposed solution.

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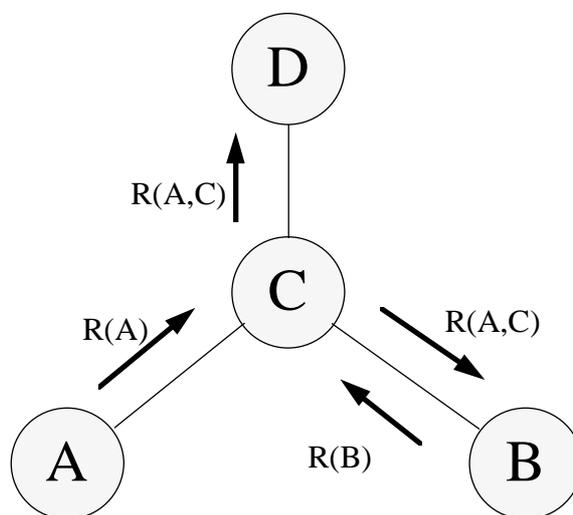
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## 1. Introduction

During the testing of TAR Release D, unexpected behaviour was observed during a test of the route merging algorithm. This problem was reported by Telegenics to Eurocontrol, where it was confirmed that the problem was due to errors in the SARPs specification for Route Merging. This paper has been prepared in order to record the problem found and the proposed solution.

## 2. Problem Statement

The Test Configuration in which this problem was found is illustrated in Figure 1. This illustrates four TAR systems (A, B, C and D), interconnected in a “Y” shaped configuration in order to test route merging at TAR System C. Initially, BIS-BIS connections are opened between C and D and A and C. The route R(A) is advertised from A to C, and then re-advertised as R(A,C) to D. A BIS-BIS connection from B to C is then opened, and route R(B) advertised from B to C. As R(B) has the same NLRI as R(A), and differs only in the security information it carries, the expected behaviour was to see R(A) and R(B) merged by C, and then advertised to D, replacing R(A,C).



**Figure 1 Test Configuration**

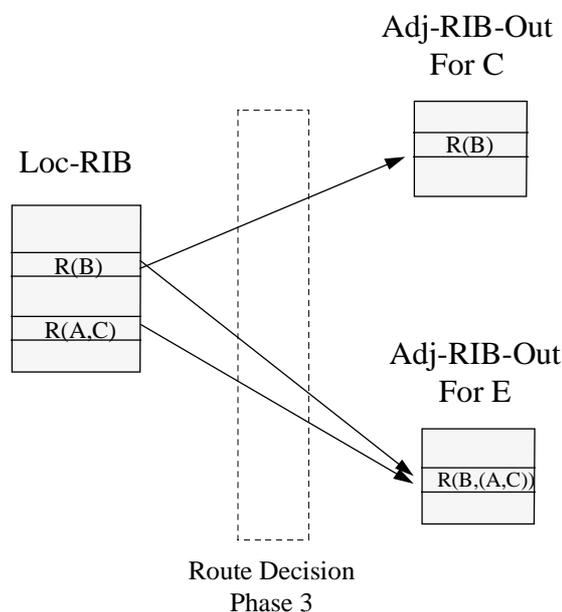
However, this is not what actually occurred. When the BIS-BIS connection between B and C was opened, R(A,C) was also (correctly) advertised from C to B. This was then merged by B with R(B). As the resulting merged route included the RDI of C in its RD\_PATH, the recently introduced rule that prevents the advertisement of a route to a BIS when the BIS’s RDI is in its RD\_PATH, was applied, and R(B) was therefore withdrawn. This behaviour, although undesirable, was in compliance with the specification, as the merged route formally replaces R(B), but is not eligible for advertisement to C. Hence, the withdrawal of R(B).

Thus far from seeing a merged route advertised from C to D, R(B) lasted for only a very short time before the routing information advertised from C to D stabilised with only R(A,C) advertised from C to D.

## 2.1 Discussion

The problem appears to come about because Route Merging is applied once during the Route Decision process, to all routes to the same NLRI and in the same loc-RIB. The merged route is then applied to each adj-RIB-out in turn. The effect of this is that the receipt of (e.g.) a low preference route from an adjacent BIS blocks the advertisement of higher preference routes to that BIS. This is because if the route merging process results in that route's RD\_Path being used in the merged route, then the merged route cannot be advertised to the BIS from the which the route had been received. This is clearly undesirable and resulted in the situation observed above.

To counter this problem, the solution would appear to be to carry out the route merging process separately for each adj-RIB-out and, in each case, ignore any routes that cannot be advertised to the corresponding remote BIS. In each case, the merged route may then always be advertised to the adjacent BIS, since all its component routes would be eligible for advertisement. Routes that should be ignored include those with the adjacent BIS's RDI in their RD\_PATH, and those with DIST\_LIST\_INCL type restrictions.



**Figure 2 Revised Route Merging**

The proposed revision is illustrated in Figure 2. This illustrates what happens during the Route Decision Phase 3 process and assumes that TAR B is connected not just to TAR C, but also to another, TAR E.

The loc-RIB contains two routes to the same NLRI, R(B) - the locally originated route - and R(A,C) - received from TAR C.

- When considering routes for inclusion in the Adj-RIB-out for TAR C, the phase 3 process recognises that R(A,C) cannot be advertised to TAR C, and hence only considers R(B). This is copied to the Adj-RIB-out for TAR C.
- When considering routes for inclusion in the Adj-RIB-out for TAR E, the phase 3 process recognises that both R(B) and R(A,C) are eligible for advertisement to TAR E, and hence merges them before adding the merged route to the Adj-RIB-out for TAR E.

The result of this is that R(B) is advertised to C and the merged route R(B,(A,C)) is advertised to E. This is the desired behaviour. R(B) and R(A) will now be merged by TAR C, which is their proper merging point for routes advertised to TAR D, while TAR E also sees both routes merged together, albeit by TAR B

In general, it should be understood that there must exist a domain in which routes such as R(A) and R(B) must exist separately i.e. when they represent different paths to the same destination, and rest of the internetwork, where they should be merged i.e. where they follow the same path. This revised rule appears to meet this requirement.

It should also be noted that this issue is independent of the Route Merging versus Route Aggregation issue. Route Merging was introduced as a simplified Route Aggregation, and the same issue applies identically to Route Aggregation.

Route Merging does result in a loss of RD\_PATH information, as the RD\_PATH information from only one of the component routes is carried forward to the merged route. This is undesirable, but does not appear to be a major problem. For example, if the TAR E introduced in Figure 2 was the connected to TAR D, then the merged route R(B,(A,C)) may be advertised to TAR D. If it contains the RD\_PATH from R(A,C) then it will not be advertised on to TAR C, as TAR C's RDI is in its RD\_PATH. Alternatively, if the RD\_PATH comes from R(B), then it may be advertised on to TAR C, but will not then be advertised to TAR B, as TAR B's RDI is in its RD\_PATH. In neither case does a routing loop occur.

### 3. Proposed Change to the draft ATN SARPs

The following replacement text for 8.3.1.6.2 is proposed, with change bars to identify the proposed changes.

#### 8.3.1.6.2 Aggregation of Routes in the Same Loc-RIB with Identical NLRI

When two or more routes exist in the same loc\_RIB and which have identical NLRI, then such routes shall be aggregated ~~after~~before the application of local policy rules that select routes for re-advertisement to each adjacent BIS, and their consequently being copied to the associated an adj-RIB-out. For each Adjacent BIS, the resulting aggregated route shall be inserted into the associated Adj-RIB-out. In order to aggregate such routes, an ATN Router shall apply one of the following two strategies:

- a) **True Route Aggregation:** the routes are aggregated according to ISO 10747 route aggregation procedures and the procedures for aggregation of the security path attribute specified in 8.3.1.6.3 below.
- b) **Route Merging:** the routes are merged by arbitrarily selecting one of these routes and updating its security path attribute to the value that would have resulted had the routes been aggregated, as above. The selected route with its updated security path attribute is then the result of the merging procedure.

*Note 1.— The former of the two strategies is preferred.*

*Note 2.— The second strategy has been introduced as an interim measure to simplify initial implementations. However, this second strategy leads to a situation where routing decisions based on RD\_Path information cannot be performed, as this information is lost in the merging process. The*

*second strategy may therefore be deleted in a later revision of these SARPs.*

*Note 3. Whenever local policy rules that select routes for advertisement to adjacent BISs select different combinations of routes from the same loc\_RIB and with identical NLRI, for advertisement to different adjacent BISs, then the Route Aggregation or Merging procedure has to be carried out separately for each Adj-RIB-out. For each Adj-RIB-out, only those routes which are eligible for advertisement to the corresponding BIS will be input to the merging/aggregation procedure. For example, a route may not be eligible for advertisement to an adjacent BIS due to distribution restrictions or a potential route loop recognised from the RD\_PATH information.*

*Note 4. An aggregated route resulting from these procedures may also be aggregated with other routes in an Adj-RIB-out, due to the application of local routing policy rules.*