

EFFICIENT LSP PROTECTION METHOD BASED ON RSVP-TE DYNAMIC TUNNEL

TECHNICAL FIELD

[0001] The present invention relates to the field of data and IP transmission devices, specifically to an efficient LSP protection method based on an RSVP-TE dynamic tunnel.

BACKGROUND

[0002] In a RSVP-TE (Resource Reservation Protocol-Traffic Engineering), a RSVP (Resource Reservation Protocol) as a signaling protocol is used to dynamically establish an LSP (Label Switching Path) in an MPLS TE (Multi-Protocol Label Switching Traffic Engineering). Usually, all LSPs established and deleted through the RSVP are CR-LSPs (Constrained Route-Label Switched Paths).

[0003] In order to realize protection of an important LSP, the LSP is configured with a standby LSP during LSP configuration, forming main and standby LSP protection. In normal situations, services are mainly processed with the main LSP; after the main LSP fails, services are switched to the standby LSP, while the main LSP will be re-established at a fixed time. After the failure of the main LSP is eliminated, the services are switched back to the main LSP. After the standby LSP fails, if the main and standby LSPs both fail, a service interruption and generation of an escape path may occur. Meanwhile, the standby LSP will be re-established at a fixed time.

[0004] When the main LSP adopts a strict route constraint and the standby LSP adopts a strict route constraint or is established in an automatic way, the main LSP cannot be successfully re-established before the failure of the main LSP is eliminated. In such case, when the standby LSP also fails, the main and standby LSPs cannot be switched

mutually, resulting in a service interruption and the generation of an escape path, thus affecting the efficiency of main and standby protection.

SUMMARY OF THE INVENTION

[0005] Aiming at the defects in the prior art, the objective of the present invention is to provide an efficient LSP protection method based on an RSVP-TE dynamic tunnel. When a main LSP or a standby LSP in a link fails, a new main LSP or standby LSP can be quickly generated, and the switching between the main and standby LSPs can be done at any time, avoiding service interruption and enhancing the efficiency of main and standby LSP protection.

[0006] In order to achieve the above objective, the present invention adopts an efficient LSP protection method based on an RSVP-TE dynamic tunnel, including using a loose route constraint to establish a main LSP, and establishing a standby LSP automatically or by means of the loose route constraint, so as to form main and standby LSP protection; after a main LSP link fails, switching a service to the standby LSP in an UP state, establishing a new main LSP and ensuring that paths of the new main LSP and the standby LSP do not completely overlap, forming new main and standby LSP protection with the standby LSP; and after a standby LSP link fails, re-establishing a new standby LSP under the condition that the main LSP is in the UP state and ensuring that paths of the new standby LSP and the main LSP do not completely overlap, and forming new main and standby LSP protection with the main LSP.

[0007] On the basis of the above technical solution, when the loose route constraint is used to establish the main LSP, an RSVP requests a main LSP route from a CSPF with a condition of loose route constraint; if the request succeeds, the main LSP is established; and if the request fails, the RSVP requests the main LSP route from the CSPF without the constraint condition until the main LSP is successfully established.

[0008] On the basis of the above technical solution, in the process of establishing the standby LSP automatically, the RSVP requests the route from the CSPF with the condition for main constraint exclusion, which means that the main LSP route is completely excluded during route calculation; and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

[0009] On the basis of the above technical solution, in the process of using the loose route constraint to establish the standby LSP, the RSVP requests the route from the CSPF with two conditions, namely the loose route constraint and main constraint exclusion; if the request succeeds, the standby LSP is established; if the request fails, the RSVP requests the route from the CSPF with the condition of main constraint exclusion until the standby LSP is successfully established; the condition of main constraint exclusion refers to complete exclusion of the main LSP route during route calculation, and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

[0010] On the basis of the above technical solution, when the main and standby LSPs are both established with the loose route constraint, the paths of the main LSP and the standby LSP are configured first and then the main LSP and the standby LSP are respectively established, wherein the standby LSP is established at any time after the establishment of the main LSP begins.

[0011] On the basis of the above technical solution, after a main LSP link fails, a service is switched to the standby LSP in an UP state; the failing main LSP is deleted; a re-establishment timer of the main LSP is started; and the establishment of a new main LSP begins after the re-establishment timer is over time.

[0012] On the basis of the above technical solution, during the process of starting the re-establishment timer of the standby LSP to establish a new main LSP, whether or not

the route requested by the standby LSP is returned to the RSVP is determined, if so, the RSVP requests the standby LSP route from the CSPF with two conditions, namely the loose route constraint and main constraint exclusion, and if not, the RSVP requests the standby LSP route from the CSPF with the condition of loose route constraint only; the standby constraint exclusion refers to complete exclusion of the standby LSP route during route calculation, and if the exclusion is incomplete, the main LSP route that meets conditions is calculated by excluding a part of the standby LSP route; and after the request regarding the main LSP route succeeds, the main LSP is established.

[0013] On the basis of the above technical solution, after the RSVP fails in requesting the main LSP route from the CSPF, whether or not the number of failures exceeds 3 is determined, if not, the main LSP is established by the step according to claim 7, if so, the re-establishment timer of the main LSP is still started; whether or not the route requested by the standby LSP is returned to the RSVP, and if so, the RSVP requests the main LSP route from the CSPF with the condition of standby constraint exclusion, and if not, the RSVP requests the main LSP route from the CSPF without the constraint condition; and after the request regarding the main LSP route, the main LSP is established.

[0014] On the basis of the above technical solution, after a standby LSP link fails, the failing standby LSP is deleted under the condition that the main LSP is in the UP state; the re-establishment timer of the standby LSP is started; and the establishment of a new standby LSP begins after the re-establishment timer is over time.

[0015] On the basis of the above technical solution, during the re-establishment of the standby LSP, when the standby LSP is configured with the loose route constraint, whether or not the route requested by the main LSP is returned to the RSVP is determined, if so, the RSVP when requests the standby LSP route from the CSPF with two conditions, namely the loose route constraint and main constraint exclusion, and if not, the RSVP requests the standby LSP route from the CSPF with the condition of loose route constraint

only; the main constraint exclusion refers to complete exclusion of the main LSP route during route calculation, and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

[0016] On the basis of the above technical solution, during the re-establishment of the standby LSP, when the standby LSP is not configured with the loose route constraint, whether or not the route requested by the main LSP is returned to the RSVP is determined, if so, the RSVP requests the standby LSP route from the CSPF with the condition of main constraint exclusion only, and if not, the RSVP requests the standby LSP route from the CSPF without any constraint conditions; the main constraint exclusion refers to complete exclusion of the main LSP route during route calculation, and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

[0017] On the basis of the above technical solution, if the request regarding the standby LSP route succeeds, a new standby LSP is established; if the request fails, whether or not the number of request failures exceeds 3 is determined, if so, a re-establishment timer of the standby-LSP is started, and the step according to claim 11 is carried out; if not, the re-establishment timer of the standby LSP is started, and after waiting time is over, a new standby LSP is established, and whether or not the standby LSP is configured with the loose route constraint is determined again.

[0018] On the basis of the above technical solution, after the link failure of the main LSP or the standby LSP is eliminated, re-optimization is carried out manually or automatically to re-optimize one or two non-LSP routes in the main and standby LSP protection to an expected path before the failure occurs.

[0019] On the basis of the above technical solution, when the re-optimization of the main LSP is started, the route returned by the CSPF is compared with the route of the current main LSP after the RSVP successfully requests the route from the CSPF; whether

or not changes occurred is determined, if not, the re-optimization of the standby LSP is started; and if so, re-optimization of the main LSP is re-established.

[0020] On the basis of the above technical solution, the re-optimization of the main LSP is re-established, where the original main LSP is deleted under the condition that the session state and the BFD of the standby LSP are UP; the RSVP requests the route from the CSFP with the condition of loose route constraint; and an optimized main LSP is established.

[0021] On the basis of the above technical solution, when the re-optimization of the standby LSP is started, the route returned by the CSPF is compared with the route of the current standby LSP after the RSVP successfully requests the route from the CSPF, whether or not changes occurred is determined, if not, end; if so, the re-optimization of the standby LSP is re-established, where the original standby LSP is deleted under the condition that the session state and the BFD state of the LSP are UP, the RSVP requests the route from the CSPF with the condition of main constraint exclusion, the standby LSP is established after optimization, the standby LSP and the main LSP do not completely overlap; and the main constraint exclusion refers to complete exclusion of the main LSP route during route calculation, and if the exclusion is incomplete, the standby LSP route that meets the conditions is calculated through excluding a part of the main LSP route.

[0022] The present invention has the following beneficial effects: the main-standby relation of the protection group is not changed; when the link of the main LSP or the standby LSP fails, it is ensured that a timed re-establishment of the main LSP or the standby LSP succeeds and the main LSP or the standby LSP, together with the original standby LSP or main standby LSP, forms new main and standby LSP protection. Moreover, after the main and standby switching occurs once, the main and standby protection can be formed again, avoiding the possibility of generating an escape path, avoiding service interruption during engineering application, and enhancing the efficiency

of the main and standby LSP protection.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG.1 is a flowchart of establishment of a main LSP with a loose route constraint in the present invention;

[0024] FIG.2 is a flowchart of automatic establishment of a standby LSP in the present invention;

[0025] FIG.3 is a flowchart of establishment of a standby LSP with a loose route constraint in the present invention;

[0026] FIG.4 is a flowchart of formation of new main and standby LSP protection when the main LPS fails and is re-established in the present invention;

[0027] FIG.5 is a flowchart of formation of new main and standby LSP protection when the standby LPS fails and is re-established in the present invention.

[0028] FIG.6 is a flowchart of specific implementation of the re-optimization of main and standby LSP protection in the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0029] The present invention is described in further detail with reference to the attached drawings and embodiments.

[0030] An efficient LSP protection method based on an RSVP-TE dynamic tunnel of the present invention includes:

[0031] Using a loose route constraint to establish a main LSP, and establishing a standby LSP automatically or by means of the loose route constraint, so as to form main and standby LSP protection, where the main LSP and standby LSP are configured according to the required establishment ways before the establishment of the main LSP and standby LSP. The loose route constraint refers to that when an RSVP requests a route

from the (CSPF Constrained Shortest Path First), the route can be loosened while the next jump is constrained, where it is not required to directly connect two nodes and other nodes may exist. After the loose route constraint is configured, it can be ensured that a new main LSP or standby LSP can be quickly re-established after a main or standby LSP link fails, so as to form new main and standby LSP protection. On the basis of the loose route constraint way, a node constraint is also included. The node constraint refers to where the path constraint can be carried out according to not only the link but also the node when the RSVP requests a route from a CSPF. The node constraint can ensure that when a certain link passing the node fails, route calculation can still work through another link that passes the node to obtain the optimal path including the node.

[0032] After a main LSP link fails, a service is switched to the standby LSP in an UP state; a new main LSP is established and it is ensured that paths of the new main LSP and the standby LSP do not completely overlap; and the new main LSP and the standby LSP form new main and standby LSP protection.

[0033] After a standby LSP link fails, a new standby LSP is re-established under the condition that the main LSP is in the UP state, and it is ensured that paths of the new standby LSP and the main LSP do not completely overlap; and the new standby LSP and the main LSP together form new main and standby LSP protection.

[0034] As shown in FIG.1, specifically, the step of establishing a main LSP with a loose route constraint includes the steps:

[0035] A1. A RSVP requests a main LSP route from a CSPF with a condition of loose route constraint. When the RSVP requests a main LSP route from a CSPF with the condition of loose route constraint, the request regarding the route is required to be implemented according to the included condition as much as possible.

[0036] A2. Whether or not the request regarding the main LSP route succeeds is determined; if so, step A5 begins; if not, step A3 begins.

[0037] A3. The RSVP requests the main LSP route from the CSPF without a constraint condition.

[0038] A4. Whether or not the request regarding the main LSP route succeeds is determined (if the RSVP receives route information returned by the CSPF, this means that the request succeeds); if not, step A3 begins; if so, step A5 begins.

[0039] A5. The main LSP is successfully established.

[0040] In the above steps, no matter whether the RSVP carries the constraint condition or not, the loose route constraint is employed instead of the strict constraint configuration.

[0041] As shown in FIG.2, on the premise that the main LSP employs the loose route constraint, a standby LSP is established automatically to form main and standby LSP protection with the main LSP by the following specific steps:

[0042] B1. The RSVP requests a standby LSP route from the CSPF with a condition of main constraint exclusion. The main constraint exclusion refers to complete exclusion of the main LSP route during route calculation, and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route to ensure that the main LSP and the standby LSP do not completely overlap.

[0043] B2. Whether or not the request regarding the standby LSP route succeeds is determined (if the RSVP receives route information returned by the CSPF, this means that the request succeeds); if so, step B3 begins; if not, step B1 begins.

[0044] B3. The standby LSP is successfully established.

[0045] As shown in FIG.3, on the premise that the main LSP employs the loose route constraint, the standby LSP is established also by means of the loose route constraint by the following specific steps:

[0046] C1. The RSVP requests a standby LSP route from the CSPF with two

conditions, namely loose route constraint and main constraint exclusion.

[0047] C2. Whether or not the request for the standby LSP route succeeds is determined; if so, step C5 begins; if not, step C3 begins.

[0048] C3. The RSVP requests the standby LSP route from the CSPF with the condition of main constraint exclusion.

[0049] C4. Whether or not the request regarding the standby LSP route succeeds is determined; if so, step C5 begins; if not, step C3 begins.

[0050] C5. The standby LSP is successfully established.

[0051] Before using the loose route constraint to establish the main LSP and the standby LSP, constraint paths are required to be established first. After the configuration is completed, routes that meet conditions are requested according to the respective loose route constraint conditions. After the requests succeed, the main LPS and standby LSP are respectively established. After the establishment of both the main and standby LSP succeeds, main and standby LSP protection is formed. Generally, the path configuration of the loose route constraint of the standby LSP is a little later than the path configuration of the loose route constraint of the main LSP, so that the establishment of the standby LSP is a little later than the establishment of the main LSP.

[0052] FIG.4 is a flowchart of formation of new main and standby LSP protection when the main LPS fails and is re-established. Specific steps include:

[0053] D1. After a main LSP link fails, a service is switched to a standby LSP under the condition that the standby LSP is in the UP state, and the failing main LSP is deleted.

[0054] D2. A re-establishment timer of the main LSP is started, and waits for the re-establishment timer to time out.

[0055] D3. Whether or not the route requested by the standby LSP is returned to the RSVP (if the route is returned, this means that a query on the standby LSP route

succeeds); if not, step D4 begins; and if so, step D5 begins.

[0056] D4. At this time, it is not required to consider the route of the standby LSP; the RSVP requests the main LSP route from the CSPF with the condition of loose route constraint only; and then, step D6 begins.

[0057] D5. The RSVP requests the main LSP route from the CSPF with two conditions, namely loose route constraint and main constraint exclusion. Main constraint exclusion refers to complete exclusion of the standby LSP route during route calculation, and if the exclusion is incomplete, the main LSP route that meets the conditions is calculated by excluding a part of the standby LSP route. Excluding the standby route can exclude the route of the standby LSP as much as possible. In this way, a new main LSP can be successfully established; the main LSP and standby LSP do not completely overlap; and as many identical links are reduced as possible.

[0058] D6. Whether or not the request regarding the main LSP route succeeds is determined; if so, step D13 begins; if not, step D7 begins.

[0059] D7. Whether or not the failure numbers of the route request is greater than 3 is determined; if not, step D2 begins; and if so, step D8 begins.

[0060] D8. The re-establishment timer of the main LSP is still started; wait for the re-establishment timer to time out.

[0061] D9. Whether or not the route requested by the standby LSP is returned to the RSVP is determined; if not, step D10 begins; and if so, step D11 begins.

[0062] D10. The RSVP requests the main LSP route from the CSPF without a constraint condition; and then, step D12 begins.

[0063] D11. The RSVP requests the main LSP route from the CSPF with the condition of standby constraint exclusion; and then, step D12 begins.

[0064] D12. Whether or not the request regarding the main LSP route succeeds is determined; if so, step D13 begins; if not, step D8 begins.

[0065] D13.A new main LSP is established, and together with the standby LSP, forms new main and standby LSP protection.

[0066] FIG.5 is a flowchart of formation of new main and standby LSP protection when the standby LPS fails and is re-established. Specific steps include:

[0067] E1.After a standby LSP link fails, the failing standby LSP is deleted when the main LSP is in the UP state.

[0068] E2. A re-establishment timer of the standby LSP is started, wait for the re-establishment timer to time out.

[0069] E3.Whether or not the standby LSP is configured with the condition of loose route constraint is inspected to determine whether or not the loose route constraint is configured; if so, step E4 begins; if not, step E7 begins.

[0070] E4. Whether or not the route requested by the main LSP is returned to the RSVP (if the route is returned, this means that a query on the main LSP route succeeds); if not, step E5 begins; and if so, step E6 begins.

[0071] E5. The RSVP requests a standby LSP route from the CSPF with two conditions, namely loose route constraint and main constraint exclusion; and then, step E10 begins.

[0072] E6. The RSVP requests the standby LSP route from the CSPF with the condition of loose route constraint only; and then, step E10begins.

[0073] E7. Whether or not the route requested by the main LSP is returned to the RSVP; if not, step E8 begins; and if so, step E9 begins.

[0074] E8. The RSVP requests the standby LSP route from the CSPF with the condition of main constraint exclusion only; and then, step E10 beings.

[0075] E9. The RSVP requests the standby LSP route from the CSPF without any constraint condition; and then, step E10 begins.

[0076] E10. Whether or not the request regarding the standby LSP route succeeds

is determined; if so, step E13 begins; if not, step E11 begins.

[0077] E11. Whether or not the number of request failures exceeds 3; if so, step E12 begins; if not, step E2 begins.

[0078] E12. The re-establishment timer of the standby LSP is started, and wait for the re-establishment timer to time out; and then, step E7 begins.

[0079] E13. A new standby LSP is established, and together with the main LSP, forms new main and standby LSP protection.

[0080] After the link failure of the main LSP or the standby LSP is eliminated, at this time it needs to re-optimize one or two non-optimal LSP routes in the main and standby LSP protection to an expected path before the failure occurs. The re-optimization function mainly includes manual operation and automatic operation. The manual operation refers to immediate re-optimization of the LSPs in all Trunks with the node Ingress according to a command arrow; the automatic operation refers to that a re-optimized timer is pre-configured, and when the timer is over time and meets the re-optimization condition, the LSPs in all Trunks with the Ingress node are automatically re-optimized. Re-optimization has two conditions; one is a path passing the minimum jumps; and the other is selection of the path with the minimum cost under the condition that the number of jumps is the same.

[0081] The re-optimization strategy is as follows: re-optimization begins under the condition that the session state and the BFD (Bidirectional Forwarding Detection) state of the main LSP and the standby LSP are both UP. Besides, the main LSP is re-optimized only under the condition that the session state and the BFD state of the standby LSP are both UP; similarly, the standby LSP is optimized only when the session state and the BFD state of the standby LSP are both UP. The two LSPs forming the main and standby protection cannot be optimized at the same time, and can only be optimized in sequence, or a service will be interrupted; and after the optimization of the main LSP is completed,

the re-optimization of the standby LSP begins.

[0082] FIG.6 shows specific implementation of the re-optimization of the main and standby LSP protection. The re-optimization implementation process is mainly divided into two parts, one is a query on re-optimization and the other is the re-establishment of re-optimization. In the two processes, a route is requested from the CSPF (involving with ISIS or OSPF protocol); and only after the request regarding the re-optimization query route succeeds, the re-establishment of re-optimization can begin. The specific steps include:

[0083] F1. When the session states and the BFD states of the main LSP and the standby LSP are both UP, the re-optimization begins. At this time, a re-optimization of the main LSP is started.

[0084] F2. A query on the re-optimization of the main LSP is carried out.

[0085] F3. Whether or not the query on that the RSVP requests a re-optimized main LSP route from the CSPF succeeds is determined (if the RSVP receives the route information from the CSPF, this means that the query succeeds); if so, step F4 begins; and if not, re-optimization ends.

[0086] F4: The route returned by the CSPF is compared with the route of the current main LSP to determine if changes occurred; if so, step F5 begins; and if not, step F10 begins.

[0087] F5. The main LSP has preferable routes; it needs to optimize the main LSP at this time; to re-establish the re-optimization of the main LSP, carry out step F6.

[0088] F6. Whether or not the session state and the BFD state of the standby LSP are both UP; if so, step F7 begins; if not, re-optimization ends.

[0089] F7. The original main LSP is deleted.

[0090] F8. The RSVP requests preferable routes so as to establish a new main LSP and determine whether or not the request regarding the main LSP route succeeds; if so,

step F9 begins; and if not, the re-optimization ends. The RSVP carries the condition of loose route constraint when requesting a route from the CSPF.

[0091] F9. The re-optimized main LSP is established.

[0092] F10. The current main LSP route is the optimal and does not need to be re-optimized, or when re-optimization of the main LSP has been completed, the re-optimization of the standby LSP is started.

[0093] F11. A query on the re-optimization of the standby LSP is carried out.

[0094] F12. Whether or not the query on that the RSVP requests a re-optimized standby LSP route from the CSPF succeeds is determined (if the RSVP receives the route information from the CSPF, this means that the query succeeds); if so, step F13 begins; and if not, re-optimization ends.

[0095] F13: The route returned by the CSPF is compared with the route of the current standby LSP to determine if changes occurred; if so, step F14 begins; and if not, re-optimization ends.

[0096] F14. The re-optimization of the standby LSP is re-established.

[0097] F15. Whether or not the session state and the BFD state of the main LSP are both UP; if so, step F16 begins; if not, re-optimization ends.

[0098] F16. The original standby LSP is deleted.

[0099] F17. The RSVP requests preferable routes so as to establish a new standby LSP and determine whether or not the request regarding the standby LSP route succeeds; if so, step F18 begins; and if not, the re-optimization ends. A RSVP carries the condition of main constraint exclusion when requesting a route from the CSPF.

[00100] F18. The re-optimized standby LSP is established.

[00101] During re-optimization and when requesting the main LSP route, the RSVP only needs to carry the condition of the loose route constraint only, because the standby LSP is re-optimized after the re-optimization of the main LSP is completed. During

re-optimization of the standby LSP and during route requesting, if the standby LSP is configured with the loose route constraint, the RSVP requests the route from the CSPF with two conditions, namely loose route constraint and the main constraint exclusion; if the standby LSP is not configured with the loose route constraint, the RSVP only carries the condition of main constraint exclusion when requesting a route from the CSPF, so as to ensure that the main LSP and the standby LSP do not completely overlap.

[00102] The present invention is not limited to the above embodiments. It shall be noted that, for those ordinarily skilled in the art, various improvements and changes can be made on the basis of the principle of the present invention. The improvements and changes shall also fall within the protective scope of the present invention. Contents not described in detail in the Description of the present invention are prior art known by those skilled in the art.

What is claimed is:

1. An efficient LSP protection method based on an RSVP-TE dynamic tunnel, characterized by comprising:

using a loose route constraint to establish a main LSP, and establishing a standby LSP automatically or by means of the loose route constraint, so as to form main and standby LSP protection;

after a main LSP link fails, switching a service to the standby LSP in an UP state, establishing a new main LSP and ensuring that paths of the new main LSP and the standby LSP do not completely overlap, forming new main and standby LSP protection with the standby LSP; and

after a standby LSP link fails, re-establishing a new standby LSP under the condition that the main LSP is in the UP state and ensuring that paths of the new standby LSP and the main LSP do not completely overlap and forming new main and standby LSP protection with the main LSP.

2. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 1, characterized in that when the loose route constraint is used to establish the main LSP, a RSVP requests a main LSP route from a CSPF with a loose route constraint condition; if the request succeeds, the main LSP is established; and if the request fails, the RSVP requests the main LSP route from the CSPF without a constraint condition until the main LSP is successfully established.

3. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 1, characterized in that in the process of establishing the standby LSP automatically, a RSVP requests a route from a CSPF with the condition of main constraint exclusion, which means that the main LSP route is completely excluded during route calculation; if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

4. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 1, characterized in that in the process of using the loose route constraint to establish the standby LSP, a RSVP requests a route from a CSPF with two conditions, namely the loose route constraint and main constraint exclusion; if the request succeeds, the standby LSP is established; if the request fails, the RSVP requests the route with the condition of main constraint exclusion until the standby LSP is successfully established; the condition of main constraint exclusion refers to complete exclusion of the main LSP route during route calculation and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

5. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 4, characterized in that when both the main and standby LSPs are established with the loose route constraint, the paths of the main LSP and the standby LSP are configured first, and then the main LSP and the standby LSP are respectively established, wherein the standby LSP is established at any time after the establishment of the main LSP begins.

6. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 1, characterized in that after a main LSP link fails, a service is switched to the standby LSP in an UP state; the failing main LSP is deleted; a re-establishment timer of the main LSP is started; and the establishment of a new main LSP begins after the re-establishment timer is over time.

7. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 6, characterized in that in the process of starting the re-establishment timer of the main LSP to establish a new main LSP, whether or not the route requested by the standby LSP is returned to a RSVP is determined; if so, the RSVP requests the main LSP route from a CSPF with two conditions, namely the loose route constraint and the

main constraint exclusion; if not, the RSVP requests the main LSP route from a CSPF with the condition of loose route constraint only; the main constraint exclusion refers to complete exclusion of the standby LSP route during route calculation, and if the exclusion is incomplete, the main LSP route that meets conditions is calculated by excluding a part of the standby LSP route; and the main LSP is established after the main LSP route request succeeds.

8. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 7, characterized in that after the RSVP fails in requesting the main LSP route from the CSPF, whether or not the number of failures exceeds 3 is determined; if not, the main LSP is established by the step according to claim 7; if so, the re-establishment timer of the main LSP is still started; whether or not the route requested by the standby LSP is returned to the RSVP is determined, if so, the RSVP requests the main LSP route from the CSPF with the condition of standby constraint exclusion and if not, the RSVP requests the main LSP route from the CSPF without the constraint condition; and after the request regarding the main LSP route succeeds, the main LSP is established.

9. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 1, characterized in that after a standby LSP link fails, the failing standby LSP is deleted under the condition that the main LSP is in the UP state; a re-establishment timer of the standby LSP is started; and the establishment of a new standby LSP begins after the re-establishment timer is over time.

10. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 9, characterized in that during the re-establishment of the standby LSP, when the standby LSP is configured with the loose route constraint, whether or not the route requested by the main LSP is returned to a RSVP is determined, if so, the RSVP requests the standby LSP route from a CSPF with two conditions, namely the loose route constraint and main constraint exclusion, and if not, the RSVP requests the standby LSP

route from a CSPF with the condition of loose route constraint only; the main constraint exclusion refers to complete exclusion of the main LSP route during route calculation, and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

11. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 9, characterized in that during the re-establishment of the standby LSP, when the standby LSP is not configured with the loose route constraint, whether or not the route requested by the main LSP is returned to the RSVP is determined, if so, the RSVP requests the standby LSP route from the CSPF with the condition of main constraint exclusion only; and if not, the RSVP requests the standby LSP route from the CSPF without any constraint conditions; the main constraint exclusion refers to complete exclusion of the main LSP route during route calculation and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.

12. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 11, characterized in that if the request regarding the standby LSP route succeeds, a new standby LSP is established; if the request fails, whether or not the number of request failures exceeds 3 is determined, if so, the re-establishment timer of the standby-LSP is started, and the step according to claim 11 is carried out; if not, the re-establishment timer of the standby LSP is started, a new standby LSP is established after waiting time is over, and whether or not the standby LSP is configured with the loose route constraint is determined again.

13. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 1, characterized in that after the link failure of the main LSP or the standby LSP is eliminated, re-optimization is carried out manually or automatically to re-optimize one or two non-optimal LSP routes in the main and standby LSP protection to

an expected path before the failure occurs.

14. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 13, characterized in that when the re-optimization of the main LSP is started, the route returned by a CSPF is compared with the route of the current main LSP after a RSVP successfully requests a route from a CSPF; whether or not changes occurred is determined, if not, the re-optimization of the standby LSP is started; and if so, re-optimization of the main LSP is re-established.

15. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 14, characterized in that re-optimization of the main LSP is re-established; the original main LSP is deleted under the condition that the session state and the BFD state of the standby LSP are UP; the RSVP requests the route from the CSFP with the condition of loose route constraint; and an optimized main LSP is established.

16. The efficient LSP protection method based on an RSVP-TE dynamic tunnel according to claim 14 or 15, characterized in that when the re-optimization of the standby LSP is started, the route returned by the CSPF is compared with the route of the current standby LSP after the RSVP successfully requests the route from the CSPF, whether or not changes occurred is determined, if not, end; and if so, the re-optimization of the standby LSP is re-established, wherein the original standby LSP is deleted under the condition that the session state and BFD state of the main LSP are UP, the RSVP requests the route from the CSPF with the condition of main constraint exclusion, the optimized standby LSP is established, the standby LSP and the main LSP do not completely overlap; and the main constraint exclusion refers to complete exclusion of the main LSP route during route calculation, and if the exclusion is incomplete, the standby LSP route that meets conditions is calculated by excluding a part of the main LSP route.