*2010 3rd International Conference on Computer and Electrical Engineering (ICCEE 2010)*
***IPCSIT vol. 53 (2012) © (2012) IACSIT Press, Singapore***
*DOI: 10.7763/IPCSIT.2012.V53.No.2.24*

# Research on the Different Protection and Restoration Mechanism of ASON

Qi Zhang[+] and Lin Xu

College of Computer Science, Sichuan University

Chengdu, China

**Abstract**—Different protection and restoration mechanism is the most important feature of automatic switched optical network (ASON). Through testing 1356NT, which is an optical network planning and design tool of Alcatel-Lucent Company, this paper analyzes the restoration time and proposes the application strategy of different circuits. It is significant for the plan and design of ASON.

**Keywords-**automatic switched optical network (ASON); protection and restoration; restoration time; application strategy

## 1. Introduction

As the physical infrastructure of next generation network, optical network carries a great amount of information. The development of optical network is still towards ultra-high speed, ultra-large capacity and ultra-long distance. Automatically Switched Optical Network (ASON) is an optical transmission network with distributed intelligent. Leading into the intelligent control plane (CP) on the basis of transport plane (TP) and management plane (MP) as well as the signaling, routing, and automatic discovery techniques is the most important features of ASON [1]. Introducing these new technologies makes the controlling of optical resources flexible, can greatly enhance network's availability and scalability, allows the network to support more flexible business, and allows operators to simplify the network structure and significantly reduce the operating costs.

## 2. Protection and Restoration Mechanism of ASON

Network survivability refers to the capability of preventing the network failures and interruption. When the network failures happen, it can find the affected business as soon as possible and re-route using the free resource in order to reduce the losses caused by the failures. The survival mechanism of ASON includes protection and restoration [2]. Protection mechanism is to pre-build some protection routes using the idle resource in order to improve the effectiveness of the connection. Compared with protection mechanism, restoration mechanism is to replace the failed connection with the new one which is built by changing the routes. These new connections will occupy the new redundant network shared resource [3].

ASON has four different types of circuits-- SBR, SNCP, PRC and GR, which have different protection and restoration mechanism. SBR supports single business and withstands multiple failures and the circuit only has restoration without protection. At the beginning there is only one working route, once the route fails, a restoration route will be generated automatically until the network can not be restored. SNCP supports double business and withstands single failure and the circuit only has protection without restoration. At the beginning there are two working routes, once one route fails, it can switch to another one automatically, but

[+] Corresponding author.
*E-mail address*: 570902796@qq.com

will not produce the restoration route. When two routes fail at the same time, the network will crash. PRC, combining with protection and restoration, supports double business and withstands multiple failures. At the beginning, there are two working routes, once one route fails, it can switch to another one automatically, and will produce the restoration route correspondingly. When two routes fail at the same time, the network will crash. GR supports double business and withstands multiple failures; it has both protection and restoration. At the beginning, there are one working route and one protection route. The protection route is previously computed, it is in inactive state at first, in other words, it does not take any resource and not work. Once the working route fails, it will be activated and then the network will re-compute a new protection route, until the network cannot be restored.

# 3. Test different Protection and Restoration Mechanism of ASON

The experiment analyzes restoration time and application strategy of different circuits by testing 1356NT which is an optical network planning tool of Alcatel-Lucent company. First of all, select five nodes from the metro network with ASON functionality to form a transmission network of high utilization and viability. The network topology is shown as following:

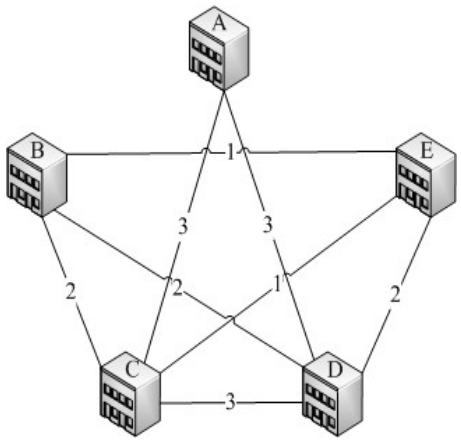


Fig.1. Network topology

In the Figure 1, A, B, C, D, E are on behalf of Network Element (NE), the number on the link represents the weight. The choice of routing follows the shortest path first algorithm. Though testing the tool, the corresponding working route, restoration route and restoration time can be checked.

## 3.1. Verify the properties of SBR

Testing process: single business, multiple failures

1) Build one label switched path (LSP) from C to D in the network as is shown in the Figure 1, set the protection type SBR and the working route C-D.

2) Set SDH analyzer in the corresponding port.

3) Break the optical fiber connection between C and D, check and record the restoration time and restoration route.

4) Make the optical fiber failure on the current path, check and record the restoration time and restoration route.

5) Repeat steps (4) several times until the network can not be restored.

The results are shown as follows:

TABLE I. THE RESULTS OF SBR

| Failures | Restoration route | Restoration time(ms) |
|---|---|---|
| C-D | C-E-D | 91.7 |
| C-E | C-B-D | 102.3 |
| B-D | C-B-E-D | 111.5 |
| B-E | C-A-D | 118.2 |

## 3.2. Verify the properties of SNCP

Testing process: double business, single failure

1) Build one label switched path (LSP) from C to D in the network as is shown in the Figure 1, set the protection type SNCP, the working route C-D and the protection route C-A-D.

2) Set SDH analyzer in the corresponding port.

3) Break the optical fiber connection between C and D, the path switches to the protection path C-A-D, without restoration route, record the restoration time 46.7ms.

4) Break the optical fiber connection between A and D, there is not restoration route.

5) Clear all the routing information and data.

### 3.3. Verify the properties of PRC

Testing process: double business, multiple failures

1) Build one label switched path (LSP) from C to D in the network as is shown in the Figure 1, set the protection type PRC, the working route C-D and the protection route C-E-D.

2) Set SDH analyzer in the corresponding port.

3) Break the optical fiber connection between C and D, the path switches to the protection path and restores one new route at the same time, check and record the restoration time and restoration route.

4) Break the new optical fiber connection of working route, the path switches to the protection path and restores one new route at the same time, check and record the restoration time and restoration route.

5) Repeat steps (4) several times until the network can not be restored.

The results are shown as follows:

TABLE II. THE RESULTS OF PRC

| Failures | Working routes | Restoration routes | Restoration time (ms) |
|---|---|---|---|
| C-D | C-E-D | C-B-D | 34.4 |
| C-E | C-B-D | C-B-E-D | 43.2 |
| B-D | C-B-E-D | C-A-D | 46.5 |

### 3.4. Verify the properties of GR

Testing process: double business, multiple failures

1) Build one label switched path (LSP) from C to D in the network as is shown in the Figure 1, set the protection type GR, the working route C-D and protection route C-E-D that is previously computed.

2) Set SDH analyzer in the corresponding port.

3) Break the optical fiber connection between C and D, the path switches to the protection path and re-computes one new protection path at the same time, check and record the restoration time and restoration route.

4) Break the new optical fiber connection of working route, the path switches to the protection path and re-computes one new protection path at the same time, check and record the restoration time and restoration route.

5) Repeat steps (4) several times until the network can not be restored.

6) Clear all the routing information and data.

The results are shown as follows:

TABLE III. THE RESULTS OF GR

| Failures | Working route | Protection route | Restoration time(ms) |
|---|---|---|---|
| C-D | C-E-D | C-B-D | 89.7 |
| C-E | C-B-D | C-B-E-D | 101.2 |
| B-D | C-B-E-D | C-A-D | 110.5 |

## 4. analyze different types of circuits

### 4.1. Rrestoration Time[4]

Both the circuits of PRC and SNCP have protection routes. When detecting failures, it switches to the protection route immediately to perform the restoration actions. Restoration time TR only includes failure detection time T1 and the node cross-connect time TX, that is: $TR = T1 + TX$. The restoration time measured in the experiment is consistent with the theoretical value calculated.

The circuits of SBR and GR need re-route to recover and the restoration time TR includes failure detection time $T1$, positioning time $T2$, transmission processing time of different message and node re-cross-connect time, that is:

$$T_R = T_1 + T_2 + \sum_{I=1}^{n} (L_i T_v) + T_M + 2\sum_{i=1}^{b} (L_i T_\rho) + 2(b-1)T_M + bT_x$$

where n is the node number from source node to destination node of the failures, b is the node number of protection route, TM is the message processing time, TX is the cross-connection time, L is the link length, and Tp is the transmission delay. The restoration time measured in the experiment is consistent with the theoretical value calculated.

### 4.2. Application Sstrategy[5]

The application of protection and restoration of ASON has flexibility and diversity. Due to different design ideas are from different protection and restoration mechanism, their business restoration time and reliability differ greatly. The following is to analyze the practical application of these circuits.

*1) PRC:* When the destination node detects failures, the path switches directly to the protection route, which requires a minimum configuration of network devices, earns the highest reliability and consumes the shortest restoration time, usually within 50ms. But it needs network to provide more redundant resource, which leads to the performance and cost are the highest, so it is used to protect the most important business of optical transport network, usually used in long-distance backbone network and metropolitan core network.

*2) SNCP:* Compared with the PRC, SNCP has the same restoration time roughly, and it needs less network equipment, but it only has the protection route without the restoration route, so the reliability is low. There is no need to provide redundant network resource for SNCP, so its performance and cost is lower than PRC. Thus it is used for the network that has less demanding on the reliability.

*3) GR:* when one node detects failures, it will notify the source node. Source node will start the protection route that is previously computed and the path will switch to the protection path through the interaction between the source nodes and destination nodes. Its reliability is relatively high and restoration time is normally less than 200ms. The resource that the business used to recover is shared, so it needs a relatively less network redundant resource. Considering the restoration time and resources compromise, GR is an ideal choice, which is often used in some important business of metro and access networks.

*4) SBR:* This type of circuit is mainly related to the re-routing. SBR needs many configuration and interaction nodes, and the redundant resource may not be enough, so its reliability is not very good. Its restoration time is relative to the network size, resource utilization and traffic load, generally costs less than 200ms. It is used for the network that requires not very high reliability.

Thus, ASON can provide varieties of protection and restoration requirements for different levels of business. Operators can make their own survival strategies of ASON according to the device level, network topology, business requirements and other factors.

## 5. Conclusions

Due to the mechanism of protection and restoration has the feature of intelligence and variety, many operators at home and abroad consider introducing ASON. Protection and restoration is one of the major technologies and advantages of ASON, the appropriate application strategy will help operators to improve network efficiency and operational service level. But now ASON is only used in the core network, in order to achieve the integration of existing traditional network and ASON, there is still a long way to go. Only these issues are all solved, can the application of ASON be more extensive.

## 6. References

[1] ITU-T Recommendation G.8080/Y.1304-2006, Architecture for the automatic switched optical networks(ASON).

[2] Jie Zhang, Yunbin Xu, Wanyi Gu, “Automatic Switched Optical Networks(ASON),” The People's Posts and Telecommunications Press. in press, 2004, pp. 53-67 .

[3] Huisheng Gao, Xiaodong Yu, Jing Guo, Weiwei Jin, “Availability research on protection mechanisms in ASON networking,” Study On Optical Communications, 2009, pp.18-20.

[4] FARRELL, ADRIAN/BRYSKIN, IGOR. GMPLS Architecture and Applications. USA: Morag Kaufmann 2006.

[5] Wei Yong, Ge Fan. Study on the survivability of ASON. Study On Optical Communications, 2009, pp. 4-6.