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An Adaptive Adjustment Mechanism for Carriage in ATTN Network

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Abstract

Internet based on TCP/IP is now faced with the problem of scalability, security, management and energy consumption, while the patch to Internet doesn't solve the drawback of IP network essentially, which further intensifies the complexity of the network. In this paper, based on the research of ATTN network, an adaptive adjustment mechanism is proposed aiming at the problem of data retention and low resource utilization rate in the automatic configuration of the carriages. In which by the forecast of data retention and resource utilization, the carrier routes are dynamically adjusted. Finally, the scheme is further optimized, and tested on ATTN simulation platform, which shows the performance of ATTN network is improved.

Keywords*: TCP/IP; ATTN network; data retention; resource utilization*

1. Introduction

With the continuous popularization of the Internet and exponential growing of the mobile terminals, the number of Internet users is increasing. At the same time, a wide range of new services are emerging, making the existing IP network architecture more and more problems exposed, and IP network shows more limitations in mobility and security. The current studies show that the most limitations of the existing IP network caused by IP slender architecture itself. Therefore, some scientists have put forward the "revolutionary" network development, to re-build a new network transmission system from the perspective of network requirements.

Currently, many countries have done mangy explorations to the future network, but due to technology and some external factors, the future network research still remain in the experimental design stage. Some well-known laboratories and organizations as follows, GENI [1] (Global Environment for Network Innovation), ITU, FIRE [2] (Future Internet Research and Experimentation) and AKARI [3] (Architecture Design Project for New Generation Network), have explored the future network in different technical areas, such as wireless network, big data computing and Cloud services [4-5].

As a branch of the research of the future network, ATTN is a new kind of network, integrating CS network and Optical domain exchange network effectively. The basic principle of ATTN is derived from the transportation of the train transport, so called as vehicle network. ATTN network is a new exploration of the future network in data transmission mode, designing to achieve data centralized and reliable transmission. Compared with the IP network: a. Because of the lack of perception in the network, IP network is uncontrollable. In contrast, ATTN which centralizes network transmission, processing the data in advance and strengthening the perception of the network, improves the overall performance of the network management. b. At present, there are over 30,000 AS (Autonomous System) distributed around the world, and the number of BGP (Border Gateway Protocol) default route has exceeded 330,000, of course, by 2020 this figure could be as high as 1.3 to 2 million, which all make IP network scalability lower. Contrary, ATTN network adopts fixed routes, reducing the frequency conversion and improving network scalability. c. It's hard for IP network to meet the data needs of different services in the core network, while ATTN network could attain differentiated quality of service in the core network, by choosing different paths based on business needs, improving overall network performance. As a consequence, compared with IP network, ATTN network also has some

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limitations in the flexibility and link security. However, link security is not the hardest hit but the data security, considering the pros and cons of ATTN network, there is some research value on the study of transmission mode in ATTN network.

The rest of the paper is organized as follows. Section II introduces the model of ATTN network. Section III presents the adaptive adjustment scheme and optimization scheme. Section IV shows the performance evaluation of real traces by network simulation. Section V summarizes our conclusions and future work.

2. Model of ATTN Network

ATTN network abandons the existing IP network infrastructure and proposes class train transporting system for information transmission based on the model of train in the life, which is a new network. The data center in ATTN network is called node while the transmission and switching units is called carriage. During transmission process, the carriages adopt fixed routing and timing exchange, different ATTN network could auto deploy the carriage routes and constantly adjust carriage routes based on network status and transmission demand [6]. What's more, the carriages could carry different types of data units, so when the data is uploaded to the carriages for centralized transmission, the nodes could reserve resources for the carriages according to the scheduling timetable in advance. Simultaneously, the carriages could immediately release the appropriate resources when passing.

ATTN transmission principle is derived from the model of train transportation. To specify the transmission progress of the nodes and carriages in the network, as shown in figure 1, the line represents one of ATTN transmission path, there are five nodes, node 0 is the originating node while the node C is the destination node, the other are intermediate nodes, and node X is the straight node that does not support the upload and download of data [7].

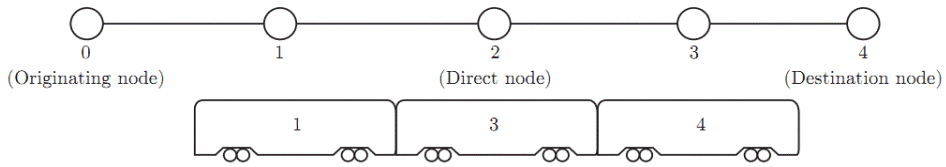

Figure 1. Distribution diagram of the carriages

Node 0 reserves appropriate resources and encapsulates the destination address into the packets of the node A, B, C, simultaneously, stores into the carriage sequentially. At the beginning time of carriages routing, node 0 sends the carriage to node X which is straight node, then the data in the node X would be sent directly to node A. Node A and node B are intermediate nodes, when the packet is sent to node A or node B, it would be downloaded and belong to the new node. Hence, node A or node B would upload the destination address for the packets to the remaining nodes, and send the carriages again. Finally, when the carriages arrive at node C, all data will be downloaded. In addition, node C would release the resources, and feedback to the management center, so the transmission is over.

In the management system of ATTN network, management unit sets routes for the carriages on the basis of monitoring the transmission needs and resources of each node, then, multicasts the information to the corresponding node timely. Therefore, according to the carriage routes uploaded to the corresponding carriage, the management unit could configure and adjust the route information dynamically, and finally, the network is always running at peak. As shown in the figure 2 is the carriage structure.

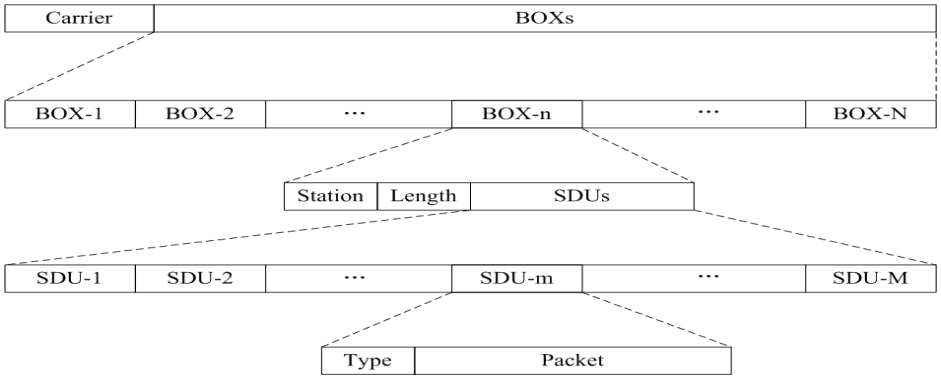

Figure 2. The structure of Carrier

In the figure, Carriage: carriage identification, BOXs: multiple BOX concatenation, SDUs: multiple SDU concatenation. Station: the node identification of SDU downloading address, Length: the length of BOX, Packet: service data, Type: packet identification.

Currently, the schemes of carriage configuration are lack of intelligence, most of which still need to be adjusted manually, and the dynamic of the routes couldn't meet the needs of users. Therefore, based on the automated configuration scheme, this paper proposes an adaptive adjustment mechanism in accordance with the forecast of data retention and resource utilization. Finally, aimed at the decline of utilization rate in above adaptive adjustment mechanism, this paper proposes a vehicle time optimization strategy, then, feasibility and effectiveness of the scheme is validated by simulation comparison.

3. Adaptive Adjustment Mechanism and Optimization Strategy

After the automated configuration of carriages is complete, the originating node would send the data to specific nodes timely in accordance with information of carriages. However, owing to the processing power and carriage routes in real ATTN network, it is likely to result in some retention of data in the node. With the time is running, the retention data in the node is gradually increasing. Meanwhile, when the data grows rapidly and there is no effective solution, the data transmission efficiency of ATTN network will decrease. To deal with this situation, the management center should monitor the performance information in real-time, and make processing and prediction of the information timely, and then adjust the carriage routes [8].

In view of the above problems, the existing mechanism in ATTN network is an adjustment mechanism based on data retention, which collects the information of nodes and carriages periodically, and increases temporary carriages timely when faced with a sudden increase of data. Moreover, if the temporary carriages have been increased more than three times in five periods, the temporary carriages routes would be set as fixed routes. The mechanism alleviates the problem of data retention in a certain degree, but the temporary carriages increasing could be handled only after collecting the information periodically, so the effect is limited. In this case, the adaptive adjustment mechanism was proposed in this paper based on the forecast of data retention and resource utilization in next period, so the temporary carriage routes could be increased or decreased in advance, ensuring the stability of the carriage routes and the efficiency of ATTN network [9-10].

3.1. Adaptive Adjustment Mechanism

The mechanism includes two aspects, the increase and decrease of carriage routes, the increase of the carriage routes is mainly based on the forecast of data retention. In this paper, two parameters ∂ , β was designed by considering historical state Q_i and data retention Q_n of current period. To make the prediction value Q_{n+1} more accurate and avoid fluctuation, the parameters ∂ , β are corrected as 0.6 and 0.4. The mean value of the history retention is $\frac{1}{n-1}\times\sum_{i=0}^{n-1}Q_i$, so Q_{n+1} is defined as Eq. (1)

$$Q_{n+1} = \frac{\partial}{n-1} \times \sum_{i=0}^{n-1} Q_i + \beta \times Q_n \quad (1)$$

According to the presence of period length, the increasing carriage routes could be classified as temporary carriage and fixed carriage. The Temporary carriage only exists in the next period and would be released when the period is finished, while the fixed carriage could run until the end of the simulation. When the predictive value of data retention in the next period is greater than Q_{add}, it reports that the current carriage routes couldn't meet the transmission demand and should be configured again. In addition, take the history retention into consideration, if the value is greater than Q_{add}, the carriage route would be set as fixed carriage. In contrast, when the value is less than Q_{add}, but Q_{n+1} is greater than Q_{add}, it reports that data retention is a burst growth and there is no universal, therefore the carriage routes are configured as temporary carriages.

The decrease of the carriage is similar with the increase of the carriage, which is based on resource utilization of the carriage, when the prediction value u_{n+1} is lower than u_{delete}, the carriage is removed. The value u_{n+1} of next period is defined as Eq. (2)

$$u_{n+1} = \frac{\partial}{n-1} \times \sum_{i=0}^{n-1} u_i + \beta \times u_n \quad (2)$$

3.2. Optimization Strategy

The Adaptive adjustment scheme dynamically adjusts the carriage routes, reducing the data retention in ATTN network. But no matter which carriage routes are increased, the resource of carriages would be consumed, resulting in the decline of the resource. Therefore, on the basis of the above scheme, this paper presents an optimization strategy to modify the carriage. When the prediction of data retention is excessive, the delay time in the node of the carriage route is revised firstly, to get more data upload by extending the delay time. Only when the data retention couldn't be resolved by adjusting the delay time, the new carriage routes would be increased.

The reason why data retention is too much is mainly from two aspects, the configuration of carriage routes and the upload of data. Therefore, it's effective to adjust the carriage routes by considering the two factors, link processing speed v_p and the number n_{ij} of carriage routes γ_{ij} from node i to node j, and the strategy is an optimization to the adaptive adjustment scheme. When the value of data retention is greater than Q_{edit} and less than Q_{add} between two nodes, the time of the carriages is modified to reduce the resource consumption. The delay time T_{delay} is defined as Eq.(3).

$$T_{\text{delay}} = \frac{\gamma_{\text{ij}}}{n_{ij} \times v_p} \quad (3)$$

In the formula, the delay time that the data retention consumes is calculated, and would be allocated fairly to all carriage routes which would pass through the node. So all the carriage routes would be effectively utilized, avoiding excessive increase of the delay time in some carriage routes. The flow chart of modifying the carriages is shown in Figure 3 (T represents data retention).

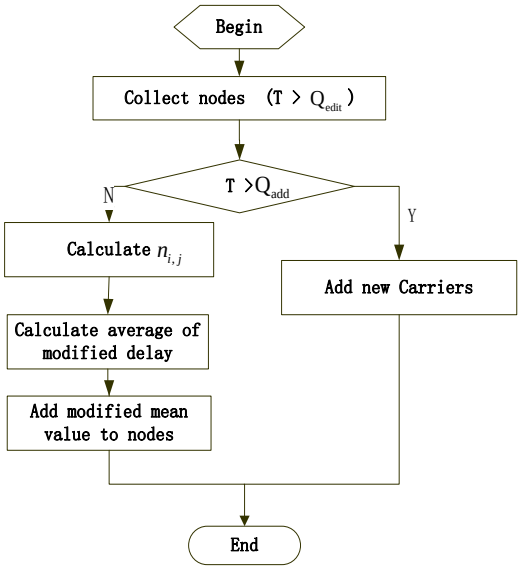

Figure 3. Optimization mechanism model

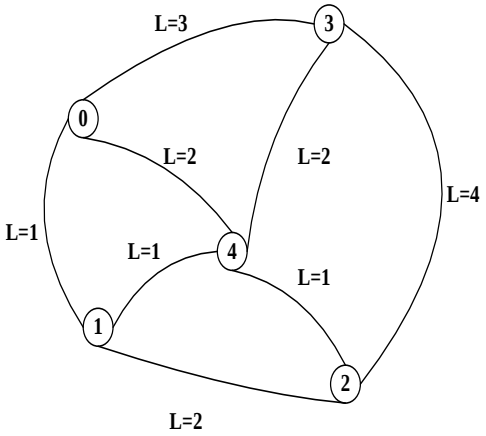

Figure 4. Network topology

4. Performance Evaluation

ATTN network is a new type of transmission model, in order to verify the feasibility of the ATTN scheme; it's urgently needed to build a new simulation platform. However, the main network simulation platforms such as OPNET, NS-3 are based on TCP / IP, which are not suitable for ATTN simulation. Therefore, this paper builds a new simulation platform by using MFC (Foundation Classes Microsoft). Firstly, configure the network topology as shown in Figure 4, 0, 1, 2, 3, 4 respectively represents the different node, while L is the route length between neighborhood nodes.

According to the automated configuration scheme, the initial schedule of the carriage routes is configured, as shown in Table 1.

Table 1. The initial schedule of the carriage routes

Line number	Carriage routes
0	2(0,5)->4(13,21)->1(29,35)->0(43,47)->3(71,73)
1	1(0,4)->0(12,18)->4(34,38)->2(46,48)
2	1(0,2)->4(10,10)->3(26,28)
3	4(0,3)->1(11,15)->0(23,25)
4	4(0,2)->3(18,20)
5	4(0,2)->2(10,12)
6	0(0,4)->1(12,18)->4(26,30)->2(38,40)
7	0(8,0)->3(34,36)
8	3(39,43)->4(59,65)->1(73,77)->0(85,87)
9	3(0,2)->4(18,18)->2(26,28)

After adding the adaptive adjustment mechanism, the data retention is shown in Figure 5. From the figure shows, due to the continuous increase of data retention in the automated configuration scheme, the rate of data retention in nodes continues to rise. Contrast with the adaptive adjustment mechanism, after adding new carriages in the previous period, the data retention is decreasing from the 4th to the 9th period. Meanwhile, aggregate the data sent by the two schemes, the resource utilization rate is shown in Figure 6, which is almost same at the beginning time, but after adding new carriages from 4th period, the resource utilization of the

adaptive adjustment mechanism is lower, that is because the transmission data is increasing which should reserve more resource in advance.

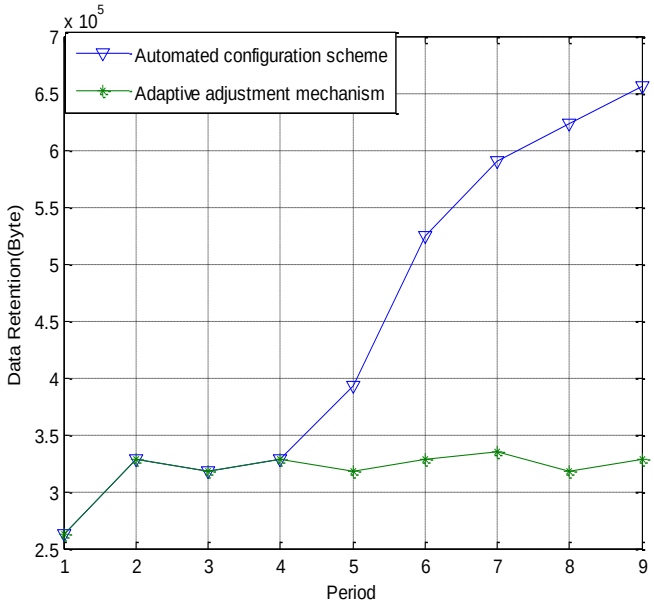

Figure 5. The comparison of retention volume

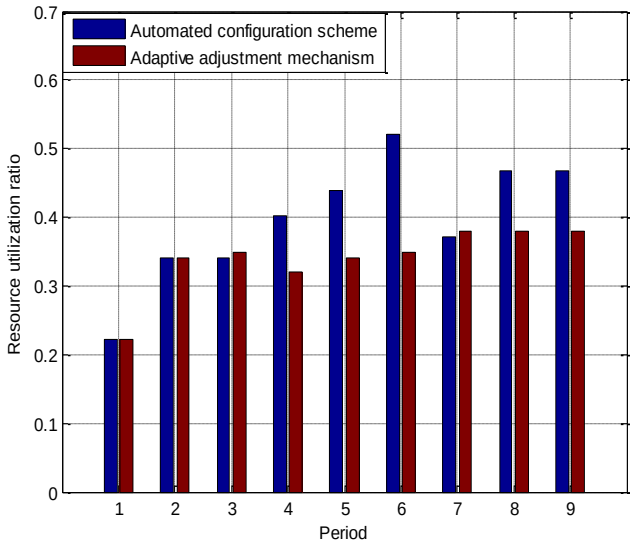

Figure 6. The comparison of resource utilization

About the problem of low resource utilization rate, this paper adds an optimization strategy to the adaptive adjustment mechanism. After optimization, the data retention and resource utilization are improved, as shown in Figure (7) and (8).

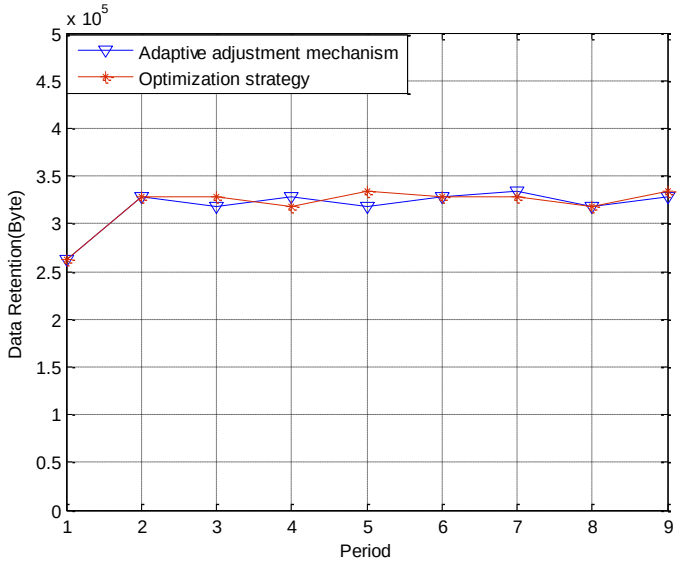

Figure 7. The comparison of retention volume after optimization

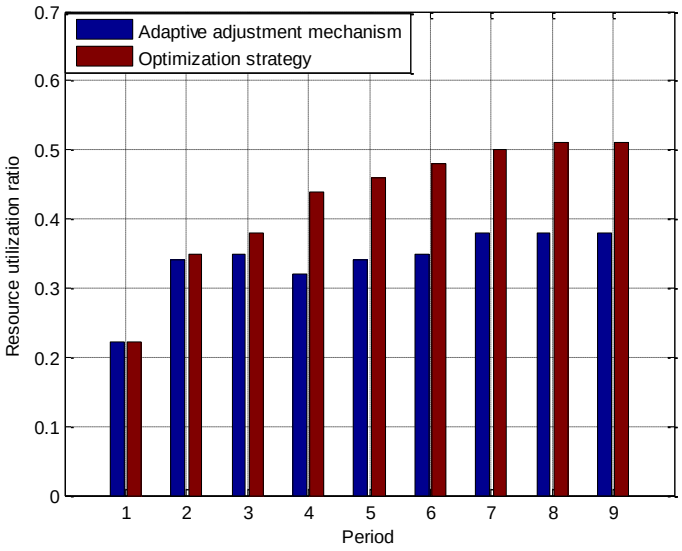

Figure 8. The comparison of resource utilization after optimization

As shown from the figures above, after adding the optimization scheme, despite that the number of increasing carriage routes is reduced, the data retention is almost same with the automated configuration scheme. And the resource utilization is getting higher because of appropriately modifying the time. As a whole, the schemes improve the performance of ATTN network.

5. Conclusion and Future work

ATTN network is a new attempt to the transmission mode of future network, which abandons the existing TCP / IP architecture. This paper presents an adaptive adjustment scheme aiming at the problem of data retention in ATTN network, in which the carriage routes are dynamically adjusted by predicting the state of next period. However, the carriage routes in

this scheme are excessive added, resulting in resource utilization lower. To solve this problem, this paper presents an optimization scheme, which adjusts the residence time of carriages in some nodes, reducing the demand of increasing carriages. Finally, by comparing with the simulation shows the system performance is improved. Overall, this paper makes some recommendations about the management structure of ATTN network, however, due to the time factor and personal ability, there are many works which should be discussed and studied, such as management modes, management functions and data monitoring, etc.

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