RSVP-CN: ONE IMPROVED RSVP MECHANISM ADAPTED TO COGNITIVE NETWORKS*

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Abstract: As an effective measure to ensure an end to end QoS, RSVP mechanism has been widely used in the QoS demanding applications. However, owing to the higher bandwidth requirements and the more complex circumstance in the networks, the current RSVP Mechanisms cannot satisfy the user's increasing requirements for Internet's QoS. The Cognitive Network has been proposed as a solution for building improved network architecture. On the basis of analyzing the existing resource reservation mechanisms and the features of cognitive network, this paper combines RVSP mechanism and the features of cognitive networks, and accordingly proposes one Improved RSVP Mechanism named RSVP-Cognition Network (RSVP-CN) to optimize the end-to-end QoS. Comprehensive simulations show that the proposed RSVP-CN mechanism efficiently improves the end-to-end QoS in the networks.

1 INTRODUCTION

With a rapid development of Internet technologies and the increasing requirements on communication, the new network services are emerging continually. And Internet traffic is growing at an exponential rate. Also, it has been driven by the increasing number of users and the introduction of new demanding applications. Clearly, the traditional network architecture that has been built in the past few years cannot offer an acceptable level of QoS to this type of applications. To address this problem, the concept of Cognitive Networks (Thomas R.W., 2005 and Fortuna Carolina, 2009) was proposed as a solution for providing end-to-end QoS guarantees over the Internet. But At present, the research involved with issues of mechanisms adapted to cognition network is still in its infancy. As the previous situation, the RSVP mechanism (Ahmad Belhoul, 2009), which is one of the most commonly applicable resource reservation mechanisms, has difficulties to cope with the growing of Internet traffic Aforementioned. The current RSVP mechanism uses the Resource Reservation to guarantee some important network services' level of QoS. And based on RSVP mechanism, Differentiated Services (DiffServ) (Spiridon Bakiras, 2004) was proposed for achieving a more suitable Resource Reservation for different types of network services. However, resource of network which has been reserved in both RSVP and DiffServ cannot be used by other network services or changed dynamically according to the Internet circumstance changing all the time. The current RSVP mechanism wastes the limited resource and cannot satisfy the user's increasing requirements for the end-to-end QoS. Furthermore, it cannot use the features of Cognition Networks, such as automatic learning, intelligence and dynamical adaptation.

To solve the above problems, this paper introduces an improved RSVP mechanism adapted to cognitive networks named RSVP-Cognition Network (RSVP-CN). In this mechanism, to make

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fully use of the advantages in cognitive network, the features of Cognitive Network (e.g. automatic learning, intelligence and dynamical adaptation) are introduced into the traditional RSVP mechanism. The RSVP-CN mentioned in this article is adapted to Cognition Networks and can increase the utilization of Network Resource. Thus, the RSVP-CN mechanism provides the higher level of QoS.

The rest of this paper is organized as follows. The Literature Review is given in the section2. The related knowledge is introduced in the section 3. The detail of RSVP-CN and the reasons why this paper introduces RSVP-CN are given in section 4. Section 5 reports a set of simulation experiments. Section 6 draws some conclusions.

2 LITERATURE REVIEW

Many Reservation Resource mechanisms have been proposed to solve the problems caused by the rapid development of internet and the increasing requirements from users. Nowadays some of them have been mature enough.

In BGRP (border gateway reservation protocol, (Ping P. Pan, 2000 and, Mohit Chamania, 2009)), the network is divided into multiple domains, and each domain can run their different resource reservation protocols. And then, all kinds of resources, status and information are stored in the domain tree structure in accordance with the core node. At finally, the router in backbone network set aside information from each domain as a whole to grasp the resource usage of entire network. Similar to the former, DARIS (dynamic aggregation of reservations for internet services, (R.Bless, 2004)) minimizes the resulting overhead, while gathering the information of resource reservation in network.

The studies on resource reservation mechanisms in wireless network also exist much. In the All-IP wireless network, the cell-based switching controller resource reservation mechanism (Bongkyo Moon, 2004) can ensure that QoS wouldn't debase while the mobile terminals move. Besides, Jiongkuan Hou, Yuguang Fang (2000) proposed a mechanism named Mobility-based channel reservation scheme for wireless mobile networks. The mechanism uses Impact Curves to describe the interference in the adjacent cell caused by a new service, and design a forecast and resource reservation algorithms based on the interference, finally solve the problem that service outages caused by the switch between cells.

Moreover, Task dividable based reservation for grid computing mechanism (PU Jing, 2008) divided resource in network into multiple sub-sets aside to improve system throughout. A Pre-Reservation Technology Based on RSVP (Guo Meng, 2004), which applied to distance learning, video-on-demand or other real-time multimedia services, gets right to use the resources in advance reservation. So from the reservation to the real beginning, this mechanism allows to set aside resources to be adjusted or canceled. Such measures improve the flexibility for the use of network resources, but they are still complex.

Although all the mechanisms above have a significant effect on improving network resource utilization and reducing rejection rate, the current studies rarely pay attention on borrowing and deployment the resources that have been set aside.

This paper introduces the feature of cognition networks into RSVP, and then proposes the RSVP-CN that provides QoS differentiated services for the heterogeneous users and allows services with a higher QoS level take up temporary operations in the idle reservation resource for other services.

3 RELATED KNOWLEDGE

3.1 Cognition Networks

Cognitive networks (Thomas R.W., 2005 and Fortuna Carolina, 2009) has been an important issue in the field of future communications, Cognitive behavioural model (Thomas R.W., 2005 and Fortuna Carolina, 2009) is shown in Figure 1: in a cognitive process that can perceive current network conditions, and then plan, decide and act on those conditions and can learn from these adaptations and use them to make future decisions, all while taking into account end-to-end goals. Cognitive technology endows communication entities with an ability of being cognitive for the surrounding environment and makes them change dynamically, intellectively and self-adaptively according to the surrounding environment.

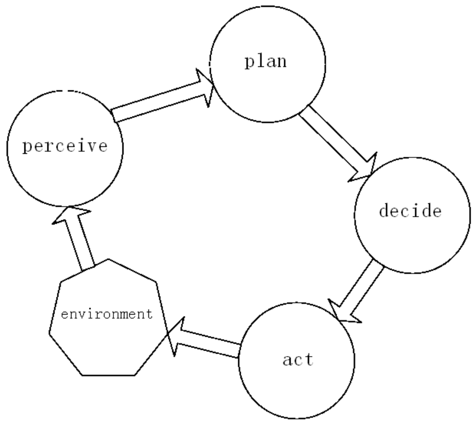

Figure 1: Cognitive behavioral model.

So, benefited from the features of Cognitive Networks, RSVP-CN can perceive the occupied reservation resources, and then decide to borrow the idle reservation resources. After acting, the change that services with a higher class of QoS take up temporary operations in the idle reservation resource for other services feedbacks to the environment. And then, a new circuit begins again.

3.2 RSVP Mechanism

RSVP (Ahmad Belhoul, 2009) can guarantee end-to-end QoS by exchanging PATH and RESV messages to reserve bandwidth of the routes. In RSVP, a source node sends PATH message to keep the state of reservation and route. Then, when the terminal which needs to reserve resources receives the PATH message, it feedbacks the RESV message. If reservation fails, the router returns RESVERR message in order to inform terminals and source nodes for processing. And in RSVP, reservation successes if the path satisfies the bandwidth request. But when idle resources don't exist, the router returns error message, the process is shown in Figure 2.

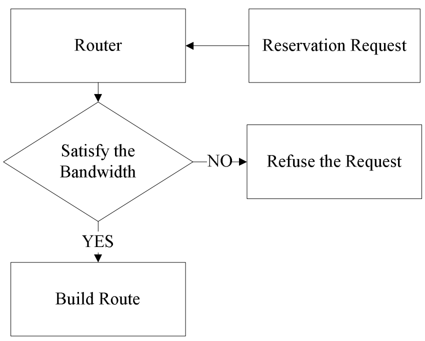

Figure 2: Reservation Process in RSVP.

While implementing QoS differentiated services, the PATH messages can carry the information that identifies the class of services' QoS. And this paper adds one module to identify the classes of QoS and decide whether to borrow the resource that has been reserved to other services.

4 THE CONSTRUCTION OF RSVP-CN

4.1 Basic Ideas

The current RSVP mechanism cannot satisfy the requirement of the acceptable level of QoS from users and isn't adapted to Cognition Networks. Hence, to solve the problems(e.g. resource wasting, low level of QoS), this paper proposed RSVP-CN which has a cognitive process that can perceive current network conditions, and then plan, decide and act on those conditions and can learn from these adaptations and use them to make future decisions, all while taking into account end-to-end goals. And in cognition networks, RSVP-CN uses the features (e.g. automatic learning, intelligence and dynamical adaptation) to identify the class of services' QoS and discovers occupied reservation. With the accurate judgment toward the circumstance of Internet, services with a higher QoS class can take up temporary operations in the idle reservation resource for other services. And the classes of QoS are differentiated according to the variety services' classes. As an improved RVSP mechanism, the advance compared with RSVP reflects in two aspects below:

1) RSVP-CN provides QoS differentiated services for the heterogeneous users.
2) RSVP-CN adds a module in the process of the RSVP, which achieves the aim of identifying the classes of the QoS and borrowing the reservation resource to the services with higher QoS class.

4.2 QoS Differentiated in RSVP-CN

In the network, heterogeneous services exist. Referring to their different importance, the services can be differentiated to several classes. In contrast to the traditional RSVP, the DiffServ (Spiridon Bakiras, 2004) whose benefit is scalability adopts this method. In RSVP-CN, as the balance between efficiency and accuracy is taken into account, QoS is divided to three classes, which are identified as high, middle and low. And this mechanism marks them with 1, 2 and 3. Thus, the mapping between services and classes of their QoS is shown in Table 1.

Table 1: Mapping between services and classes of their QoS.

QoS Class	Services Class
1	Low
2	Middle
3	High

RSVP-CN allows services with a higher QoS class take up temporary operations in the idle reservation resource for other services.

4.3 Cognition Module

In RSVP-CN, when a new service requests for reservation resource, RSVP mechanism judges whether build the reservation according to the bandwidth. Of course, while the route satisfies the reservation's requirement for bandwidth, it can be allocated bandwidth for reservation. But in Cognition Networks, the communication entities can perceive current network conditions. Hence, the source nodes, routers and terminals can search the idle reservation resources, and then decide that whether to borrow them or not. So this paper proposed one improved mechanism named RSVP-CN that adds a cognition module in the process of RSVP. And the module is shown in Figure 3.

Compared with the RSVP mechanism, RSVP-CN adds a process named Cognition Module which has two functions below:

3) Identifying the classes of QoS differentiated services.
4) Judging whether to borrow the reservation resource to the services with high QoS class.

The added module collects the information perceived by source nodes, terminals and routers, and then implements the process that allocating the idle reservation resource requested by services whose QoS class is lower than new reservation request. Besides, new service that has the same QoS

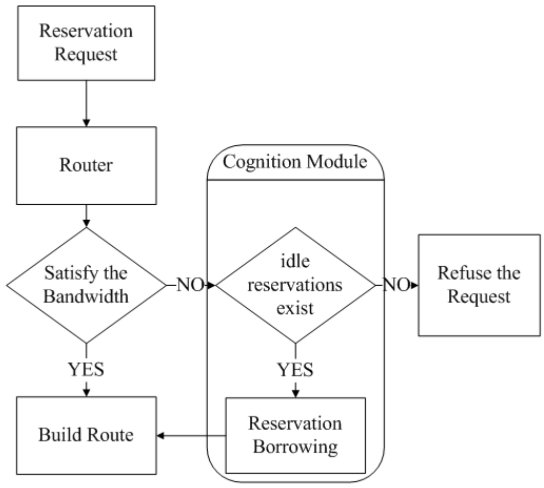

Figure 3: Reservation Process in RSVP-CN.

class with previous one would be refused. And after the new service finishes occupation, it returns the resource to previous reservation. Moreover, if some services are so important that reservation can't be borrowed their classes of QoS would be identified as the highest. So, RVSP-CN would be little possible to have a bad effect on the communication of important services (e.g. military communication).

5 SIMULATIONS

RVSP-CN mentioned in this paper was simulated with the well-known OPNET network simulator. This paper chooses the simulated network with a typical topology shown in Figure 4 below.

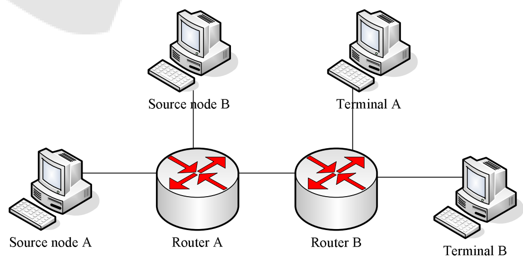

Figure 4: Simulated topology.

The widths of access links from the sender and to the receivers were set to 100Mb/s. The time that simulation takes is 150s. Additionally, a simulation for comparison is made with RSVP [10], which is the original mechanism optimized in this paper. And in the topology that this paper chooses, Source node

A and Source node B send reservation requests for services with different QoS level in a certain rate. And this paper measured number of successful requests, which reflects resource utilization and network efficiency. The simulation result is shown in Figure 5 below.

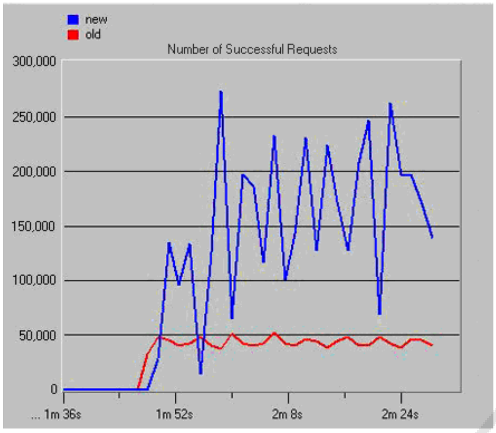

Figure 5: Number of successful requests.

In Figure 5, blue line shows the number of successful requests when topology used RSVP-CN. And the other line reflects the number of successful requests while using RSVP. Through comparison we can conclude that the improved mechanism has a significant increase in the number of requests for accept services' reservation resource. Hence, RSVP-CN can provide higher network resource utilization, reducing rejection rate and network efficiency.

Additionally, in order to reflect the change in QoS, this paper measured end-to-end delay between Router A and Router B, which is an important index for QoS. The simulation result is shown in Figure 6 below.

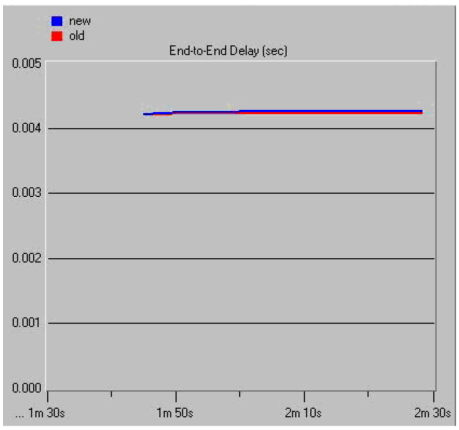

Figure 6: Delay (seconds).

In Figure 6, blue line shows end-to-end delay when topology used RSVP-CN. And the other line reflects end-to-end delay while using RSVP. Through comparison we can conclude that although the blue line generally is over the red line, the difference is not large. Hence, RSVP-CN don't recede QoS, but it has increased the number of requests.

6 CONCLUSIONS

According to cognitive networks being capacity of perceiving the state parameters of internet's environment self-learning and adaptively. This paper proposed one improved RSVP mechanism adapted to cognitive networks – RVSP-CN. The proposed mechanism combined with features of cognition networks is an effective way to provide reservation resource in the internet.

Today introducing the concept of cognition networks to current mechanisms is still in its infancy. But in the future there will be more relevant studies in the field. And the mechanisms adapted to cognition networks will involve with more aspects in the network, such as server load balance, the existing prediction algorithms, even for the re-classification and definition for QoS indicators.

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