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# Research on the QoS Control Technology in Overlay Network Based on Distribution Application

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**Abstract.** In recent years, most distributed multimedia applications are deployed directly on the Internet, and to carry real-time streaming services on the Internet is still very serious challenges. Internet is constructed on the basis of TCP/IP protocol, which provides the only best effort service, and adopts the best strategy of meet competition for all the service requests. This method lacks efficient resource scheduling classification, which leads to a variety of network resource sharing prone to bottlenecks and reduce the network throughput. Therefore, a good way to guarantee quality of service on multimedia application should be established based on the existing Internet architecture. In this paper, firstly, the low load balancing QoS routing technology is proposed with the application requirements of distributed multimedia services in overlay network. Characterization of the path through the establishment on the profit and loss model of resource consumption, resource consumption will be bound into the path of incremental choices. Secondly, the fast QoS re-routing technology is studied, and the introduction of reconstruction costs model, as constrained alternative routing process. Theoretical analysis shows that the method can effectively improve the efficiency of route recovery time and reduce the recovery delay. Finally, a dynamic QoS-aware approach to changes in demand is established. The training samples by the principle of self-learning assessment model to establish a unified system of shielding parameters of the difference between the ability to adapt to different QoS parameters for monitoring.

**Keywords:** QoS control, Route technology, Overlay network, Distribution application

## 1. Introduction

Today, with the micro-electronics, audio-visual, computer and communication technology, multimedia technology has been given new content, people can provide a variety of real-time multimedia network applications: video on demand (VOD) [1], video conferencing [2], interactive TV [3], video surveillance [4], involving the production, design, management, research, education, health, security and entertainment. Multimedia system is no longer an isolated stand-alone multimedia information processing system, but into a wealth of network behavior, with ability to interact with a distributed multimedia system.

However, most of the distributed multimedia applications are deployed directly on the Internet, and to carry real-time streaming services on the Internet is still very serious challenges. First of all, Internet is the TCP / IP protocol is built on the basis provides the only "best effort" service, for all service requests are based on the best strategy to meet competition, the lack of efficient resource scheduling classification [5]. Is a direct consequence of this approach led to a variety of network resource sharing prone to bottlenecks and reduce the network throughput. Secondly, TCP or UDP protocols while traditional Internet applications provide some fault tolerance and error correction features, but is not applicable for real-time business. TCP retransmission mechanism to delay the introduction of real-time business can not be tolerated. The UDP is a connectionless unreliable protocol, can not guarantee real-time business continuity and stability [6].

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## 2. The Related Work on QoS Control Technology in Overlay Network

The well-known model of integrated services (1ntServ) and the Differentiated Services (DiffServ) are proposed by IETF to guarantee the QoS of IP layer [7]. IntServ concern is how to ensure appropriate QoS for each stream to obtain services through resource reservation protocol (RSVP) to reserve resources in the data path, but because of the need to save each router for each data stream of information and resource reservation data, which makes 1ntServ relatively poor scalability. DiffServ is a problem encountered for IntServ raised, it will be divided into the network edge and core area, edge router, the region needs to have a strong ability to complete the flow regulating function, Including classification and adjustment (measurement, marking, shaping and dropping), and admission control functions, while the core domain of the router edge routers only need to gathering streams classified according to certain rules (per hop behavior, PHB) forwarding treatment, making core router has a good scalability [8]. DiffServ edge router through the classification and regulation of PHB combination of a core router to complete the same service, but because there is no reservation system, and can not guarantee end to end QoS. It also proposed in the IP layer QOS to ensure a variety of mechanisms, such as multi-protocol label switching (MPLS), traffic engineering (TE) and QoS routing, these mechanisms are often combined with 1ntServ or DiffServ [9].

IETF's security technologies are mainly various types of QoS IP layer for network, application of this technology is to modify the underlying network architecture for the price. Therefore, as integrated services and differentiated service model such systems is difficult in the Internet technology has also large-scale application. Subsequently, it is proposed according to the different needs of many overlay network model and the model they studied their own testing and deployment, achieved some desired effect, they use the Internet top design agreement models and algorithms for network performance improvement and optimization [10], thus avoiding application-specific changes in the underlying infrastructure needs, as shown in Figure 1 describes the development process of overlay network.

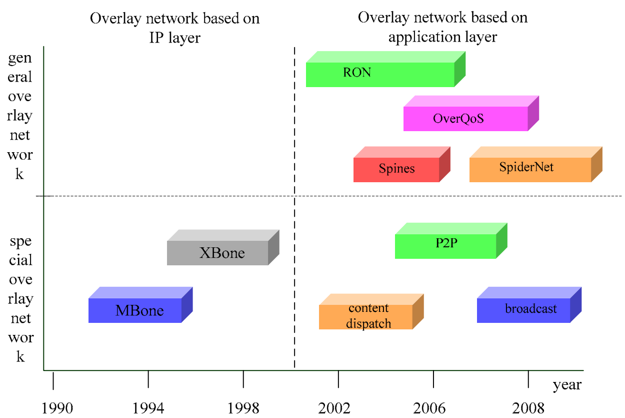


Fig. 1: The history graph of overlay network

The overlay network system made the initial to solve the efficiency of IP transmission, which deployed in the network layer, through the realization of the transformation of traditional routers [11]. In 1992, the first overlay network system MBone is developed by Eriksson who works on the Massachusetts Institute of Technology [12]. The system "Tunnel system" deployment of existing IP multicast Internet side of a large-scale network, aimed at resolving the IP Multicast in the Internet on a large scale can not be the problem. In 1998, XBone is to meet the IP-based network infrastructure projects to accelerate the deployment of overlay network designed control system. It can end automatically configure the IP address and domain graphical user interface, this design enables easy routing configuration and SSL encrypted HTTP session through the remote maintenance [13]. With the increasing demand for distributed application, overlay network technologies are applied in the application layer of the distributed system, during the various branches of research. Targeted at specific applications, such studies are usually based on well-defined structure (well-defined-structure-based) applications designed.

In 2001, David Andersen designed a distributed system built for a reliable and flexible network coverage RON (Resilient Overlay Networks) [14]. The system goal is to provide reliable end to end data transfer recovery mechanism, through the interaction between nodes, the performance monitoring and data collection methods can be found in the path loss within a few seconds, and periodic performance degradation and make it back to normal. In 2003, Claudiu Danilo and Yair Amir developed a data transmission for multimedia coverage of the network Spines [15]. The system-by-hop transport protocol design and real-time recovery protocols can be very good to improve the real-time transmission delay, packet loss and throughput, can support the right have higher QoS requirements of real-time transmission of multimedia services such as VoIP, video conference, 3GPP's IP Multimedia Subsystem IMS, etc. In 2004, Subramanian Design OverQoS system is a scalable quality of service QoS guarantee coverage network [16]. OverQoS can be of different QoS requirements of service data flow classification, the same service data flow QoS requirements are converging to a bundle of resources is a bundle as the basic unit of allocation scheduling. In 2006, Xiaohui Gu proposed specific overlay network middleware, multimedia delivery system of the original SpiderNet. It enables dynamic distributed multimedia service composition mechanisms [17]. The system in the region of measurement protocols (BCP) and load balancing strategy for the design of a QoS-aware service composition algorithm, can improve the utilization of network resources.

# 3. The Low Load Balancing QoS Routing Technology

## 3.1. QoS Routing Model

The system needs to meet the QoS service composition problem as a multi-constrained QoS routing problem, the model is defined as follows:

(1). QoS Routing in Overlay Network

Given a graph G = (V, E), find a path P = （ω 1, ..., ω k, ω ∈ E), from the source node Vs to destination node Vd. Path must satisfy the following conditions:

① End to end service gain is greater than the minimum gain constraint.

$$G(P) = \sum_{i=1}^{n} G(P_i) > G', i = 1,2,\ldots\ldots k, P_i \in P \tag{1}$$

② End to end service costs is less than the maximum cost of service constraint.

$$C(P) = \sum_{i=1}^{n} C(P_i) > C', i = 1,2,\ldots\ldots k, P_i \in P \tag{2}$$

(2). Heuristic function of link load balancing

Routing model uses the classical source routing the shortest path algorithm Dijkstra, The algorithm relies on greedy principles, always select the maximum or minimum weight with the link as the shortest path, and calculating the current link load balancing function is the level of heuristic algorithm core. Affect the degree of load balancing factor is divided into two categories: Characterization of resource utilization of the gain factor G and the characterization of resource consumption, profit and loss factor C. Therefore, it needs to establish the gain and loss calculation model.

Implementation of Dijkstra algorithm assuming a red dot to the existence of service path between the source nodes is P, hop number is $t_p$, services to meet the basic constraints $T = \{r, c, q, c\}$ (latency, bandwidth, reliability, etc.), various load balancing constraint factor as follows:

① gain calculation

$$C(P) = \frac{(\sum_{i=1}^{t_p} C(m_i))^2}{t_p \cdot \sum_{i=1}^{t_p} C(m_i)^2}, m_i \in P \tag{3}$$

$C(m_i)$ is path P on the availability of computing resources of nodes $m_i \cdot C(m_i) = c_i / c_i'$ , $c_i$ is the link i available computing power. $c_i'$ is the maximum computing power.

$$B(P) = \frac{(\sum_{i=1}^{t_p} B(l_i))^2}{t_p \cdot \sum_{i=1}^{t_p} B(l_i)^2}, l_i \in P \tag{4}$$

$B(l_i)$ is for the path P on the node $l_i$ bandwidth availability, $B(l_i) = r_i / r_i'$ , $r_i$ is is the link i available computing power. $r_i'$ is the maximum computing power.

② profit and loss calculation

Access to the path T after the traffic caused by the consumption rate of increment of the system:

$$\begin{aligned} \Delta \mathrm{B(P)} &= (r_t/r_1 + \lambda_1 r_t/r_2 + \lambda_1 \lambda_2 r_t/r_3 \ldots\ldots + \prod_{\mathrm{i=1}}^{\mathrm{t_p-1}} \lambda r_t \Big/ r_{t_p}) \Big/ r_{total} \\ &= (1/r_1 + \lambda_1/r_2 + \ldots\ldots + \prod_{\mathrm{i=1}}^{\mathrm{t_p-1}} \lambda_{\mathrm{i}} \Big/ r_{t_p}) \frac{r_t}{r_{total}} \end{aligned} \tag{5}$$

$\lambda_i$ is node i on the flow of factors, $r_i$ is the link i available bandwidth, $r_{total}$ is the sum of the current link available bandwidth resources. Considering the general routing problem, take $\lambda_1 = \lambda_2 = \cdots \cdots \lambda_{t_P-1} = 1$. Simplified formula for the incremental flow coefficient is as follows:

$$\Delta B(P) = \sum_{i=1}^{i=t_p} \frac{r_t}{r_i \cdot r_{total}} \tag{6}$$

### 3.2. Weighted Strategy Based on System Load State

Algorithm respectively for the system in overload and light load situation of the price of the service consumption and optimization design of the different needs of the situation model system load, dynamically weighted load balancing and network usage factors, the algorithm can be adaptive to the service resources distribution of fair dealing. We adopt exponential weighting method, $\alpha$ is load factor, set the threshold based on the system load the decision state model is as follows in Table.1:

## 4. The Fast QoS Re-Routing Technology Based on Reconstruction Model

### 4.1. Expansion of the Four-Way Multi-Direction Search Algorithm

The Figure.2 describes the basic principles of FRRA algorithm.

Assume the existence of service T, the service path is S-> D, failure region is located in the path S1-> S2 Department, the implementation of the LBQAR algorithm to solve four interval were alternative routes: S-> D, S-> S3 , S2-> D and S1-> S3. It will be a collection of alternative routes were merged with the original path can not repeat were obtained four new alternative paths.

Table 1: System Load Condition Evaluation Model

| | |
|---|---|
| $\alpha = 0.2$ | Volatility of system average load SALF is below the set range of lower |
| $\alpha = 0.5$ | Volatility of system average load SALF is between the set range |
| $\alpha = 0.8$ | Volatility of system average load SALF is high the set range of upper |

$$\mathrm{SALF} = \frac{(\sum_{i=1}^{n} C(m_i))^2}{n \cdot \sum_{i=1}^{n} C(m_i)^2} \times \frac{(\sum_{i=1}^{k} B(l_i))^2}{k \cdot \sum_{i=1}^{k} B(l_i)^2}, m_i, l_i \in G \tag{7}$$

n, k is the number of nodes and link for G.

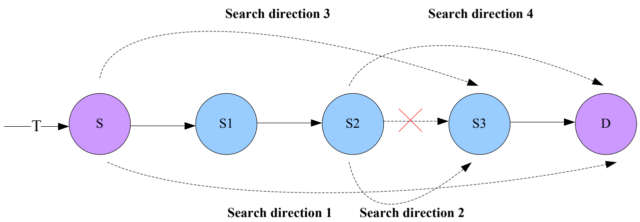


Figure 1. The process of four-way search

## 4.2. Reconstruction Cost Model

Selecting set of alternative paths, the building model reconstruction costs for each alternative path is to the value of the option. Firstly, we calculate the gain of each path in the QoS $\omega$ (gain of function definition depends on the target problem). Get the new path the path to re-establish the connection set of $P_1$. Available to connect the old path need to close the path set $P_2$. To create a new link connecting the delay and delay closing the old connection obtained reconstruction delay T. Finally calculate the gain of each path of QoS - the proportion of reconstruction delay factor, take the path of the four options the highest scale factor value of the path for the final results of alternative paths to meet targets.

$$w = f_{li}(G(QoS_A), G(QoS_B), \ldots\ldots) \tag{8}$$

$$P_1 = |F\{Path_{new}\}| - |F\{Path_{new}\} \cap F\{Path_{old}\}| \tag{9}$$

$$P_2 = |F\{Path_{old}\}| - |F\{Path_{new}\} \cap F\{Path_{old}\}| - Path_{invalid} \tag{10}$$

$$T = Delay(P_1) + Delay(P_2) \tag{11}$$

# 5. Dynamic QOs Aware Approach to Changes In Demand

## 5.1. Basic Principles and Ideas

Its basic principle is that through the means of measuring ability of the user QoS parameters of sampling and evaluation methods of static threshold based on the judge QoS "overflow" exception. The static threshold method must still rely on experience concludes threshold range, the range would affect the accuracy of anomaly detection, can not be applied in a variety of different QoS requirements under variable perceptual situation.

The basic idea is based on the current access bandwidth, the maximum demand for bandwidth, real-time transmission delay, packet loss rate and other parameters (more parameters can be obtained) to establish information needs of business transfer characterization, current model projections based on statistical analysis of quality of service required parameters of appropriate coping strategies to adjust the quality of service levels to meet the multimedia data distribution, to reduce data transmission delay, jitter delay to avoid serious data packet loss, bit error.

## 5.2. QoS Requirements Based on Changes in Residual Calculation Method of Dynamic Perception

Demand characteristics of the user's QoS feature is divided into active and passive characteristics of two kinds. The so-called active features is the user for the service demands made by the initiative, such as the user requests the video source format, size, bit rate, etc., this feature stems from the nature of the application, with the request change the mode. The passive characteristics of that platform by means of measuring the user's physical ability to detect conditions, such as the user's available bandwidth, packet loss, delay, etc., in the face of such changes in user demand often requires platform system with adaptive adjustment capacity. Multimedia services can be set so the basic feature set of users.

Characterization of QoS state for each user characteristic variables that may be seen as a transition between different states of a parametric model, each state is Gaussian distribution, this model is called finite mixture model GMM. A QoS observation of a variable X is K a Gaussian distribution in a generation, the following equation follows:

$$x_i = m_k + \varepsilon_k, k = 1, \ldots\ldots K \tag{12}$$

$$P(x_i) = \sum_{i=1}^{k} \frac{\pi_k}{\sqrt{2\pi} \cdot \phi_k} \exp \frac{-(x_i - m_k)}{2\phi_k^2} \tag{13}$$

## 5.3. Experiment Analysis

In WIFI wireless network, is estimated based on the item's residual model checking point of the delay QoS parameters. From Figure.3 can be seen, when the abnormal situation, the residual distribution of the beating of a sudden, the changed distribution remains approximately normal distribution, but the average is no longer close to zero, but has a more large deviations. Figure.4 can be found in the abnormal distribution of the residual mean time the pre-slight changes, if the situation can be perceived changes in catch, will be an earlier occurrence of anticipated exceptions to take measures to prevent abnormal.

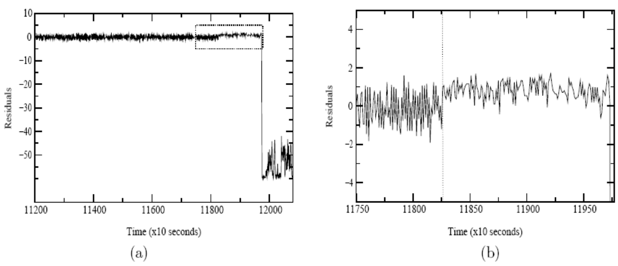


Fig. 2: The experiment analysis results

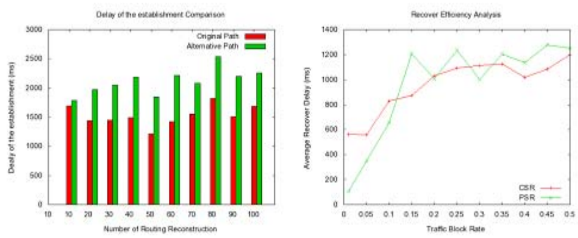


Fig. 3: The reconstruction delay the recovery process

## 6. Conclusion

LBQAR algorithm is introduced based on the traditional method of resource consumption constraints, there is less consumption of resources helpful in choosing the path load balancing to reduce the service load on the system's impact and improve throughput. Furthermore, the algorithm based on system load conditions using the weighted-loss and gain factor of the method, makes the system under light load to maximize resource utilization, minimize system under the heavy loss, to achieve equitable distribution of resources.

FFRA algorithm is based on the introduction of the traditional path of reconstruction algorithm when the delay constraint as one of alternative path selection criteria will help select an alternative path to recovery faster. Algorithm is also proposed direction of the path search using multiple extension methods of region-wide failure, can increase the effective number of alternative paths of candidates can improve the quality of alternative paths selected probability of success.

Dynamic QoS requirements of the adjacent sensing method using estimated values of the residuals between the observed parameters of the distribution is independent of the distribution of characteristics, to avoid the experience of different QoS parameters need to infer the threshold range of different issues, breaking the static threshold method limitations.

## 7. Acknowledgment

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