Method of Forming Complex Services in Networks using Virtualization Technology of Network Functions

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Abstract

NFV technology allows you to replace physical network devices with certain functions with their software image as virtual network devices that perform the same functions on public server equipment. In order to cover the whole range of solutions for providing the required quality of service, it is necessary to develop a method for increasing the QoS level, in the absence of services with the required level of quality of service. In order to solve the problem, a mathematical method for the formation of a distributed complex service based on the information on available atomic services in the network is proposed. The proposed method allow to increase the reliability and performance of the requested services. Applying the method of forming a distributed service and a method to increase the reliability of the service will allow to supplement and improve the mechanism of formation of services with the required quality indicators, increase the number of better services in the network, reduce the load of services with high PCs through the use of services with lower values of parameters QoS.

Keywords

Network functions virtualization (NFV), virtual network, complex service, Quality of Service (QoS), atomic services

1. Introduction

NFV technology allows you to replace physical network devices with certain functions with their software image as virtual network devices that perform the same functions on public server equipment. Physical network devices, in this case, can be switches, routers, etc., which performed the physical function of switching, routing, etc. Virtual network devices perform virtual network functions of switching, routing, etc. NFV technology originated among non-traditional methods of network development and is designed to overcome a number of limitations in the development of communication networks (flexibility, scaling, administration, etc.) and add additional benefits to this development (freedom of equipment choice, speed and efficiency, flexibility, etc.).

Interaction of computers with each other, as well as with other active network equipment, in TCP / IP-networks is organized on the basis of the use of network services, which are provided by special processes of the network operating system (OS). A network service provides network users with a set of services, also called a network service. Examples of network services are web servers (World Wide Web sites), e-mail, FTP servers for file sharing, and more.

In accordance with the recommendations of RFC 7149 and IETF P1904.3, as well as several other recommendations [2–4, 9], for the assessment of quality indicators for integrated services, it is suggested to use a set of indicators:

• The cost of providing a comprehensive service Cost(s)
• Response time when forming an integrated service T(s)
• Reliability of the service R(s)
• Availability of service Av(s)

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In order to cover the full range of solutions to ensure the required quality of service, it is necessary to develop a method of increasing the level of QoS in the absence of services with the required level of service quality. The maintenance of the required quality indicators often amounts to solving the optimization problem in the formation of services [5, 6, 7, 10].

In that case, if the complex service satisfying the given restrictions will not be found in the selection of its composite (atomic services), which allow to form. In order to cover the whole range of solutions for providing the required quality of service, it is necessary to develop a method for increasing the QoS level, in the absence of services with the required level of quality of service. In order to solve the problem, a mathematical method for the formation of a distributed complex service based on the information on available atomic services in the network is proposed.

At the heart of the proposed method is the idea of forming an complex service consisting of several services from a multitude of available services whose quality indicators are below the set standards, the simultaneous use of which will increase the availability of the service:

$$CS_i \subset CS,\ CS_l = \{ CS_1, CS_2, \dots ,CS_i, \dots , CS_n \},$$

$$CS_i = \{ S_w, S_{w+1}, \dots ,S_{w+y} \},$$

where i – number of complex services in the set CS, w – service number in the selected subset of atomic services CS_i, z – number of services in a subset of atomic services CS_i, y – any number from 1 to (z – w), while the situation is possible when $CS_i \cap CS_{i+1} \neq \emptyset$, S – functionally equivalent services. Distributed complex service can be represented as a combination of a variety of services P_i. In this case, QoS parameters of atomic services P_i may have values lower than the required ones, however, due to their simultaneous use, the aggregate performance indicators of the distributed service increase.

The method of forming a distributed service allows you to create a service with specified values of quality parameters in the case when there is no service with the required quality indicators in the network with support for virtualization technology. This algorithm is below.

The values of the considered QoS parameters are represented by the set L. Information on the QoS indicators of atomic services is extracted from the modified UDDI register [1].

The set Q represents the value of the QoS parameter, which does not meet the user's requirements. The set Q belongs to the set L, $Q \subset L$. The set Z also belongs to the set L, $Z \subset L$, and includes all the parameters of this set, except for the parameter belonging to the set Q, $Z = L \setminus Q$.

2. Pseudocode for Forming a Complex CS Service

Beginning:
Selection of parameters QoS from SLA (Service level agreement):

$$SLA_{req} = \{Cost_{req}, T_{req}, R_{req}, S_{req}, Av_{req}\};$$

for $w = 1..N$
  search S_w, which is part of a comprehensive service CS;
for $w = 1..N$
  search S_w, which are functionally equivalent;
for $w = 1..N$
  formation of a set of S_w services that meet the requirements for quality of service QoS;
i = 0;
i = i + 1;
if I < N
  then Calculation max P_i;
  If G $\subset$ L
  then if $M_{K\,sum} \geq M_K (SLA_{req})$;
    j = 0;
    j = j + 1;
    if j < d
    if H $\subset$ L then if $M_{Dj\,sum} \geq M_{Dj} (SLA_{req})$

if j < d then go to “ j = j + 1 ”;
else Saving the service in QoS;
f = f + 1;
else if $M_{Dj\,sum} \geq M_{Dj}\ (SLA_{req})$
if j < d then go to “ j = j + 1”;
else Saving the service in QoS;
f = f + 1;
else
else if $M_{K\,sum} \geq M_K\ (SLA_{req})$
j = 0;
j = j + 1;
if j < d
if H ⊂ L then if $M_{Dj\,sum} \geq M_{Dj}\ (SLA_{req})$
if j < d then go to “ j = j + 1 ”;
else Saving the service in QoS;
f = f + 1;
else if $M_{Dj\,sum} \geq M_{Dj}\ (SLA_{req})$
if j < d then go to “ j = j + 1 ”;
else Saving the service in QoS;
f = f + 1;
else go to “ i = i + 1 ”;
else if f > 0
then if f > 1
then QoS generation for a set of S-compliant services $SLA_{req} = \{Cost_{req}, T_{req}, R_{req}, S_{req}, Av_{req}\}$;
Rationing of values *R*;
Deciding on the provision of a comprehensive CS service;
Formation of information on access to a comprehensive CS service;
else Generation of a message about the impossibility of providing the service to the user
The end.

3. Results and Discussion

The set *H* and *G* belong to the set L, $G \subset L$, $H \subset L$, $Z \cup H = L$. The set *H* includes the PCs that need to be maximized, and the set *G* includes quality indicators that need to be minimized.

User requirements for quality of service are represented by many

$$SLA_{req} = \{Cost_{req}, T_{req}, R_{req}, S_{req}, Av_{req}\}.$$

Search of all CS of this service without taking into account quality indicators should be carried out in the event that at the request of the user the service with necessary PCs is not found in a network.

Further, the integral QoS indices of the selected integrated service are compared with the requirements of the quality of service provided by the set SLA_{req}.

In the case where the QoS parameter tends to maximize its values, then the comparison is performed as follows:

$$M_{K\,sum} \geq M_K\ (SLA_{req})$$

Otherwise, $K \subset G$:

$$M_{K\,sum} \geq M_K\ (SLA_{req}).$$

If satisfies the $M_{K\,sum}$ requirements for the QoS parameter that belongs to the set *K*, then the other QoS parameters, which belong to the set *Z*, are checked. This action is necessary in order for the selected complex service not only to have quality characteristics not lower than the required parameters, but also retained the value the remaining parameters within the required limits. In case if Z_j this parameter QoS belongs to the set H ($Z_j \subset H$), then the comparison takes place as follows:

$$M_{Dj\,sum} \geq M_{Dj}\ (SLA_{req})$$

Otherwise, $Z_j \subset H$:

$$M_{Dj\ sum} \geq M_{Dj}\ (SLA_{req}).$$

In the event that the integral values of the quality indices from the set Z are lower than the required ones, then the following subset of the services CS i selected from the set is checked. In the opposite case, the service i is stored in the set $CS1$.

If there are unchecked subsets in the CS set, the verification process continues. Otherwise, an analysis of the formed set of $CS1$ is performed.

If the set $CS1$ is empty, a message is sent to the user about the absence of a network service with the required PC. If the $CS1$ set consists of one service, then the user is provided with the address of this service.

In the event that the $CS1$ set includes more than one S service, then the calculation procedure for the service with the best parameters is performed.

In the first stage, a matrix of quality QoSM services is created which are included in the set of $CS1$ and the vector of SLA_VEC with the requirements of the user on the quality of service:

$SLA\_VEC = SLA_{req} = \{Cost_{req}, T_{req}, R_{req}, S_{req}, Av_{req}\}$,

where f – the number of services in the set $CS1$, i - the service number in the set $CS1$, j - the number of the QoS parameter in the set L, and 1 - the number of QoS parameters in the set L.

Next, the normalization of the PC of the matrix QoSM and the vector SLA_VEC is performed.

The next step is to calculate the Euclidean distance between the vectors $CS1$ and SLA_VEC:

$$dis\ (CS1_t\ , SLA\_VEC) = \sqrt{\textstyle\sum_{a=1}^{l}} (CS1_{t\,a} - SLA\_VEC_a)^2.$$

In the event that for the user some parameters are more important than others, then when comparing services, this priority is taken into account using the weighting factor represented by the vector K, $K=\{k_1, k_2, \ldots, k_a, \ldots, k_l\}$:

$$dis\ (CS1_t\ , SLA\_VEC) = \sqrt{\textstyle\sum_{a=1}^{l}} (CS1_{t\,a} - SLA\_VEC_a)^2 * k_i\ .$$

In the next step, the $CS1$ service with a minimum Euclidean distance is determined. Further, the address of the selected service is provided to the user.

4. Conclusion

The proposed method allow to increase the reliability and performance of the requested services. Applying the method of forming a distributed service and a method to increase the reliability of the service will allow to supplement and improve the mechanism of formation of services with the required quality indicators, increase the number of better services in the network, reduce the load of services with high PCs through the use of services with lower values of parameters QoS.

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