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# Research on Cross-node Interaction Method based on Cross-domain Network

Du Zeyan<sup>1,3</sup>, Li Binyong<sup>2,a</sup>, Xie Dayong<sup>1</sup>, Huang Lang<sup>1</sup>, Han Min<sup>2</sup>

<sup>1</sup>College of Yinxing Hospitality Management, Chengdu University of Information Technology, 611743 Chengdu, China

<sup>2</sup>College of Cybersecurity, Chengdu University of Information Technology, 610225 Chengdu, China

<sup>3</sup>College of Management and Economics, Kunming University of Science and Technology, 650093 Kunming, China

<sup>a</sup>Corresponding author: lby@cuit.edu.cn

**Abstract.** In this paper, a cross-node interaction method based on cross-domain network is proposed to overcome the slow speed of single-path or double-path information interaction between traditional network nodes, as well as the defect of node fault affecting overall interaction. Based on this method, the cooperative interaction between cross-domain nodes is studied by establishing the relationship among the receiving and sending points, the inner node ring, the middle node ring, and the outer node ring between the task receiving points, the inner node ring, the middle node ring and the outer node ring. The node function and the node association function are constructed by using the information transfer and interaction path between the nodes and the receiving and sending points of the task, which avoids the phenomenon of too few access paths and congestion. Therefore, each path of cross-domain network can be reasonably utilized, which provides a scientific and feasible method to ensure the stability of cooperative interaction of cross-domain network.

## 1. Introduction

Interaction is the behavior that occurs between two or more parties that can interact with each other. In the traditional network node interaction, each node is interrelated and dependent, each interaction has a causal relationship. It takes the network as the transmission medium and stipulates that entities cooperate with each other in the process of requesting resources or services.

However, the existing network node interaction methods, node-to-node information association or transmission paths are usually only one or two. Although the structure is relatively simple, when it is necessary to deal with a large number of or multi-level tasks, there are only a few limited information transmission paths, which will lead to congestion and congestion in the transmission of information tasks. Therefore, the efficiency of task release and customer access will be greatly affected, and the efficiency of information interaction will also be greatly reduced.

In order to overcome the shortcomings of the existing technical schemes, this paper proposes a cross-node cross-cooperative interaction method based on cross-domain networks. This method avoids the slow speed of single-path or double-path information interaction between traditional nodes, the disadvantage of node damage affecting the overall interaction, and the phenomenon of too few access paths and congestion, which improves the stability of cooperative interaction.



## 2. Cross-node interaction scheme for cross-domain networks

In order to analyze the network-based node interaction, the overall solution shown in figure 1 is presented in this paper.

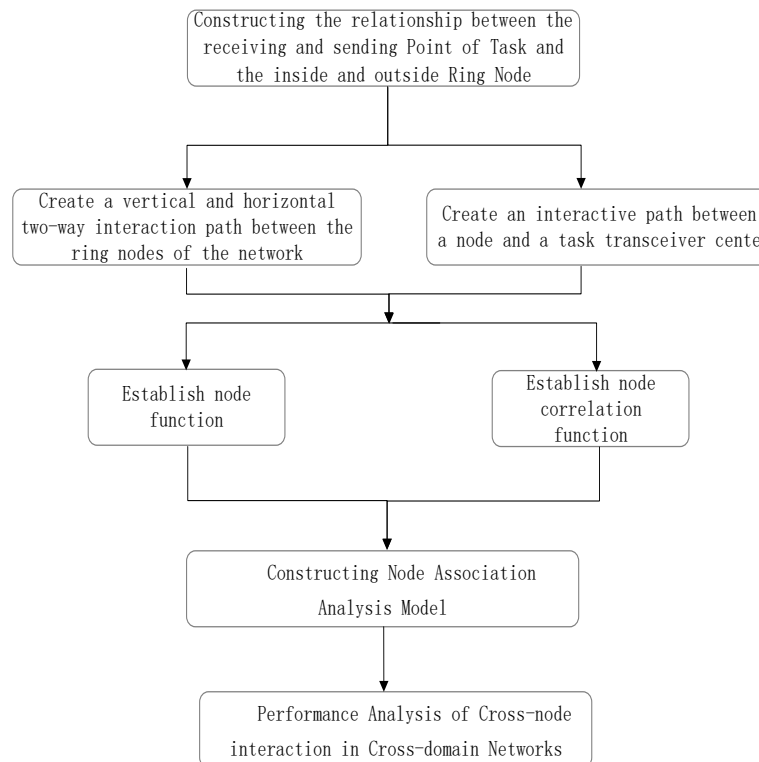


Figure 1. the overall scheme of node relationship analysis in cross-domain networks

## 3. Cross-node interaction design for cross-domain networks

### 3.1 Constructing topological association of cross-domain networks

The cross-domain network with cross-node interaction, including the task receiving and sending point, the task receiving and sending point is connected with the service processing ring, there are several task nodes on the service processing ring, and the task receiving and sending point sends the task directly to the task node.

For cross-domain networks, the topology distribution of the task nodes over the traffic processing ring is designed as follows:

Firstly, the traffic processing ring is divided into inner node ring, middle node ring and outer node ring, and the inner node ring.

In the middle node ring and the outer node ring, the three node rings are centered on the receiving and sending point of the task. The network transmission distance of all services on the same node ring is equal at the sending point of the task, which ensures that the time and level of the node processing tasks on the same node ring are the same. Thus, the node processing tasks on each node ring are more orderly.

Secondly, there are several nodes on the three node rings, and the number of nodes on the inner node ring, the middle node ring and the outer node is 4, 16, 32 respectively.

Thirdly, the nodes on the inner node ring and the nodes in the middle node ring that have network association are connected by the network association line. A number of nodes with network association between the nodes in the middle node ring and the nodes in the outer node ring are also connected by the network correlation line.

Finally, several nodes on the same ring are connected with each other, and the tasks on several nodes on the same ring are transmitted and shared, and the tasks of the same class or the same level are processed.

### 3.2 Constructing interactive paths for network nod

It is assumed that the network transmission path length ratio of the inner node ring, the middle node ring and the outer node ring to the receiving point of the task is 1:2:3. Then the nodes on the inner node ring, the node on the middle node ring and the node on the outer node ring are also 1:2:3. The length of the network transmission path from the receiving point of the task is 1:2:3. The radius ratio is the ratio of the network transmission path, the inner node ring, the middle node ring and the outer node ring have 4, 16, 32 small circles representing the nodes respectively. If the path length of network transmission is longer, the transmission time of information will be longer. Therefore, the speed of receiving the signal directly from the receiving point of the task is the fastest in the inner node ring and the slowest in the outer node ring.

In order to facilitate the discussion, the task node on the inner node ring can complete the task of the first stage, and the task node on the middle node ring can complete the task of the second stage. The outer node ring can finish the third stage task, deal with the first stage task first, then deal with the second stage task, and finally deal with the third stage task. Step by step in this way, processing tasks are more orderly and effective. The sending point of the task is the sending point of the initial task or information and the receiving end of the final processing result.

Each node in the inner node ring is associated with at least one node on the outer node ring. After completing the task of the first stage on the inner node ring, if there is no task in the second stage, the task in the first stage is processed. It transfers directly from the nodes on the inner node ring to the nodes on the outer node ring, and improves the efficiency of service processing. There is an association between the receiving and sending points of the task and the nodes on the inner node ring, the middle node ring and the outer node ring. In this way, the task receiving and sending point can directly publish the task information to any of the nodes on the three node rings, and the task receiving point can also receive the processing results of the nodes on the three node rings directly. In this way, it not only guarantees the efficiency of receiving and receiving tasks, but also provides multiple paths for information transmission, and improves the fault tolerance rate of information transmission.

### 3.3 Constructing node correlation function

The task receiving point, inner node ring, middle node ring and outer node ring are set to  $f(0)$ ,  $f(1)$ ,  $f(2)$ ,  $f(3)$  function respectively. Then  $f(1)_i$ ,  $f(2)_j$ ,  $f(3)_k$  denote the  $i$  node on the inner node ring, the  $j$  node on the middle node ring and the  $k$  node on the outer node ring respectively. This creates a three-ring node network centered on the point at which the task receives and sends:  $1 \leq i \leq 4, 1 \leq j \leq 16, 1 \leq k \leq 32$ .

Where,  $f(0)$  is associated with one of the nodes on  $f(1)$ ,  $f(2)$ ,  $f(3)$ , and every  $f(1)_i$  is associated with  $f(3)_k$ . At the same time, each  $f(2)_j$  is associated with two different  $f(1)_i$ , and then each  $f(3)_k$  is associated with two different  $f(1)_i$ . The results of the association relationship are combined into several relational representation functions, and the two nodes with the association connection are connected in a straight line. The set of  $f(1)_i$ ,  $f(2)_j$ ,  $f(3)_k$  functions contains network nodes with a specific path length or a specific hierarchy on the ring of three nodes.

Further, the association representation function includes  $f(3)_k^{2,j}$ ,  $f(2)_j^{1,i}$ ,  $f(1)_i^{3,k}$ ,  $f(0)^{1,i}$ ,  $f(0)^{2,j}$  and  $f(0)^{3,k}$ .  $f(3)_k^{2,j}$ ,  $f(2)_j^{1,i}$ ,  $f(1)_i^{3,k}$  respectively, indicating that the  $k$ th node on the outer node ring and the  $j$  node in the middle node ring are associated with each other. There is an association and cooperation relationship between the  $j$ th node on the middle node ring and the  $i$  node on the inner node ring, and the first node on the inner node ring and the  $k$  node on the outer node ring.  $f(0)^{1,i}$ ,  $f(0)^{2,j}$  and  $f(0)^{3,k}$  denotes the network association between the receiving and sending points of the task and the inner node ring, the middle node ring and the outer node ring respectively.

### 3.4 Constructing build node association model

The node function can be obtained by marking the node association on the task receiving point, inner node ring, middle node ring and outer node ring according to the above method. On this basis, the node correlation analysis diagram is made by using node function, as shown in figure 2.

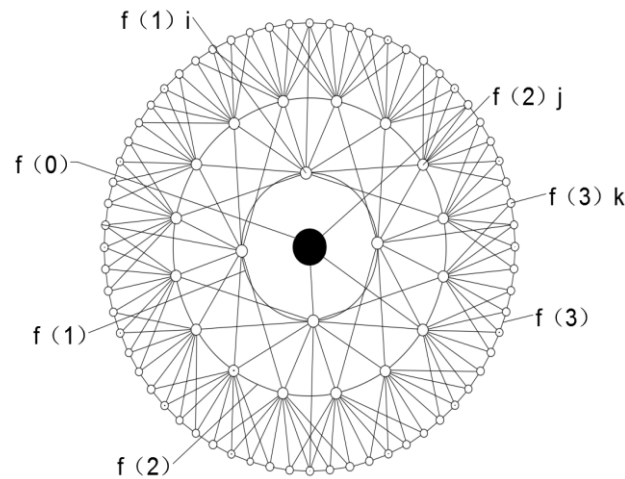


Figure 2. node association model for cross-domain networks

In this cross-domain network,  $f(3)_k^{2,j}$  contains 128 pieces of data,  $f(2)_j^{1,i}$  contains 32 pieces of data, and  $f(1)_i^{3,k}$  contains 4 pieces of data. Each data can represent not only the association between two nodes, but also the associated connection line.

Since each node on the outer node ring is connected to two different nodes on the middle node ring, the number of connection lines between the outer node ring and the middle node ring is 128. Each node on the middle node ring is also connected to the nodes on the two inner node rings, so the number of connections between the middle node ring and the node on the inner node ring is 32. Each node in the inner node ring is connected to one of the nodes in the outer node ring, so the number of connection lines between the inner node ring and the node in the outer node ring is 4. Each data can represent either the association relationship between two nodes or the associated connection line. In the node association analysis model, it is represented as the connection line connecting the two nodes on the ring of different nodes. That is, a specific associated connection path and a signal transmission path.

## 4. Performance analysis of cross-node interaction in cross-domain networks

By using the above-mentioned cross interactive connection, the outer node ring and the middle node ring, the middle node ring and the inner node ring, and the inner node ring and the outer node ring are connected and interacted, and the interrelation and interaction between the outer node ring and the middle node ring are made. This kind of cross-linking mode between vertical and transverse two-way cross-node makes the cooperative mode more diverse, the paths more changeable, and more optional and transferable ways.

Based on the node association analysis model of cross-domain network, the following task processing modes are summarized:

(1) Only to deal with the first stage of the task, the task sending point directly to the node on the inner node ring to issue the task, and then after the task processing is completed, the processing results are sent back to the task receiving and sending point, the path of receiving and receiving information is  $f(0)_i^{1,i}$ .

(2) Only the task of the second stage needs to be processed, the task sending and receiving point directly issues a task to a node on the middle node ring, and after the task processing is completed, the

processing result is sent back to the task receiving and receiving point, and the sending and receiving path of the task or the information is  $f(0)^{2,j}$ .

(3) Only to deal with the third stage of the task, the task sending point directly to the node on the outer node ring to issue the task, and then after the task processing is completed, the processing results are sent back to the task receiving and sending point, the receiving and sending path of the task or information is  $f(0)^{3,k}$ .

(4) This need to deal with the first stage, the second stage of the task, the task receiving and sending point first through the  $f(0)^{1,i}$  path to the task node on the inner node ring, after the task processing, The tasks processed on the inner node ring are then transferred to the nodes on the middle node ring through the  $f(2)^{1,i}$  path. After the task processing, the final results are sent back from  $f(0)^{2,j}$  to the task publishing point to complete the recovery of the results.

(5) This needs to deal with the tasks of the first stage and the third stage. The task receiving point first publishes the task to the task node on the inner node ring through the  $f(0)^{1,i}$  path. After the task is processed, the processed task on the inner node ring is transferred to the node on the outer node ring through the  $f(1)^{3,k}$  path. After the task is processed, the final result is sent back from  $f(0)^{3,k}$  to the task publishing point to complete the collection of the result.

(6) This needs to deal with the tasks of the second stage and the third stage. The task receiving and sending point first publishes the task to the task node on the middle node ring through the  $f(0)^{2,j}$  path. After the task is processed, the processed task on the middle node ring is transferred to the node on the outer node ring through the  $f(3)^{2,j}$  path. After the task is processed, the final result is sent back from  $f(0)^{3,k}$  to the task publishing point to complete the collection of the result.

(7) To deal with all the tasks in the first stage, the second stage, and the third stage, the receiving and sending point of the task first publishes the task to the task node on the inner node ring through the  $f(0)^{1,i}$  path. After the task is processed, the processed task on the inner node ring is passed to the node on the middle node ring through the  $f(2)^{1,i}$  path. After the task is processed, the task is passed to the node on the outer node ring through the  $f(3)^{2,j}$  path. After the task is processed, the final result is sent back from the  $f(0)^{3,k}$  path to the task publishing point to complete the collection of the result.

To sum up, when the task is published to the node on the node ring, all the paths are reasonably utilized, which can directly complete the individual tasks of each stage, but also can complete the comprehensive tasks of each stage in turn, there are many associated connection paths and many transmission paths. The efficiency of task dispatch is high, the speed of information transmission and interaction is fast, the information will not be blocked or crowded, and the stability of cooperative interaction can be improved.

## 5. Conclusions

By studying the propagation paths of various nodes and information, this paper can express the significance of the cooperative interaction model between vertical and transverse nodes more intuitively. The cross-node interaction method of cross-domain network proposed in this paper has the advantage of multiple associated connection paths and improves the coupling degree of node interconnection flexibly. When the number of nodes is determined, the method can effectively increase the cross-domain network interaction path, improve the efficiency of information access and task transfer, and reduce the possibility of failure of task publishing and information access. The whole cooperative interaction system is more stable. At the same time, this method not only has high efficiency of cooperation and interaction, but also avoids the phenomenon of too few access paths and congestion. It has the advantages of high fault tolerance, high speed of information transmission and interaction, and improves the stability of cooperative interaction in cross-domain networks.

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