INTRODUCTION

The earliest research on the reliability of computer network service system can date back to the 1950s, when Mr. Lee investigated into the exchange network during computer communication and found that transmission information failures among network components are caused by substantial reduction of the total transmission capacity of telecommunication exchange networks that resulted in network congestion and extensive breakdown of these networks, leading to tremendous economic losses and preventing the timely exchange of the related information. In his research, Mr. Lee attributed the call congestion in network communication to network link failures, and proposed a connectivity-based network reliability testing standard. Early researches on computer network reliability were always concentrated on communication network.

Following the great progress made by the Defense Advanced Research Projects Agency (DARPA) of the superpower USA in the 1960s in the research of the reliability of computer network service systems, many authors voiced their own opinions. During this period, the optimization research on computer network service quality was typically focused on network connectivity as a measurement criterion for networks. Network connectivity mainly refers to the connectivity of computer network. For any cloud service that has to be connected via computer user, communication can never be functional unless computer network is incorporated, or the computer network is failure-free at the nodes. Ball et al. proved that an NP problem whose probability is hardly calculated accurately in network connectivity, which is well accepted by many researchers, who made intensive studies into the impact of network operability on reliability in some literatures.

In the 1980s, with the rapid development of network technology, the popularity of network and the gradual increase of computer users, network managers discovered some new problems. For example, even good network connectivity was not able to ensure that the computer network can work stably. Delay and congestion frequently occurred in network and consequently result in a reduction in the network performance. This was likely to prevent some network operation-related businesses from working normally. During this period, research on the smooth operation of network became an evaluation criterion for network service quality.

In the 1990s, with the acceleration and popularization of computer network service, the reliability level...
of network system service quality became a focus of concern. The use of related network service systems such as circuit network, transportation network, power network and logistics network added to the feasibility evaluation problems of computer network service. Reliability research on computer network became a greater concern.

With the development of computer service quality, Monte Carlo method has been widely applied in computer network as a probability statistical method that measures the reliability level of network service. For computer network service systems demanding high reliability, big data sampling calculation is needed to meet an evaluation standard of some users for network service satisfaction. Many authors have proposed sampling methods favorable for variance reduction to address some problems. These include the sequential destruction method in Wong and Easton and the limited sampling method in Fishman.

Development of smart algorithms for computer network service successfully adapts to the many nodes and links between computer network service systems. Approximate calculation of reliability in an era of large big data networks becomes particularly important. Some researchers used genetic algorithms and their modifications to solve network planning problems based on reliability level and obtained satisfactory optimization results as references for other researchers. Some other researchers applied coarse-grained parallel genetic algorithms in network service quality optimization and conducted empirical verification to confirm the effectiveness of their ant colony optimization (ACO).

2 MODELING

In big data era, the optimization of computer network service is mainly supervised by the government. Network information has to be reviewed before indispensable information service is provided to the society. For resources and information services on government websites that can be shared by online users, big data transmission should try to avoid network transmission congestions. For this purpose, resource distribution has to be optimized before the information transmitted can provide its own function and value.

2.1 Current service state of computer network

For the evaluation of the current computer network service, we can use the method in MPs, Lin Project Team. Assume we can have k, where K is not less than the transmission quantity between calculations with two MPs. During data transmission, path disjoint refers to the condition where any two paths in the many data transmission networks do not contain the same transmission links. This assumption will definitely reduce the chosen number of transmitted data. Also, in a multi-source, multi-home transmission system, even a designated starting point or receiving point will not result in path disjoint for data transmission. The sketch of multi-source, multi-home network transmission is shown in Fig.1 below.

As shown in Figure 1 above, in the multi-source, multi-home network, the data quantity needed to be transmitted by paths $P_1 = \{a_1, a_3, a_5\}$ and $P_2 = \{a_2, a_4, a_6\}$ is $d_1$, where $a_i$ stands for path $a_i$; $i=1, 2,…; \text{and } n$ means there are $n$ paths for data transmission. $P_1$ and $P_2$ are two disjoint paths. According to the multi-source, multi-home network diagram, the data information of another unit is transmitted from S2 by paths $P_3 = \{a_7, a_8, a_9\}$ and $P_4 = \{a_9, a_{10}\}$, where $P_3$ and $P_4$ are two disjoint paths. During this simulated network data transmission, only $P_2$ and $P_3$ contain the same path $a_5$. If the data transmission is large, competition will exist between the two data streams for passing $a_5$ first so as to transmit the data. In the era of practical big data transmission, priority of this competitiveness frequently occurs. It is also the key to be investigated during current data transmission processes.

So far, many network transmission optimization researches are descriptions on single-source, single-home network, whereas multi-source, multi-home network data transmission is more common in network service. How to distribute resources while optimizing network resource reliability has gradually become the focus of these researches.

As to the reliability of sharing big data transmission by jointed data paths, little concrete quantitative study has been made into the reliability level of data transmission among communication lines. In our study, we...
assume big data transmission between communication subnets and resource subnets. A sketch of these communication subnets and resource subnets is shown in Figure 2.

With regards to the public satisfaction of computer network service systems, there are many factors affecting the different levels of evaluation indexes. Here we are going to describe the network transmission process.

2.2 Optimized algorithm for computer network service

According to big data network transmission, we make the following hypotheses:

(1) Each of the nodes in the network transmission process is reliable, and each reliable node is replaced by two nodes connected to an unreliable line.

(2) The transmission number of each transmission line is a non-negative integer and complies with standard normal distribution; different transmission lines have independent flows from each other.

(3) The network transmission system complies with the conservation law of flow transmission. That is, the information inflow at each node equals to the information outflow at this node.

(4) On a shared path, the priority of transmission follows the “first come, first transmit” principle.

Based on these hypotheses, the computer network data stream transmission containing shared network lines is shown in Figure 3 below.

![Figure 3. Data stream transmission of shared network line.](image)

The network topology is shown in Figure 3. In MSN algorithm, the data d1(k), k=1,2,…a, d1(k) produced at s1 at any time is opposite side and has to be transmitted to t via P1 within a given time. A data produced at s2 at any time is d2(j), which has to be transmitted from s2 to t via P2 within a given time.

As the class orders of data rows d1(1), d2(2),…, d1(a) are all transmitted by a via d2, these determinants must be combined into one row. Here, k is the intermediate quantity; ta(k) stands the arrival at node u, u=1, 2, 3,…m. When all the data have arrived at other nodes, a new row SEQU is generated.

Let A(k) and B(j) stand for the times when s1 and s2; (k) and (j) stand for the waiting times at the node. The first data generated to s1 and s2 also include

\[ A(1)=T_{10}, TW(1)=0, B(1)=T_{20}, tt(1)=0. \]

However, as the data of d1 and 2 will be reused, t(1) is not necessarily 0. Assume d1 arrives at the node first, t1 is definitely 0. In SEQU algorithm, the data before de1 is s2, and B stands for the data before d1 in SEQU. t(1) is derived from the formula below:

\[
tw_i(1) = \begin{cases} 0 & \text{if } ta_i(1) \geq t_i(w) \\ tw_i(w) - ta_i(1) & \text{other} \end{cases}
\]

In the same way, assume d2(1) is the first data to arrive at the node, then tw(1)=0; otherwise w=1,2,…a stands for the data before d2 in SEQU algorithm, and tt(1) is expressed by the following formula:

\[
tw_i(1) = \begin{cases} 0 & \text{if } tt_i(l) \geq t_i(w) \\ tw_i(w) - ta_i(1) & \text{other} \end{cases}
\]

And T1(K) and T2(J) stand for the time intervals produced by d1 and d2. The time when the two nodes of data we consider is indicated below:

\[ A(k) = A(k-1) + T_i(k-1), k = 2,3,…,\alpha \]

\[ B(j) = A(j-1) + T_j(j-1), j = 2,3,…,\beta \]

Let ts(k) stand for the time when d1(k) leaves; t(k) stands for the time point when d1(k) leaves node u; and t(k) stands for the time point when d1(k) arrives at t. The following is the formula for the time variables of d1(k), k=1,2,…a:

\[ ts(k) = A(k) + tw_0(k) + d_1(k)/x_1 \]
\[ ta_1(k) = ts(k) + t_1 \]
\[ t_1(k) = ta_1(k) + tw_1(k) + d_1(k)/x_2 \]
\[ ta_2(k) = t_1(k) + t_2 \]
\[ t_2(k) = ta_2(k) + tw_2(k) + d_1(k)/x_3 \]
\[ ta(k) = t_2(k) + t_3 \]

There, we let tts(j) stand for the time leaving s2, then t(j) will stand for the time when d1(k) leaves node u, where ta(k) stands for the time when d1(k) arrives at home point t. The following is a formula for the time variables of d1(k), k=1,2,…a:

\[ tts(j) = B(j) + tw_0(j) + d_1(j)/x_4 \]
\[ tta_1(j) = tts(j) + t_1 \]
\[ t_1(j) = tta_1(j) + tw_1(j) + d_1(j)/x_5 \]
\[ tta_2(j) = t_1(j) + t_2 \]
\[ t_2(j) = tta_2(j) + tw_2(j) + d_1(j)/x_5 \]
According to the analysis above, the waiting time during data transmission process includes two types: the waiting time for the same data sources and that for different data sources. As \( t_{w_0}(k), t_{w_2}(k), t_{w_0}(j) \) and \( t_{w_2}(j) \), where \( k=2,3,\ldots,\alpha \) and \( j=2,3,\ldots,\beta \), \( q=2,3 \) are the option for data priority caused by the competition of homologous data on shared links, its result can be derived using the formula below:

\[
t_{w_0}(k) = \begin{cases} 0 & \text{if } A(k) \geq ts(k-1) \\ (ts(k-1) - A(k)) & \text{other} \end{cases}
\]

\[
t_{w_2}(k) = \begin{cases} 0 & \text{if } ta_2(k) \geq t_2(k-1) \\ t_2(k-1) - ta_2(k) & \text{other} \end{cases}
\]

\[
t_{w_0}(j) = \begin{cases} 0 & \text{if } B(j) \geq t_1(j-1) \\ (ts(j-1) - B(j)) & \text{other} \end{cases}
\]

\[
t_{w_2}(j) = \begin{cases} 0 & \text{if } ta_2(j) \geq t_2(j-1) \\ (ts(j-1) - ta_2(j)) & \text{other} \end{cases}
\]

As \( t_{w_0}(k), t_{w_2}(k), t_{w_0}(j) \) and \( t_{w_2}(j) \), where \( k=2,3,\ldots,\alpha \) and \( j=2,3,\ldots,\beta \), \( q=2,3 \) are the option for data priority caused by the competition of homologous data on shared links, the calculation is divided into two cases:

1. In SEQU, if \( d_1(k) \) is the data at the front, then \( d_1(k-1) \) can be deduced according to \( tw_1(k), k=2,3,\ldots, \alpha \), using the formula below:

\[
tw_1(k) = \begin{cases} 0 & \text{if } ta_1(j) \geq t_1(j-1) \\ t_1(k-1) - ta_1(k) & \text{other} \end{cases}
\]

2. In SEQU, if \( d_2(j) \) is the data at the front, then \( d_2(j-1) \) can be deduced according to \( tw_2(j), j=2,3,\ldots, \beta \), using the formula below:

\[
tw_2(j) = \begin{cases} 0 & \text{if } ta_2(j) \geq t_2(j-1) \\ (tt_1(v) - ta_2(j)) & \text{other} \end{cases}
\]

In the same way, if \( d_2(j) \) is the data at the front, then \( d_2(j-1) \) can be deduced according to \( tw_2(j), j=2,3,\ldots, \beta \), using the formula below:

\[
tw_3(j) = \begin{cases} 0 & \text{if } ta_3(j) \geq t_3(j-1) \\ (tt_1(v) - ta_3(j)) & \text{other} \end{cases}
\]

If time limitations are considered, \( ta(k) \) and \( tta(j) \) must be kept within their respective time limitations for transmission, i.e.:

\[
ta(k) \leq A(k) + Tth_1(k), k=2,3,\ldots,\alpha
\]

\[
tta(j) \leq B(j) + Tth_2(j), j=2,3,\ldots,\beta
\]

Here, \( Tth_1(k) \) and \( Tth_2(j) \) can be relevant to the magnitude of the \( d_i(k) \) and \( d_j(j) \) data quantities. Here, we assume \( Tth_1(k) \) and \( Tth_2(j) \) are linear to \( d_i(k) \) and \( d_j(j) \), and then we can yield the expressions for \( d_i(k) \) and \( d_j(j) \) as follows:

\[
Tth_1(k) = a \times d_1(k) + b_1
\]

\[
Tth_2(j) = a \times d_2(j) + b_2
\]

Here, \( a, b, c \) and \( d \) are the network model parameters given by the network manager.

Assume that the data distribution is discrete distribution, in the case of \( d_i(k) \), \( k=1,2,3,\ldots,\alpha \) as an example, the magnitude of data can be selected as \( dd_i, i=1,2,\ldots, nu+1 \) according to \( nu+1 \), and the interval probability of each \( dd \) corresponding data is \( Pr [Pr_{nu} \leq Pr_i \leq Pr_{nu+1}] \), where \( Pr_0 \) and \( Pr_{nu+1} = 1 \), \( d_i(k) = 1,2,\ldots, \alpha \) can be derived from the algorithm below:

1. \[ Initialization \] \( k = 0 \).

2. Generate a values complying with the uniform distribution of \( (0,1) \) \( r_1, r_2, \ldots, r_{\alpha} \).

3. \( k = k + 1 \), where \( d_i(k) \) can be derived from the formula below:

\[
d_i(k) = \begin{cases} dd_1 & \text{if } 0 = Pr_0 \leq r_i \leq Pr_{nu} \\ dd_2 & \text{if } Pr_{nu} < r_i \leq Pr_{nu+1} \\ \vdots & \text{other} \end{cases}
\]

4. Calculate the next \( d_i(k) \).

According to this idea, we can yield the result of \( d_j(j) \), \( j=1,2,\ldots, \beta \).

To ensure that all data produced at the two sources considered here can be transmitted to the nodes, the capacity of the paths cannot be negative. Define that \( (d_i(k), Tth_1(k), P_r) - X \) stands for the network state of the unit data quantity that can be successfully
transmitted into $d_i(k)$ via $P_1$, $k=1,2,\ldots$, under the limitation of $T_{th}(k)$, and thereby determine the concrete process for the qualified network capacity of each data.

2.3 Application of big data network transmission

Considering that the main factor affecting the evaluation of computer network service is the service delay caused by big data transmission, it is necessary to make concrete optimization researches on concrete computer network service systems. The structural diagram of a typical computer network service system for government open public affairs information is shown in Figure 4 below.

With the gradual refinement of China’s computer network service systems, some service systems are gradually optimized. To adapt to the development of the times, how to improve overall competence by making use of big data transmission, how to share information in a timely manner and how to effectively secure important information have become a focus of concern. In big era data, computer network service systems are more inclined to the improvement of necessary functions such as data mining, collection and analysis. As such, it is more important for website information service to adapt to the characteristics of the information service of the website itself as exemplified by Figure 5, Structural diagram of individualized information websites.

![Figure 4. Structural diagram of computer network service system.](image)

![Figure 5. Structural diagram of individualized information websites.](image)

With regards to computer network service, defects exist in the website performance evaluation indexes for China’s service sector. Table 1 shows the performance evaluation statistical index system for the Chinese government service websites in 2014 as an example.

From the performance evaluation index system for the Chinese government websites in 2014, China’s computer service network system evaluation indexes are becoming more diversified. If the service quality of a computer network system is reflected from website layout alone, the result would be too generalized. Hence, in the entire performance evaluation system, “Information Disclosure” is a major index that has the highest weight, contributing 30% of the total weight, followed by “Interactive Communication”, which contributes 22% of the total weight, “Transaction Service”, which contributes 18% of the total, “Public Opinion Guidance”, which contributes 13% of the total, “Website Function & Management”, which contributes 12% of the total, and “New Media Application”, which contributes 5% of the total.

![Table 1. Performance Evaluation Index System for Chinese Government Websites 2014.](image)
3 CONCLUSIONS

With the gradual refinement of China’s computer network service systems, some service systems are gradually optimized. To adapt to the development of the times, how to improve overall competence by making use of big data transmission, how to share information in a timely manner and how to effectively secure important information have become a focus of concern. In big era data, computer network service systems are more inclined to the improvement of necessary functions such as data mining, collection and analysis.

In big data era, it is urgent to cultivate talents for big data information processing technology in line with the construction of computer network service systems. More efforts must be made in the construction of a professional big data processing workforce to accommodate the revolution of computer network service systems in big data era. To cultivate talents for big data processing, it is important to master key utility technologies including statistical data analysis, data processing and numerical analysis so as to better optimize computer network service systems in big data background.

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