THE IMPACT OF COMPUTER NETWORK RESERVATION FOR BUSINESS EFFICIENCY

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Abstract. Creating a high value-added product requires reliable computerized workplace. Loss of working time due to non-functioning computers reduces the efficiency of companies. The paper examines the impact of computer reliability and their reservation on working time losses, and shows how the loss of working time depends on the efficiency of computer service organization. The waiting times for fault recovery and the recovery of the fault itself are evaluated. A methodology for calculating backup jobs is established, which evaluates the reliability of computers, their purchase price and workplace productivity.

Keywords: Computer Reservation System, Computer Network Reliability.

Introduction

The sound functioning of the jobs of computerised enterprises ensures the creation of high added value. Various glitches can cause hardware and software problems. In this scenario, the workstation moves to a crash state that does not create a product, which reduces the company's operational efficiency. Reserve jobs are created to improve efficiency.

Technical support service logs the event of crash and queues the workstation for troubleshooting. When time comes, the fault is eliminated. Both queue time and troubleshooting times are common in random sizes. As a result, the duration of the workplace failure status is a random size. Fault removal processes are examined by queuing theory [Robert B. Cooper. 1981. p. 347].

This work only assesses the average queue, troubleshooting and failure status.

In small and medium-sized enterprises, the number of computers does not exceed a few dozen. The design of computer networks requires a calculation of the number of reserve jobs appropriate to be installed. Such calculation must estimate the value generated per unit of time and the cost of installing and servicing the new workstation. In the event that the value generated in the average failure state exceeds the cost of installation and servicing one workplace, it is appropriate to install it. In the case of a large number of jobs, it may be necessary to create several such places.

In the company, all jobs are usually connected to a local network that is still connected to the Internet. They are connected to remote information systems with the help of the Internet. Both local network equipment and internet connection network equipment must be reserved to achieve high reliability of such connection.

The ojective of this paper is to assess the dependence of the company's operational efficiency on the number of basic and reserve jobs, reliability of network equipment and a method for reservation as well as technical solutions for internet access.

Related Works

General questions of practical application of the reliability theory are considered [Patrick D. T. O'Connor, Andre Kleyner. 2012 (p.484)]. The Cumulative Binomial Method for Median Ranks method is used to obtain an estimate of the unreliability for each failure. The results obtained can be applied to assess the reliability of mobile Ad-Hoc networks.

Issues of modelling of the reliability of stationary Computer Systems and Networks have been addressed [Gerardo Rubino. 1998. (p. 275-302)]. It is noted that the exploration of high reliability systems requires tens of billions of realisations.

Works dealing with traffic reservation issues are widely presented [Yi-Kuei Lin, Louis Cheng-Lu Yeng. ,2012, p. 18]. This paper proposes a modified stochastic-flow network model to evaluate the network reliability of a practical computer network with multiple sources where data is transmitted through several international light paths.

It is necessary to mention the application of artificial neural network theory to local network reliability issues [Anuradha, Anil Kumar Solanki, Harish Kumar, Krishna Kant Sing. 2019 p.p. 2153–2163]. This algorithm is more efficient to calculate reliability in comparison with Monte Carlo Simulation and other algorithms.

The reliability of the multi-terminal network is addressed [Hector Cancela, Gerardo Rubino, Marla E 2001,p. 567-579.]. In this work, an artificial neural network algorithm has been developed to compute the all-terminal network reliability measure. The idea is to compute the reliability for the connection between network nodes under the assumption of independent behaviour by the different links.

The theoretical results of the reliability of information transmission networks are provided for equipment manufacturers [Martin L. Shooman, 2002. p. 528)].

Structure of the System

The business local network consists of computers, network switches, and routers accordingly connected by signal chains. At the end of the network at least one router is used, in addition to the appropriate number of switches depending on the number of employees using personal computers. In the event, the workplace's personal computer is in a state of failure, the business experiences downtime, and the company's performance is falling. In a state of failure, the workplace can be used for various reasons as follows:

a) Workstation failure,
b) Network switch failure,
c) Network router crash.

In the event of a failure of one or more jobs, there may be pre-provisioned reserve jobs. The more jobs there are in the business, the more reserve jobs are needed. Network switch failure causes many locations to crash. Therefore, it is appropriate to reserve network switches.

In the case where business information systems are remote, it is appropriate to reserve both network routers and interconnection paths to systems. Next, we will examine the dependencies of job downtime on the ways in which equipment is reserving and equipment reliability.

Let's mark the duration of the workplace failure status Δ (downtime). This duration depends on the wait time for recovery and the time δ (Figure 1) to restore the failure. Times Δ and δ depend on the nature of the failure, as well as on the policy of organising the workplace return to service and on the number and qualifications of the service personnel.

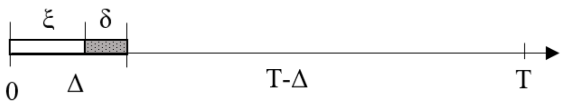

Figure 1. Equipment maintenance process time components

The duration of the failure status is related to the time ξ and δ dependency:

$$\Delta = \xi + \delta, \qquad (1)$$

In practice, it is more convenient to use the total failure status time in the time interval T. The duration of each failure state of computer network equipment is random size. In calculations of reliability, it is convenient to use the average fault status value, which is usually set for the entire batch of equipment.

Let the batch contain K-unit equipment, and the duration of the failure state of each of the equipment (i=1,...,L) is Δji. Then, the average failure time of all equipment in the batch

$$\Delta = \frac{1}{K \cdot L_j} \sum_{j=1}^{K} \sum_{i=1}^{L} \Delta_{ji}. \qquad (2)$$

Knowing the average failure status time Δ in the equipment failure state monitoring range T, the reliability of the equipment is expressed in a ratio

$$P = \frac{T-\Delta}{T} = 1 - \frac{\Delta}{T} \quad , \qquad (3)$$

or

$$\Delta = T(1-P). \qquad (4)$$

Let M of the possible N jobs (M≤N) be in working order (Figure 2). There is a computer in every workplace.

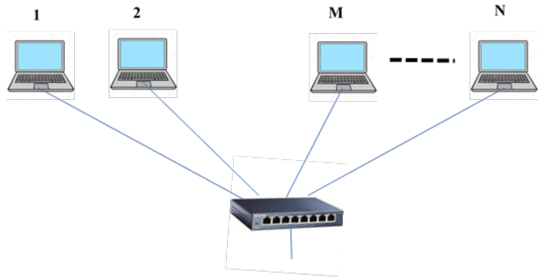

Figure 2. Reservations of workplaces

Then total average failure state time using the general workplace reserve (N-M)

$$\Delta_{M/N} = T\left(1 - P_{M/N}\right), \qquad (5)$$

$P_{M/N}$ is probability of M/N workplaces readiness when functioning M of N workplaces. When P ≈1 and estimating [Martin L. Shooman, 2002. p. 101]

$$P_{M/N} = 1 - \sum_{n=N-M+1}^{N} C_n^N (1-P)^n, \qquad (6)$$

where:

$$C_n^N = \frac{N!}{(N-n)!n!} \qquad (7)$$

the number of n-combinations in the set of N workplaces.

Reservation of network equipment in a local area network (LAN).

Let the workplaces be reserved by additional shared computers numbering N-M. When reserving with network switches S1,... SQ, each computer must have Q network ports. The average total duration of the failure state needs to be found for N from M jobs

$$\Delta SQ = T(1-PSQ) \qquad (8)$$

Where PSQ - probability that M out of N jobs will be in unemployment due to Q-switch fault

$$P_{SQ} = 1 - \prod_{q=1}^{Q} \left(1 - P_{Sq}\right), \qquad (9)$$

$$P_{Sq} = P(S_q)\, P_{M/N} . \qquad (10)$$

It can be noted from (10) that the duration of N-jobs unemployment is highly dependent on the of PSq value.

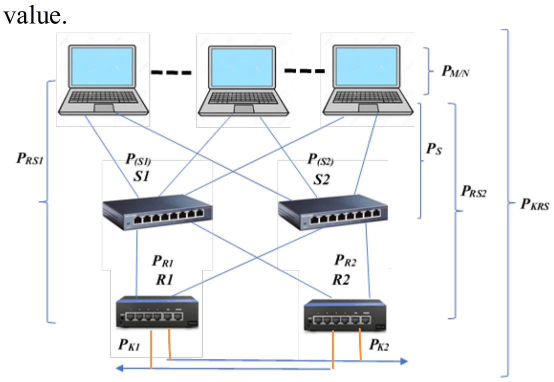

Figure 3. Reservations of workplaces and network equipment

Therefore, it is appropriate to reserve the information flows entering switches using routers R1 and R2, which have no probability of disruption of work in PR1 and PR2 respectively. They will manage the directions of incoming flows. In this case, the probability of unemployment time in the case of M from N jobs

ΔKRS=T(1-PRS), (11)

Where:

PRS=1-(1- PR1S)(1- PR2S)), (12)

$P_{R1S} = P_{R1}\left(1 - \prod_{q=1}^{Q}\left(1 - P_{Sq}\right)\right),$ (13)

$P_{R2S} = P_{R2}\left(1 - \prod_{q=1}^{Q}\left(1 - P_{Sq}\right)\right).$ (14)

In the event that we assess the reliability of directions up to R1 and R2 in PK1 and PK2 respectively, the

$P_{R1S} = P_{K1} \cdot P_{R1}\left(1 - \prod_{q=1}^{Q}\left(1 - P_{Sq}\right)\right)$ (15)

$P_{R2S} = P_{K2} \cdot P_{R2}\left(1 - \prod_{q=1}^{Q}\left(1 - P_{Sq}\right)\right)$ (16)

Calculation results

Probability of preparing the workplace P=0.99. Year duration T=525960 min.

Reservation M/N (Figure 2)

a) M=N=10. Then 10 job preparedness probability

$P_{10/10} = 1 - \sum_{n=1}^{10} C_n^{10}(1-P)^n = 0.8955,$

$\Delta_{10/10} = T\left(1 - P_{10/10}\right)$ =54962 min

b) M=10. N=11. Then 10 job preparedness probability

$$P_{10/11} = 1 - \sum_{n=2}^{11} C_n^{11}(1-P)^n = 0.9943,$$

$$\Delta_{M/N} = T\left(1 - P_{10/11}\right) = 2980\, min$$

c) M=10. N=12. Then 10 job preparedness probability

$$P_{10/12} = 1 - \sum_{n=3}^{12} C_n^{12}(1-P)^n = 0.9998,$$

$\Delta_{10/12} = T\left(1 - P_{10/12}\right) = 118\, min.$

The dependence of non-working time ΔM/N on P values and the number of reserve computers (N-M) is given in Figure 4.

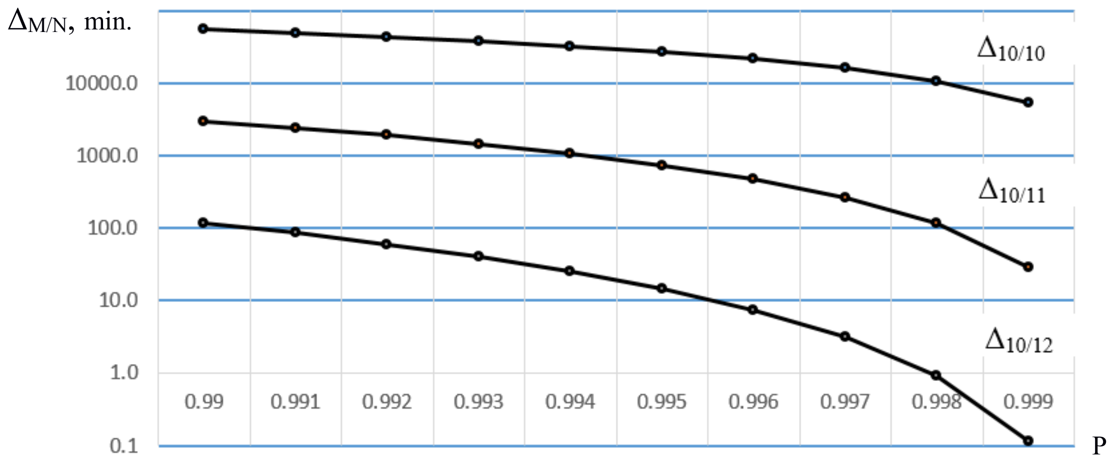

Figure 4. The dependence of non-working time $\Delta_{M/N}$ on P values and the number of reserve computers (N-M)

Reservation M/N and network equipment (Figure 3).

Let the total failure state duration ΔM/N of M/N reserved workplaces be known and Q=2. Then according (13) and (14)

$P_{R1S} = P_{R1}\left(1 - (1 - P_{S1})(1 - P_{S2})\right),$

$P_{R2S} = P_{R2}\left(1 - (1 - P_{S1})(1 - P_{S2})\right).$

Let the probability of workplace readiness be P = 0.99. Year duration T = 525960 min.

PS1 = PS2= 0.99

PR1 = PR2= 0.99 (17)

PK1 = PK2= 0.99

In the case where $P_{M/N}$ = 0.99 ($\Delta_{M/N}$=5260 mins), and consistently without reservation to combine switches and browsers and one direction to the system with parameters (17), this is

$\Delta_{M/N} = T\left(1 - P_{M/N} \cdot P_{S1} \cdot P_{R1} \cdot P_{K1}\right)$ =20725 min.

After booking according to Figure 3 with Q=2, $\Delta_{M/N}$=216 min. In the case where $P_{M/N}$ = 0.999 ($\Delta_{M/N}$=526 min),, and consistently without reservation to combine switches and browsers and one direction to the system with parameters (17), this is

$\Delta_{\mathrm{M/N}} = T(1 - P_{M/N} \cdot P_{S1} \cdot P_{R1} \cdot P_{K1}) =$2101 min.

After booking according to Figure 3 with Q=2, $\Delta_{M/N}$=211 min. In the case when PM/N = 0.999 ($\Delta_{M/N}$=526 min),, and consistently without reservation, combine switches and browsers and form one direction into the system with parameters $P_{S1}=P_{S2}$=0.999; $P_{R1}=P_{R2}$= 0.999; P_{K1} = P_{K2}= 0.999,

$\Delta_{M/N} = T(1 - P_{\mathrm{M/N}} \cdot P_{S1} \cdot P_{R1} \cdot P_{K1}) =$2101 min.

After booking according to Figure 3 with Q=2, $\Delta_{M/N}$=2 min. The results obtained suggest that when workplaces are switched on to an external system, reservations only make sense when the reliability of the network equipment is at least equal to the reliability of the jobs.

Conclusions

Job reservations can significantly reduce the company's downtime depending on the reliability of jobs. In the case of an external system, the time of downtime of the company depends on the reliability of the equipment on the network. As workstations are switched to an external system, reservations only make sense if the reliability of network equipment is higher than workplace reliability.

Further increase of workplace reliability is possible through a higher network reservation and use of additional incoming flows. In each case, an optimal solution method is required taking into account the added value created by a single workplace, the acquisition costs of network equipment as well as the charge of incoming flows.

Reliable power supply of the information transmission network equipment has a significant impact on the reliability of the workplaces. Autonomous renewable power sources can be used for this purpose.

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