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CONFLICT RESOLUTION IN COMPUTER SYSTEM

Annotation

In the network during data transmission there are uncertain situations that prevent the receipt of data packets to the destination nodes. Therefore, the problem of resolving deadlocks is one of the most important in the design of data transmission (especially with buffering) in computer networks. There are two traditional approaches to solving deadlocks: networks and schemes are designed that eliminate deadlocks; development of a distributed algorithm that detects a deadlock situation and then derives the network from this situation using some permitted distributed algorithm. The proposed approach is based on providing indivisible resources to processes in such a way as to minimize losses due to conflicts. The multicriteria problem of providing indivisible resources to processes is investigated, and the principle of optimality is expressed by the known binary relation on the set of average vectors of penalties for conflicts on each of resources. It is shown that the joint use of the apparatus of choice theory and the classical apparatus allows to expand the known problem statements by using more general principles of optimality; examples of solving multicriteria problems of optimal conflict resolution management in computer systems are given. Quantitative estimates of the gain at the chosen optimal strategy of conflict resolution in multiprocessor computer systems are obtained.

Keywords: computer system; multicriteria problems; conflicts in computer systems; optimal strategy; deadlocks; prevention of deadlocks

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КОНФЛІКТИ В КОМП'ЮТЕРНИХ СИСТЕМАХ ТА ЇХ ВИРІШЕННЯ

Анотація

В мережі при передачі даних виникають невизначені ситуації, що перешкоджають надходженню пакетів даних у вузли призначення. Тому проблема вирішення тупикових ситуацій є однією з найважливіших при проектуванні передачі даних (особливо з буферизацією) у комп'ютерних мережах. Існують два традиційні підходи по вирішенню тупикових ситуацій: проектуються мережі і схеми, які виключають виникнення тупикових ситуацій; розробка розподіленого алгоритму, який виявляє тупикову ситуацію і потім виводить мережу з цієї ситуації за допомогою деякого дозволеного розподіленого алгоритму. Запропонований підхід базується на тому, щоб надавати неподільні ресурси процесам таким чином, щоб мінімізувати втрати через конфлікти. Досліджуються багатокритеріальна задача надання неподільних ресурсів процесам, причому принцип оптимальності виражається відомим бінарним відношенням на множині середніх векторів штрафів за конфлікти по кожному з ресурсів. Показано, що спільне використання апарату теорії вибору і класичного апарату дозволяє розширити відомі постановки завдань за рахунок використання більш загальних принципів оптимальності; наводяться приклади розв'язання багатокритеріальних задач оптимального управління вирішення конфліктів в комп'ютерних системах. Отримано кількісні оцінки виграшу при обраній оптимальній стратегії розв'язання конфліктів в багатопроцесорних комп'ютерних системах.

Ключові слова: *комп'ютерна система; конфлікти в комп'ютерних системах; багатокритеріальні задачі; оптимальна стратегія; тупики; запобігання тупикових ситуацій*

1. Problem statement

The search for practically applicable algorithms for solving deadlocks is of great practical importance for information security of the computational process and in this regard, the article is devoted to solving an important and urgent problem.

The severity of the situation depends on the types of processes that are in a stalemate, the types of resources used, the number of processes and many other factors. Conflicts are associated with process delays and reduce the productivity of the CS. However, despite the relative simplicity of this phenomenon, deadlocks are still poorly understood, and known methods of "fighting" deadlocks are not always effective, and therefore require some research [1].

One of the methods of "struggle" is to prevent deadlocks. Predicting the emergence of deadlocks in the future. Known methods [1,2,4,5], based on the definition and prevention of states in which deadlocks may occur. This uses preliminary information about what resources the process may require at runtime. Before allocating the free resource of the process, the condition is checked for "security". A state is "safe" if the allocation of process resources cannot lead to deadlocks in the future. Otherwise, the condition is considered "dangerous", and the allocation of resources is delayed. One of the variants of this method is proposed in [1]. The obvious disadvantage of avoiding deadlocks is the need to have a priori information about future resource needs, which is not always possible. One way to "fight" deadlocks in the absence of a priori information about the needs of the process in resources - to identify deadlocks. Detection of deadlocks (does not yet lead to their solution) is a periodic use of an algorithm that checks the current allocation of resources to determine whether there is a deadlock, and if so, what processes are involved in it [3,5,6]. The aim of the work is to develop methods and algorithms to minimize losses due to deadlocks in the CS through the use of optimal conflict resolution strategy. The proposed approach is particularly effective for eliminating deadlocks in the control of the CS, having a fixed set of programs.

2. Presenting main material

When solving problems on the CS, several processes may require the same resource (processor, channel, table), which is provided to only one of them. Or, for example, in the course of functioning of modern multiprocessor CS there can be queues of requests for allocation of free memory. They are formed due to conflicts when accessing general data (list of free memory, etc.), as well as when implementing mechanisms for redistribution and reorganization of memory. Such situations are called conflicts, and resources are called indivisible.

Suppose we have k types of resources. In the general case, each type is characterized by the amount of resources k_i. Under the CS we understand the set of processes $P=\{p_1, p_2, ..., p_m\}$, which can simultaneously operate in the CS and the set of resources $R=\{r_1, r_2, ..., r_n\}$, which can request and use processes. We distinguish the main types of indivisible resources of the CS: information (R_1), software (R_2), hardware (R_3). An example of a resource of type R_1 is the memory allocation table in the operating system, the allocation table of external devices; example of resource R_2 – non-retentable programs: simplex method, logarithm calculation; hardware type R_3 – disk, I / O channel, printing device. Conflicts can arise repeatedly. Within each process, you can identify critical areas where it needs an indivisible resource. At any one time, no more than one process may use an indivisible resource; while other processes that claim this resource are temporarily blocked and must wait until it is released [7,8,9].

Thus, the challenge is to provide indivisible resources to processes so as to minimize losses due to conflicts. The procedure for providing indivisible resources to processes is called the strategy S of conflict resolution [1,2].

One of the possible methods of mathematical description of the problem of conflict resolution in a multiprocessor CS can be the use of Markov random processes. Let the *i-th* process in the CS $i=\overline{1,n}$ 1, have $m+1$ states A_j^i $(j=\overline{0,\ m})$, (where$j=\overline{0,\ m}$ – is the number of the indivisible resource). In the absence of other processes, the behavior of the *i-th* process $i=\overline{1,n}$ is described by a Markov chain with the probability of transitions P_{qt}^i $(q=\overline{0,m},\ t=\overline{0,m})$. State A_0^i does not correspond to any of the critical parts of the *i-th* process; state A_j^i $(j=\overline{0,\ m})$ corresponds to the *j-th* critical section. Many processes that are in a state corresponding to the critical area of the same indivisible resource, called a group of conflicting processes.

Let M_i – be the set of states of the *i-th* process. The state of the whole set of processes at any time is the point of the set $M=M_1,...,M_n$. Consider the subset $K_j \subset M$:

$$K_j=\{s\in M\,|(\exists_i\neq i)[s_i=A_j^i,\ s_i=A_j^i]\}, \tag{1}$$

where $j\in\{1,\dots,m\}$. The subset K_j specifies the state with M, in which at least two processes claim the *j -th* resource. We enter the value

$$X(s,\ K_j\ )=\begin{cases}1, & s\in K_j,\\ 0, & s\notin K_j,\end{cases} \tag{2}$$

and consider the vector $X=(X(s,\ K_1\ ),\ \dots,\ X(s,\ K_m\ )).X=(X(s,\ K_1),\ \dots,X(s,\ K_m\ ))$, which determines the fines in the state $s\in M$ or conflicts on each of the indivisible resources. The penalty is equal to the waiting time of each of the resources.

We set the binary ratio R on the set of average vectors of penalties for conflicts on each of the resources during the operation of the CS (or vectors of average fines per unit time, if the operation of the CS is infinite). The task of conflict resolution is to find the R-optimal strategy.

Let us establish a correspondence between the considered problem and the problem of finding R-optimal Markov chain control strategies. Let's build a Markov chain. Take M for many states of the circuit.

The states $s\in M$ are vectors: $s=(s_1,\dots,s_m)$ where $s_i\in\{1,\dots,m\}$ – is the state of the *i-th* process at the moment t; s_i=j means that the *i-th* process at time t requires the *j -th* resource. Let $n=2$, $s_1(t)=j$ i $s_2(t)=j$. Then the *j -th* resource can be provided to only one of the processes. The process to which the *j -th* resource at time t was not provided, the same resource is needed at *(t + 1) -th* moment.

Therefore, the transition from state $(i,\ j)$ to state $(j,\ \ddot{j})$, where $j\neq j$, $\ddot{j}\neq j$ is impossible.

Thus, the transition probabilities depend on which process is given the *j -th* resource. If you give the resource to the *1-st* process, then the state, $(i,\ j)$ will go to the state $(j,\ j)$ with probability p_{ij}^1 or to the state (j,j), with probability $1-\sum_{j\neq j}p_{jj}^1=p_{jj}^1$. If we give the resource to the 2nd process, then (j,j) will pass into в (j,j) with probability p_{jj}^2. Similarly, the transition probabilities in the general case of n processes (n>2) are determined.

In this case, it is more convenient to talk about minimizing fines than about maximizing income. The equivalence of the tasks is obvious. The vector of the penalty does not depend on the decision, but depends only on the states: $r_s^k=r_s$; the components of the m - dimensional vector r_s are determined by formula (2). The challenge is to find the R-optimal strategy for such a chain. Thus, the required match is established. This allows you to reduce the original problem to a single-criterion [3,9-11].

3. Conclusion

An effective strategy for information process management in multiprocessor CS has been developed and proposed, which detects and prohibits deadlocks in computer systems. A distinctive feature of the proposed effective methods and algorithms for eliminating dead ends is the possibility of using them in the development and operation of multiprocessor CS operating in real time. This example confirms the efficiency, effectiveness and viability of the proposed method and algorithm for solving deadlocks in multiprocessor CS. The proposed method and algorithm reduces the average number of conflicts in the CS by 30-40%.

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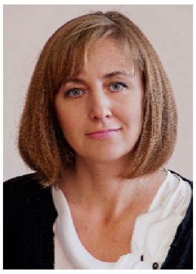

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