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MODIFIED GENETIC ALGORITHMS FOR CHANNEL ALLOCATION FOR DISTRIBUTED CHANNEL ALLOCATION

The performance of cellular systems depends upon a good channel allocation technique. In this article genetic al-go-rithm based distributed dynamic fault tolerant channel allocation model is proposed. The channel allocation algorithm in the proposed model is based on mutual exclusion algorithm for distributed system. The article describes a chromosome structure, fitness functions and an example of algorithm.

Keywords: *Distributed Channel Allocation System, Fault Tolerance, Mutual Exclusion.*

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МОДИФИЦИРОВАННЫЕ ГЕНЕТИЧЕСКИЕ АЛГОРИТМЫ ДЛЯ РАСПРЕДЕЛЕНИЯ ВЫДЕЛЕННЫХ КАНАЛОВ

Производительность систем сотовой связи зависит от эффективности выделения каналов. Предлагается распределенная отказоустойчивая модель выделения каналов на базе генетического алгоритма. Алгоритм распределения каналов в предлагаемой модели основан на алгоритме взаимного исключения для распределенных систем. Приведены особенности формирования структуры хромосом для генетических алгоритмов, фитнесс-функции и пример алгоритма.

Ключевые слова*: распределенная система выделения каналов, взаимное исключение, отказоустойчивость.*

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МОДИФІКОВАНІ ГЕНЕТИЧНІ АЛГОРИТМИ ДЛЯ РОЗПОДІЛУ ВИДІЛЕНИХ КАНАЛІВ

Продуктивність систем сотового зв'язку залежить від ефективності розподілу каналу. Запропоновано розподілена відмовостійка динамічна модель розподілу каналів на основі генетичного алгоритму. Алгоритм розподілу каналів у запропонованій моделі базується на алгоритмі взаємного виключення для розподілених систем. Описуються особливості формування структури хромосом для генетичних алгоритмів, фітнес-функції і приклад алгоритма.

Ключові слова*: розподілена система виділення каналів, відмовостійкість, взаємне виключення.*

Introduction. In cellular networks, the geographical area is divided into smaller regions called hexagon cells. In each cell, there is one mobile service station (MSS) which serves the mobile hosts (MHs) present in the cell. A MH can communicate with other mobile hosts in the system only through MSS in the cell even if the mobile hosts are in the same cell. Before an MH can communicate with another MH, the MSS in the cell should allocate a channel to support the communication.

Wireless channels are limited system resources so they should be reused as much as possible.

When a MH in a cell needs a channel to support a cell, it sends a request message to MSS in its cell.

When the MSS in this cell receives such a request message, it tries to allocate a channel to support the call by using the channel allocation algorithm. If some available channels exist in the cell, then the MSS will pick one in such a way that it avoids co-channel interference and achieves a good channel reuse pattern.

Unlike the centralized channel allocation, in distributed channel allocation algorithm there is no central controller such as a mobile switching centre. Instead a MSS exists in each cell, which allocates a channel in that cell based upon local information. Resource planning and no resource planning are two basic models in distributed system for channel allocation. In the resource planning model channels (called primary channels) are pre-allocated to cells. In case primary channels are not sufficient to support a communication in a cell, it borrows channels (called secondary channels) from neighboring cells. The secondary channels are returned to the cell where from it has been borrowed

In a no resource planning model, channels are not pre-allocated to any cell, but kept in a set, known to every cell. The main contribution of the paper is to apply genetic algorithm (GA)

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for fault tolerant channel allocation for distributed environment. Channel allocation falls in NP class of problems and therefore evolutionary algorithm like GA [12, 13] can be applied to find a suboptimum solution. GA maintains a population that evolves according to the rules of selection, cross over mutation, etc. All individuals are evaluated against a fitness function. The fittest individuals are more likely to be selected for reproduction in the next generation.

Related Works. Several authors have addressed the problems of distributed dynamic channel allocation [1–10, 15].Some problems are studied under resource planning [3–5, 7] and some are under non resource planning [1, 2, 6]. Fault tolerance problems have been addressed in [1, 4, 6, 7, 9, 15]. Zomaya and Wright [8] have proposed GA (genetic algorithm) based dynamic channel allocation (DCA) model in which they have modified mutation operator (genetic operator). They have compared their model with that of fixed channel allocation (FCA) and greedy borrowing heuristics for average number of blocked channels metric and show that their GA based model works better and has a slight edge over the heuristic model. Fault tolerance is the ability of a system to respond gracefully to an expected hardware and software failure. Khanbary and Vidyarthy [9, 10] have proposed a GA based fault tolerant channel allocation to minimize the average number of blocked hosts and handoff failures in mobile computing environment. They consider handoff problem by using channel reservation and channel borrowing techniques. Mohapatra [11] has applied modified GA for channel allocation for DCA. A new genetic operator is introduced for improving a simple GA.

Proposed model. The model proposed in this work extends the idea presented in [1] by applying GA based techniques for distributed dynamic fault tolerance channel allocation. Our model is based on mutual exclusion algorithm for distributed system allowing a cell being in multiple critical sections concurrently. The proposed model falls under the non resource planning model. In this model, all the channels are kept in a set which is known to each cell. Channels are not pre-allocated to any cell except reservation of some channels for handoff calls for real time connections. In the proposed model, a MSS makes all the channel allocation decision on behalf of the mobile hosts using a genetic algorithm. When a mobile host in a cell needs a channel to support a session (if it is a new cell) and if it is not available in the cell , it sends a request time stamped with Lamppost's clock [14] to neighboring MSSs to find out availability of any free channel. After a round of message exchange with neighboring cells, a channel is transferred to the requesting cell.

Encoding schemes. One of the most important aspects that control a GA's performance is the encoding method chosen. The encoding refers to the method by which the problem parameters are mapped into chromosomes. A particular encoding can be weak or strong. A strong encoding exploits features of the solution space in the mapping:

each cell is represented by a chromosome;

a chromosome is an array of length 15 as shown in figure 1;

the zeroth location of the chromosome array represents the time stamp value;

the first location of the chromosome array represents the number of blocked hosts;

the second location of the chromosome array is for the number of free channels;

the next six locations contain the information about the channel lending to six neighbor cells;

the last six locations contain the information about the channel borrowing from 6 neighboring cells;

the chromosome of a cell and the chromosome of its six neighboring cells form a matrix of 7x15 called a super-chromosome;

chromosomes are combined into a super-chromosome and all the super-chromosomes together give the information about the whole network.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Fig. 1. Chromosome structure

Fitness Function. The fitness function is used to measure the fitness value of each chromosome. The chromosome with good fitness value will be selected with the objective of minimizing the number of blocked hosts and handoff failures.

The fitness function used in this model is as follows

Fitness= blocked hosts (1)

Let us consider a simple step by step illustration of GA.

Assume that each solution (chromosome) is represented by a bit string and its size of population is 4. Assume also that the fitness value of each string is merely the binary number represented by the string as a whole (e.g seven-bit string 0000111 gives the fitness value of decimal 7).

The following initial population is generated randomly:

S1 0101010
S2 1011001
S3 1100001
S4 1111001

We further assume here that the cross over takes place and a pair is selected for mating. The crossing location between the two randomly selected strings between [1, length of a string-1]. For example when a length of a string L is 7, K is chosen over [1, 6].

Suppose a string of L =7 is 1011001, the bit position K is defined as follows

Bit Parity K: 1 2 3 4 5 6
String Example: 1: 0: 1: 1: 0: 0: 1,

where ":" indicates the location for cross over .

Assume the strings S2 and S3 are selected randomly for crossover:

S2 1011001
S3 1100001

Assume K =3 is randomly selected as the location for crossover

S2 101: 1001
S3 110: 0001

Crossover now takes place, generating the new off springs: S2'and S3'

S2': 1010001
S3': 1101001

The remaining strings S1 and S4 with K =4 as a random crossing location create another two new offspring's S1' and S4' as

The following table sums the result after the crossover operation:

String number	Si	Crossover Location, K	New Offspring, Si'
1	0101010	4	0101000
2	1011001	3	1010001
3	1100001	3	1101001
4	1111000	4	1111010

Mutation operation takes place infrequently, for example the mutation per 1000 bit.

For example, suppose we transfer 24 bits of a packet. Hence, there will be no mutation for this iteration. Probability is 24/1000 = 0.024. In case of mutation, any string among the population may be randomly picked up and the string may change its value from 1 to 0. For example a string 1111010 has been randomly selected. After the mutation the string will be 1110010.

The following algorithm is proposed:

1. Input the total number of channels and mobile hosts.
2. Assign channels to each cell based on initial demand.
3. Perform reuse _channels ( ).
4. Initialize generation number // simulation runs.
5. Initialize generation _ Index = 0.
6. Initialize total_ blocked_ hosts = 0.
7. Initialize logical time stamp T= 0.
8. Distribute hosts among the cells in proportion to each cell capacity.
9. Create initial population (chromosome).
10. Calculate the number of free channels and blocked hosts of each channel.
11. Repeat all steps starting from 12 to 20 until the generation _ index = generation no.
12. T = T + 1 // increment time stamp.
13. Perform reserved_ channels ( ).
14. Perform lend_ borrow ( ).
15. Calculate fitness ( ) // according to (1).
16. Select the best chromosome as the current chromosome.
17. Calculate the free channel and blocked hosts of each cell again.
18. Output the number of blocked hosts and handoff failures resulted in the current generation.
19. Increment generation _ index.
20 Total _ blocked _ hosts = Total _ blocked _ hosts + blocked hosts.

21 Average _blocked _ hosts = Total _blocked_ hosts / generation _ no.

22 Output Average _ blocked _ hosts.

Conclusion. In this article we have developed a GA based model for distributed dynamic fault tolerant channel allocation. In our scheme fault tolerance is managed through channel reservation for real time traffic handoff calls. Our model makes use of Lamport's logical clock to totally order the requests for channels among the neighboring cells. The performance of the algorithm is proposed to measure through the average number of blocked hosts and handoff failures in each generation. In the future we will simulate the proposed model and compare it with the similar protocol developed recently.

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