Dominatable Distributed Computer Network

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Abstract

In a computer network within the field of a computer complex, a distibuted computer network has been investigated as the main current of a computer network. However, it is not a mission-oriented computer network. In this paper, a dominatable distributed computer network (DDC network) is represented as the mission-oriented and distributed computer network. The concept for the DDC network design and the composition of the network system is discussed by using a family and a control distance. Network control and communication protocols are also investigated. The DDC network can execute shared parallel processing in several nodes.

1. Introduction

A computer network is categorized into three types: (1) centralized type, (2) distributed type, and (3) ring type with regard to network configuration. The distributed computer network has advantages of resource sharing capability, expansibility and high reliability by virtue of compensated network formation. However the distributed computer network is not suitable to process an urgent big job or sequential procedures by host computers because heading time will be required to put hosts in order and to get integrated jobs from host computers.

In this paper, a dominatable distributed computer network (DDC network) will be presented to overcome these shortcomings by effective use of data communication lines. This is a computer network that is able to concentrate dominatable computers for an urgent big job execution. In other circumstances, host computers execute usual jobs as elements of the distributed computer network. The DDC network is composed as shown in Fig. 1, that is, a subnetwork forms a family, and these multiple families are connected to each other. The family is considered to be a local computer network and interface message processors in the family are located in comparatively close distance. Sometimes it may be an inhouse network. The fundamental concept of the DDC network

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is discussed first. Composition of the DDC network by using a control distance and a selection method of DIMP (Dominatable Interface Message Processor) are presented next. A network control for mission oriented configuration, especially a control method of AIMP (Active IMP) by DIMP and function of data exchange, is investigated. The validity of the DDC network is also evaluated.

2. Fundamental concept of the DDC network

The fundamental concept of the DDC network is define as follows.

(1) The DDC network has features of a distributed computer network as it is: it has functions of resource sharing, distributed control and independence of host computers.

(2) Arbitrary resources within a control-limited distance can be used concentrically for processing of a special job; a specified node in the network can control the others and it can supervise shared parallel processing of a job by multiple host computers.

(3) It is an easily expansible network, where network expansion does not affect resources.

(4) Failure-tolerant capability is considered for network reliability and availability; for reliability, the network is formed as failure tolerant communication network and for availability, effective diagnosis will be applied.

3. Composition of the family of the DDC network

The family of the DDC network consists of multiple IMP or TIP (Terminal IMP), host computers and terminals, same as the usual distributed computer network. Fig. 2 shows an example of the family.

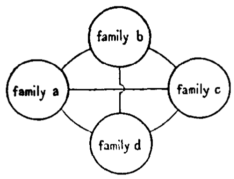

Fig. 1 An example of the DDC network composition

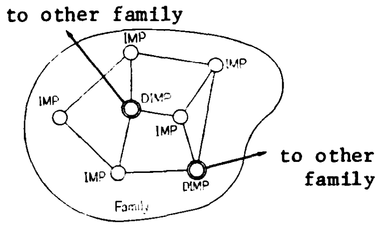

Fig. 2 An example of the family conception

There exists a dominatable IMP different from the usual IMP having functions of the distributed computer network. A family is connected with an other family by connection between their DIMP's. A family range, that is, the range that an arbitrary IMP including host computers belongs to the family, is defined as follows. Family IMP's should be located within the control limited distance (c-distance) of the DIMP;

an IMP in the family should be controlled by the DIMP in case of execution of an urgent job. The control limit is determined by delay time of a control signal which is also transmitted by store-and-forward exchanging. Let a link between two IMP nodes v_i and v_j be e_{ij}, its channel capacity be c_{ij} (bit/sec), the length of a control information signal be λ_c (bit), additional signal (including a header etc.) be λ_e (bit), propagation delay time of the link e_{ij} be d_{ij} (sec), the maximum flow rate be $\mu_{ij\max}$ (bit/sec), and the maximum delay time be $t_{ij\max}$. The maximum delay time $t_{ij\max}$ of the link $e_{ij\max}$ is given by

$$t_{ij\max}=\frac{\lambda}{c_{ij}-\mu_{ij\max}}-\frac{\lambda}{c_{ij}}+\frac{\lambda_c}{c_{ij}}+d_{ij} \qquad (3.\ 1)$$

$$(\lambda=\lambda_c+\lambda_e)$$

Let a link set of the path P_{qr} routed from a DIMP node v_q to an IMP node v_r be E_{qr}, and the delay time on the path P_{qr} be $\sum_q t_{ij\max}$. The relation between the maximum delay time and the permitted value is given by

$$\max_q \sum t_{ij\max} \leqq r \qquad (3.\ 2)$$

From the equation (3. 1),

$$\max_q \sum\left\{\frac{\lambda}{c_{ij}-\mu_{ij\max}}-\frac{\lambda}{c_{ij}}+\frac{\lambda_c}{c_{ij}}+d_{ij}\right\}\leqq r \qquad (3.\ 3)$$

An IMP fulfilling the relation (3. 3) for all DIMP's belongs to the family. Selection of DIMP's will take into account: (1) user enviroment of a network, (2) host ability within a family, (3) communication capacity on links, and (4) composition of shortest spanning tree of the family network minimizing the sum of link delay time within the family. The item (4) is discussed here further. Let the average flow rate in the link e_{ij} be μ_{ij}, and the average delay time of control signals and additional signals be t_{ij}. The following relation holds.

$$t_{ij}=\frac{\lambda}{c_{ij}-\mu_{ij}}-\frac{\lambda}{c_{ij}}+\frac{\lambda_c}{c_{ij}}+d_{ij} \qquad (3.\ 4)$$

A family can be considered as the weighted subgraph G' by assigning edges to links, vertices to nodes, and weight to average delay time t_{ij} respectively. The minimization of the sum of the average delay time is equivalent to obtain the shortest spanning tree T' in the weighted graph G'. So the center of the moment on the shortest spanning tree T' may be selected as the DIMP node. If a distance is equivalently replaced to a unit weight, the distance may be considered as the number of links.

4. The DDC network control

The DDC network is the same as the distributed network in network control when it processes an usual job, but it is different in network control when it processes an urgent big job. Features of the control are: (1) one node to multiple nodes control and (2) multiple nodes to one node communication.

Procedures to composit routes from the DIMP to multiple IMP's, to transmit and to process a big job, and to collect the results are briefly discussed next. (1) Composition of routes: If the DIMP admits necessity of family cocentration for dominatable distributed function (DD function) or a host computer requires it, then the DIMP executes preliminary processing of the jobs, such as partitioning job, assignment of resources, selection of transmitting routes, and so on. The DIMP transmits the dominatable control signals to those AIMP's by using stored and forward data exchanges. Links are reserved for data transmission after the dominatable control signal passes each node and exchange function becomes the line exchange function. (2) Transmission of jobs to host computers via AIMP's: Partitioned jobs are parallelly sent to AIMP's by using link-connection channels. Each AIMP sends back the acceptance signal to the DIMP, and the DIMP checks the signal and removes control by multiple direction channel exchange. (3) Transmission of results of partitioned jobs: There are two method for sending results to the DIMP: (a) a method by using multiple direction channel exchange and (b) a method by using packet transmission depending upon the amount of processed data.

Routing for control signals to multiple AIMP's is required for the purpose of control and data transmission. Routes are selected in such a way that control signals pass each controlled node (AIMP) in serial or parallel at once, and the sum of delay time of links to pass through is minimized for efficient network process. The routing method is the problem that a shortest spanning subtree is composed on the weighted graph.

5. Evaluation of the DDC network

Computer simulation is performed to evaluate the DDC network experimentally, where control and information signals are assumed to be exchanged by switching exchanges instead of packet transmission. Priority exchange scheme is also assumed, that is, high priority messages are transmitted earlier than scheduled control massages. Fig. 3 shows the simulation result of the relation between the message length and delay time of exchange and transmission, where the transmission rate is assumed to be 50 kbit/sec and α denotes the average number of message per second. Other simulation results are shown in Fig. 4 and Fig. 5, where t_f is processing time for DDC network control and partitioning job and t_j is job processing time executed by single host. If the job is partitioned into n_a jobs and they are processed by n_a host computers, job processing time is assumed to be $t_{pr} = t_j/n_a$. t_a is defined as the total time for job partitioning processing time, compositing processing time and job distributing time, that is, the preprocessing time. Fig. 4 shows the relation between the message length and the total preprocessing time t_a, and this means the high performance property of the DDC network. Fig. 5 shows that there is an optimal number of IMP's for distributed job processing.

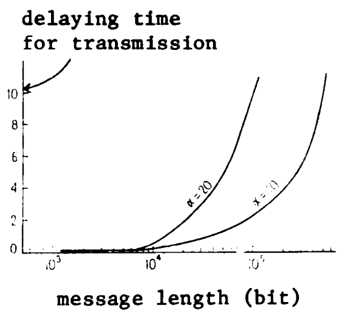

Fig. 3

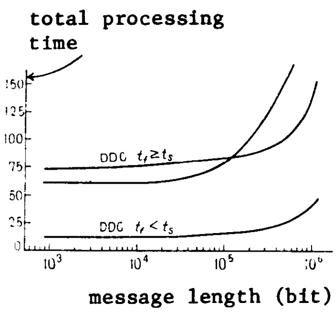

Fig. 4

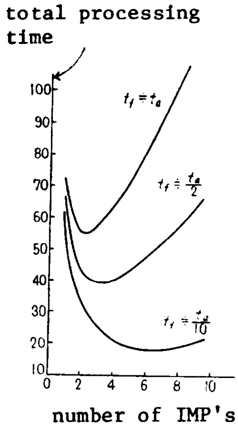

Fig. 5

6. Conclusion

A new computer network configuration is discussed in this paper as the dominatable distributed function network, and it is simulated to evaluate its performance. It is pointed out that there exists an optimal control distance to control IMP's and distribute jobs to them caused by preprocessing time and delaying time for control signal exchanges and information transmission. The DDC network is proposed as a practical high performance network.

References

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