Implications of Fault Tolerance in Distributed Systems

V.S. Tondre
B. B. Sc. College,
Amravati (Mah.),
,

V.M. Thakare, Ph.D
S.S. Sherekar, Ph.D
S.G.B.A.U. Amravati. (Mah.),

R.V. Dharaskar, Ph.D
M.P.G.I.
Nanded (Mah.)

ABSTRACT

In communication network, the number of nodes is continuously passing messages to each other in a particular fashion. Every node knows its neighboring peer. So, it is necessary to learn the topology of the entire network. Usually, in this type of network many resources are shared and deal with faulty components. Therefore, Fault tolerance is measure issue of the concern in the communication distributed system. To raise the performance of fault-tolerant routing can highly enhance the stability and efficiency of network.
The paper focuses on the fault tolerance techniques for the guaranteed communication in distributed systems.

Keywords

Distributed system, Fault Tolerance, etc.

1. INTRODUCTION

The size of computer networks is rapidly increasing. At the same time parallel programming environments in distributed systems also have been developed rapidly with very high speed networks.

Unfortunately, existing distributed systems are not enough to guarantee the completion of parallel processes within a specific time frame due to their built-in failure factors and faulty components of the network.

So, to deal with network with faulty components and basic factors has become unavoidable. Single local failure can also be critical to parallel processes and hamper other computations [1].

In distributed systems, nodes join or leave the network at high rate. Therefore, communication between the nodes requires multiple relay nodes to transfer. In this type of high dynamic characteristics network, routing disruption become frequent events due to the nodes fail or exit.

Additionally, security is another important aspect in distributed system. Only prevention and detection measures for the security purpose are not enough. It requires some extra remedial measures for better security with routing [2].

An efficient communication network is crucial for distributed systems. So, the communication network should have a small delay, ability to easily route message, high data throughput, easy expandability and high reliability. Here the last requirement means that even if the some node and/or link failure occurs, the distributed system should be able to survive and perform satisfactory. As the fundamental challenges are unique to distributed systems and communication network that is fault-tolerance. Now most of the researchers, work on this challenge, some of the examples of related problems includes consensus problems, Byzantine fault tolerance, and self-stabilization. Especially, the problem of keeping all non-faulty nodes in a network connected and developing efficient and reliable routing algorithms in a network with faults has been extensively studied in recently years [3].

This paper analyses the recent methods of fault tolerance which deals with the fault tolerance, regarding with distributed memory sharing, routing. The main purpose of the routing algorithm is to construct a fault-free path between source and destination nodes.

2. FAULT-TOLERANCE

A computer system or component designed so that, when the component of the system fails, a backup component or procedure can immediately take its place with no loss of service. Fault tolerance can be provided with software, or embedded in hardware, or provided by some combination. Fault-Tolerance is not only a property of the distributed system but also characterize the rules by which they interact. Such as the protocol TCP is designed to allow reliable two-way communication in a packet-switched network, even in the presence of communication links which are imperfect or overloaded. It does this by requiring the endpoints of the communication to expect packet loss, duplication, reordering and corruption, so that these conditions do not damage data integrity, and only reduce throughput by a proportional amount.
The fault tolerance technique must require:

- No single point of failure
- No single point of repair
- Fault isolation to the failing component
- Fault containment to prevent propagation of the failure
- Availability of reversion modes

3. TECHNIQUES OF FAULT-TOLERANCE

In this section, different fault tolerance techniques are analyzed, which are implemented by researchers in distributed system. The analysis is presented in from of table shown in table 3.1. It shows the method, advantages and disadvantages.

Table 3.1: Analysis of Fault Tolerance Methods

Sr. No.	Name of Method	Name of Authors	Technique of the method	Advantages	Disadvantages
1.	FTPA for Parallel Recomputing	Xuejun Yang et al	1. The program is divided into certain no. of section. 2. It allows the manipulation of each program section into a fault tolerant section. 3. It redistributes the workload of the failed process to the surviving processes which then recomputed the workload in parallel.	1. It achieves the fast self-recovery 2. It saves data at data saving point for correct recovery. 3. It gives guarantee of correct recovery.	1. The size of the program section is large. 2. It is not tested on real applications. 3. It handles only single fault.
2.	Replication based fault tolerant	John Paul Walters And Vipin Chaudhary	1. User level check pointing is implemented. i.e., it implement a checkpoint replication system in which it distributes the overhead of check pointing evenly over all nodes participating in the computation. 2. It uses the common existing strategies with dedicated checkpoint servers, SANs, parallel file system.	1. It reduces the impact of heavy I/O on network storage. 2. It is less expensive. 3. It gives guarantee of correct recovery	1. Not tested on real applications. 2. The check pointing overheads are increased as the no. of nodes increased.
3.	Fault tolerance using Explorer and Detector Algorithm	Mikhail Nesterenko And Se´ Bastien Tixeuil	1. In first algorithm, it matches the respective connectivity lower bounds. These bounds can be viewed as working tolerance of the algorithm. 2. The second algorithm alerts the system about the presence of the fault instead of masking it. 3. It also include to terminate and handle topology changes, discover neighbor if ports are known, discover no. of routes instead of complete topology, and reliable arbitrary information instead of topological data.	1. It specifies to operate correctly until the number of faults exceeds the theoretical tolerance limit. 2. Detectors require weaker connectivity. 3. Asymptotically it is more efficient.	1. As the system scale increased, the arbitrary nodes affected, it may became difficult to the designer to build the lot of redundant links.
4.	Fault Tolerance using Lazy Garbage Collection	Florin Sultan et al	1. It is integrated approach of independent checkpointing and logging. For garbage collection of checkpoint and logs. Two algorithms are Lazy Log Trimming (LLT) and checkpoint Garbage Collection (CGC). It allows laziness into the garbage collection mechanism and to determine the safe bounds on the state to be retained by taking into account the consistency constraints of the memory model.	1. It periodically stores the state of computation. 2. This process can conveniently choose when to checkpoint. 3. It controls the size of the logs and checkpoint in stable storage. 4. The stable storage used by a process	1. It efficiently tolerates single-fault failures. 2. Logging of I/O interaction do not used for recovery.
5.	Optimal Fault Tolerant routing algorithm	Hettiehe P. Dharmasena and Xin Yan	1. It generates the relocation matrix of the source node 0 and then used to determine the position of optimal copy of the destination node n. 2. Optimal fault tolerant message consist of two parts. The first part is finding the location of the optimal copy and second is actually the routing the message along the shortest path.	1. In the algorithm it uses the local information and guarantees an optimal path. 2. It does not use routing tables. 3. Each node takes constant time to route the message to the next node. 4. It reduces the	1. It finds the optimal route, upto three node failures occur.

				nonfaulty nodes available for routes.	
6.	Fault tolerance in DSM (Distributed Shared Memory)	Constantine Katsinis and Diana Hecht	1. It is based on the SOME-Bus architecture. 2. Protocol FT0 uses separate DSM and FT activities to maintain cache coherence and fault tolerance. 3. Protocol FT1 relies on message broadcasts to combine DSM and FT activities, hide most of the cost due to fault tolerance	1. It uses the natural broadcast of messages and DSM mechanism. 2. It does not require additional network communications. 3. It improves the DSM performance during normal operation.	1. A system configuration is used with 32 nodes and 2 threads per node.
7.	Consensus-Based fault-tolerance	Udo Fritzke Jr. et al.	1. The protocol is based on each group which has a logical clock to generate timestamps for the messages it receives. 2. When receive a message, processes of a group use a consensus protocol as a sub protocol 3. Compute the maximal one, which becomes the definitive timestamp associated with message. 4. Then, within each group, processes execute a second consensus protocol to consistently update their logical clocks. 5. Finally, a message can be delivered. Close to total order broadcast.	1. The consensus cost of the protocol is reduced. 2. It solves the total order multicast to multiple group's problem. 3. The cost of the original protocol can be reduced.	1. It is applicable for network of the unix workstation only.
8.	Software-based rerouting	Young-Joo Suh el al	1 When message come across a faulty link, it is removed from the network by the local router . 2. Delivered to the messaging layer of the local nodes operating system for rerouting and reinjection. 3. The rerouting must consider dependencies across multiple routers caused by small buffers and pipelined dataflow of wormhole switching.	1. It is possible that in a mean time to repair on the order of hours to days. 2. It delivers robust interprocessor communication performance. 3. It is compact, fast, oblivious routers and affecting only the fraction of message traffic that encounters faults.	1. These method required hardware support within a network routers. 2. The probability of the second or third fault occurring before the first fault is repaired is very low.

4. ANALYSIS AND DISSCUSION

In the above section different methods of the routing is discussed.

5. CONCLUSION

This paper highlights the different techniques of fault tolerance in distributed systems. Fault tolerance can be provided with software, or embedded in hardware, or provided by some combination. Here, only software implementation techniques are covered. Every technique has certain advantages, disadvantages and limitations. These techniques generally required substantially hardware support with the network routers, has to deliver robust interprocessor communication and performance in the presence of a relatively large number of faulty components.

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