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Network Fault Correction in Overlay Network through Optimality

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***Abstract*—**End-to-end inference to diagnose and repair the data-forwarding failures, our optimization goal to minimize the faults at minimum expected cost of correcting allfaulty nodes that cannot properly deliver data. First checking the nodes that has the least checking cost does not minimize the expected costin fault localization. We construct a potential function for identifying the candidate nodes, one of which should be first checked by an optimal strategy. .We proposes efficient inferring approach to the node to be checked in large-scale networks.

***Index Terms*—**Network Management, Network Diagnosis and Correction, Fault Localization and Repair, Reliability Engineering.

I. INTRODUCTION

Network components are prone to a variety of faults such as packet loss, link cut, or node outage. To prevent the faulty components from hindering network applications, it is important to diagnose (i.e., detect and localize) the components that are the root cause of network faults. However, it is also desirable to repair the faulty components to enable them to return to their operational states. Therefore, we focus on network fault correction, by which we mean not only to diagnose, but also to repair all faulty components within a network. In addition, it has been shown that a network outage can bring significant economic loss.

As a result, we want to devise a cost effective network fault correction mechanism that corrects all network faults at minimum cost. To diagnose (but not repair) network faults, recent approaches like use all network nodes to collaboratively achieve this. For instance, in hop-by-hop authentication each hop inspects packets received from its previous hop and reports errors when packets are found to be corrupted. While such a distributed infrastructure can accurately pinpoint network faults, deploying and maintaining numerous monitoring points in a large-scale network introduces heavy computational overhead in collecting network statistics and involves complicated administrative management. In particular, it is difficult to directly monitor and access all overlay nodes in an externally managed network, whose routing nodes are independently operated by various administrative domains. In this case, we can only infer the network condition from end-to-end information.

We consider an end-to-end inference approach which, using end-to-end measurements, infers components that are probably faulty in forwarding data in an application-layer overlay network whose overlay nodes are externally managed by independent administrative domains. We start with a routing tree topology with a set of overlay nodes, since a tree-based setting is typically seen in destination-based routing and where each overlay node builds a routing tree with itself as a root, as well as in multicast routing, where a routing tree is built to connect members in a multicast group. We then monitor every root-to-leaf overlay path. If a path exhibits any “anomalous behavior” in forwarding data, then some “faulty” overlay node on the path must be responsible. In practice, the precise definition of an “anomalous behavior” depends on specific applications. For instance, a path is said to be anomalous if it fails to deliver a number of correct packets within a time window. Using the path information collected at the application endpoints (i.e., leaf nodes), we can narrow down the space of possibly faulty overlay nodes.

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II. PROBLEM IN THE SYSTEM

Failure model[1]

Nodes can delay or drop packets to be forwarded because of power outage, full transmission queues, hardware errors, or route misconfiguration .The fail-stop model ,the failure probabilities *{pi}* can then be characterized via statistical measurements of reliability indexes. Node failures and the corresponding failure probabilities *{pi}* are all independent

Cost model[1]

The checking costs *{ci}* using the personnel hours and wages required for troubleshootingproblems or the cost of test equipment. The checking costs can be highly varying, depending on the administrative domains in which the checked nodes resides.The total checking cost is the only cost component being considered in our optimization problem.we assume that *pi* and *ci* can be anyvalues in [0, 1] and [0,*1*].

III. OPTIMIZATION PROBLEM

End-to-end inference approach for correcting data-path failures.Assume each node I has a priori known

- Failure probability p_i: the likelihood that node i has failed.
- Checking cost c_i: the cost needed to perform sanity tests on node i.

Minimize the expected total checking cost of correcting (i.e., diagnosing and repairing) all faulty nodes.

Finding Good/Bad Paths

For each data path,

- Good – if the data path has no faulty node and can deliver data
- Bad – if the data path has at least one faulty node and cannot deliver data

Each node has the same data-forwarding behavior across all paths upon which it lies.This implies if a node lies on at least one good path, it is a non-faulty (good) node.

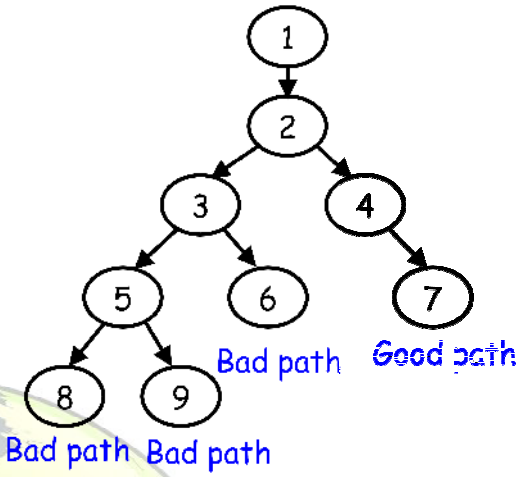

Fig 1.Finding Good and Bad Path.

Forming a Bad Tree

Monitor data streams from the root node 1 to each of the leaf nodes 6, 7, 8, 9.Keep only bad paths, and remove any nodes that are known to be good.

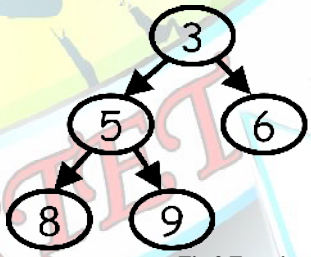

Fig 2.Forming Bad Path.

IV. INFERENCE ALGORITHM

Our inference algorithm selects which nodes to check, each node i is associated with a potential function.

$$\phi(i,T) = \frac{\Pr(\mathcal{T}|\mathcal{X}_i,\mathcal{A}_i)p_i}{c_i(1-p_i)}.$$

- p_i = failure probability of node i
- c_i = checking cost of node i
- Pr(T | X_i, A_i) = conditional probability of having a bad tree
  - ✓ T = the event that the tree is a bad tree
  - ✓ X_i = the event that node i is bad

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- ✓ A_i = the event that ancestors of node i are good

we should first check the node with high p_i and small c_i, i.e., the node with the high potential first.For general cases, we don't know which candidate node should be checked first to minimize the expected cost.

V. PROPOSED APPROACH

We propose several efficient heuristics for inferring the best node to be checked in large-scale networks. By extensive simulation, we show that we can infer the best node in at least 95% of time, and that first checking the candidate nodes rather than the most likely faulty nodes can decrease the checking cost of correcting all faulty nodes. As a result, we want to devise a cost effective network fault correction mechanism that corrects all network faults at minimum cost. To diagnose (but not repair) network faults, recent approaches like use all network nodes to collaboratively achieve this. For instance, in hop-by-hop authentication each hop inspects packets received from its previous hop and reports errors when packets are found to be corrupted. While such a distributed infrastructure can accurately pinpoint network faults, deploying and maintaining numerous monitoring points in a large-scale network introduces heavy computational overhead in collecting network statistics and involves complicated administrative management.

We present the optimality results for an end-to-end inference approach to correct (i.e., diagnose and repair) probabilistic network faults at minimum expected cost. One motivating application of using this end-to-end inference approach is an externally managed overlay network, where we cannot directly access and monitor nodes that are independently operated by different administrative domains, but instead we must infer failures via end to-end measurements. We show that first checking the node that is most likely faulty or has the least checking cost does not necessarily minimize the expected cost of correcting all faulty nodes.

VI. FAULT DETECTION AND CORRECTION

Implementation is the stage of the project when the theoretical design is turned out into a working system. Thus it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective. The implementation stage involves careful planning, investigation of the existing system and it's constraints on implementation, designing of methods to achieve changeover and evaluation of changeover methods.

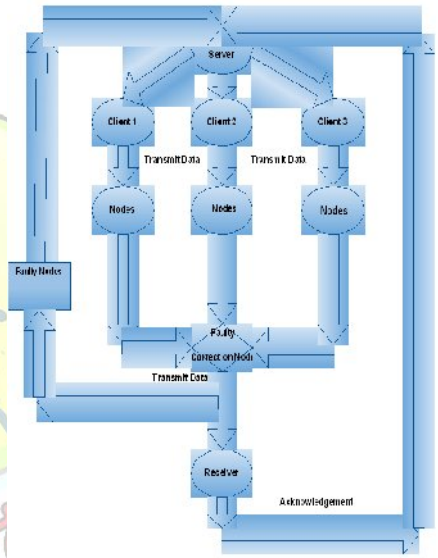

Fig 3.Data Flow for Detection and Correction.

A. Transmitter Module

The transmitter sends a packet to the receiver and waits for its acknowledgment. Based on error-detection results, the receiver generates either a negative acknowledgment (NACK) or a positive acknowledgment (ACK) for each received packet and sends it over a feedback channel. If an ACK is received, the transmitter sends out a next packet; otherwise, if an NACK is received, retransmission of the same packet will be scheduled immediately, and this process continues until the packet is positively acknowledged.

B. Fault Node Diagnosis And Correction

We consider an end-to-end approach of inferring probabilistic data-forwarding failures in an externally managed overlay network, where overlay

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nodes are independently operated by various administrative domains. Our optimization goal is to minimize the expected cost of correcting (i.e., diagnosing and repairing) all faulty overlay nodes that cannot properly deliver data. Instead of first checking the most likely faulty nodes as in conventional fault localization problems, we prove that an optimal strategy should start with checking one of the candidate nodes, which are identified based on a potential function that we develop. We propose several efficient heuristics for inferring the best node to be checked in large-scale networks. By extensive simulation, we show that we can infer the best node in at least 95% of time, and that first checking the candidate nodes rather than the most likely faulty nodes can decrease the checking cost of correcting all faulty nodes.

C. *Receiver Module*

Each data packet in the system is identified by a unique integer number, referred to as the node number. The transmitter has a buffer, referred to as the transmission queue, to store packet node waiting for transmission or retransmission. The transmission queue is assumed to have an infinite supply of packets, referred to as the heavy-traffic condition in relative studies in nodes.In the transmitter sends packets to the receiver continuously and receives acknowledgments as well. To preserve the original arriving order of packets at the receiver, the system has a buffer, referred to as the nodes buffer, to store the correctly received packets that have not been released.

VII. CONCLUSION

We presented optimality results for diagnosing and repairing all data-path failures, with an objective to minimize the expected total checking cost.We also constructed a potential function to identify candidate nodes, one of which must be checked first to minimize the expected total checking cost. Our proposed approach reduces the cost of correcting all faulty nodes.

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