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Efficient Cost Correction of Faulty Overlay nodes

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Abstract—**Optimality results are presented 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. In view of this, we construct a potential function for identifying the candidate nodes, one of which should be first checked by an optimal strategy. Due to the difficulty of finding the best node from the set of candidate nodes, we propose several efficient heuristics that are suitable for correcting fault nodes in large-scale overlay networks. We show that the candidate node with the highest potential is actually the best node in at least 95% of time, and that checking first the candidate nodes can reduce the cost of correcting faulty nodes as compared to checking first the most likely faulty nodes.

Index Terms—WSN, adhoc network, Multilayer neural network

I. INTRODUCTION

An overlay network is a layer of virtual network topology on top of the physical network, which directly interfaces to users. With the rapid advancement of Internet and computing technology, much more aggregate information and computing resources are available from clients or peers than from a limited number of centralized servers. Overlay networks provide us with the following advantages and opportunities to better utilize the increasingly growing Internet information and resources.

(1) Overlay networks allow both networking developers and application users to easily design and implement their own communication environment and protocols on top of the Internet, such as data routing and file sharing management.

(2) Data routing in overlay networks can be very flexible, quickly detecting and avoiding network congestions by adaptively selecting paths based on different metrics, such as probed latency.

(3) The end-nodes in overlay networks are highly connected to each other due to flexible routing. As long as the physical network connections exist, one end-node can always communicate to another end-node via overlay networks. Thus, scalability and robustness in overlay networks are two attractive features.

(4) The high connectivity of increasingly more end-nodes to join overlay networks enables effective sharing of a huge amount of information and resources available in the Internet.

Typical overlay networks include multicast overlays, peer-to-peer overlays (e.g. Gnutella and Kazaa), parallel file downloading overlays (e.g. BitTorrent and eDonkey), routing overlays (e.g. skype for VoIP).

Overlay networks also create several challenges and problems for us to do research. First, overlay networks not only have no controls of physical networks, but also lack critical physical network information. Second, because of the indirect or even mis-communications between overlay and underlay networks, in practice, inefficient usage network resources are quite often in many overlay applications, such as mismatch between overlay and underlay topology, inaccurate probing results among end-to-end nodes due to network dynamics, generating a large amount of redundant messages, and others.

Third, since the overlay networks are open to all kinds of Internet users, security and privacy issues can be quite serious. Fourth, overlay networks are highly decentralized, thus they are likely to have weak ability for resource coordinations. Finally, fairness of resource sharing and collaborations among end-nodes in overlay networks are two critical issues that have not been well addressed. We are conducting research to address several issues of performance, reliability, privacy, and coordinations in overlay networks. We focus on structured and unstructured P2P overlays, routing overlays for VoIP, and parallel file downloading overlays.

We consider the problem of routing in an adversarial environment, where a sophisticated adversary has penetrated arbitrary parts of the routing infrastructure and attempts to disrupt routing. We present protocols [1] that are able to route packets as long as at least one non-faulty path exists between the source and the destination. These protocols have low communication overhead, low processing requirements, low incremental cost, and fast fault detection. We also present extensions to the protocols that penalize adversarial routers by blocking their traffic. Our proposed solution is to replace a binary faulty vs. non-faulty verdict with a more continuous fault metric: a single packet drop should not result in the outright removal of a link.

We develop failure-resilient techniques [2] for monitoring link delays and faults in a Service Provide or Enterprise IP network. Our two-phased approach attempts to minimize both the monitoring infrastructure costs as well as the additional traffic due to probe messages. In the first phase of our approach, we compute the locations of a minimal set of monitoring stations such that all network links are covered, even in the presence of several link failures. Subsequently, in the second phase, we compute a minimal set of probe messages that are transmitted by the stations to measure link delays and isolate network faults. We show that both the station selection problem as well as the probe assignment problem is NP-hard.

Robust measurements of network dynamics [3] are increasingly important to the design and operation of large internet works like the Internet. However, administrative diversity makes it impractical to monitor every link on an end-to-end path. At the same time, it is difficult to determine the performance characteristics of individual links from end-to-end measurements of uncast traffic.`In this paper, we introduce the use of end-to-end measurements of multicas*t* traffic to infer network-internal characteristics. The bandwidth efficiency of multicast traffic makes it suitable for large-scale measurements of both end-to-end and internal network dynamics.

We studied the bandwidth provisioning problem for the service overlay networks. We considered both the static and dynamic bandwidth provisioning models and our study took into account various factors such as QoS, traffic demand distributions, and bandwidth costs. The approximate optimal solution we presented to the static bandwidth provisioning problem is generic [4] in the sense that it applies to different marginal distributions of the traffic demands on the routes in a network, which makes the solution very attractive facing different traffic arrival behaviors. In this paper, we have assumed the route between a source gateway and a destination gateway is predetermined. Currently, we are investigating the functionalities of the service gateways in support of service-aware (multipath) routing, which will have great impact on how an SON should be provisioned.

The use of multicast inference [5] on end-to-end measurement has recently been proposed as a means to infer network internal characteristics such as packet link loss rate and delay. In this paper we propose three types of algorithm that use loss measurements to infer the underlying multicast topology: (i) a grouping estimator that exploits the monotonicity of loss rates with increasing path length; (ii) a maximum likelihood estimator; and (iii) a Bayesian estimator. We establish their consistency, compare their complexity and accuracy, and analyze the modes of failure and their asymptotic probabilities. We have proposed and established the consistency of a number of algorithms for inferring logical multicast topology from end-to-end multicast loss measurements.

II. PROPOSED SYSTEM

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 introducesheavy 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.

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

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.

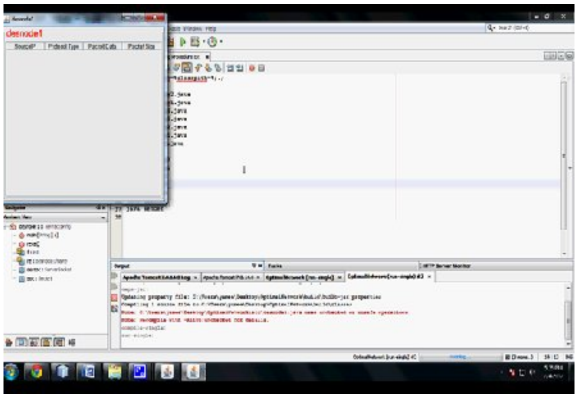

Fig.1. Entering node and packet

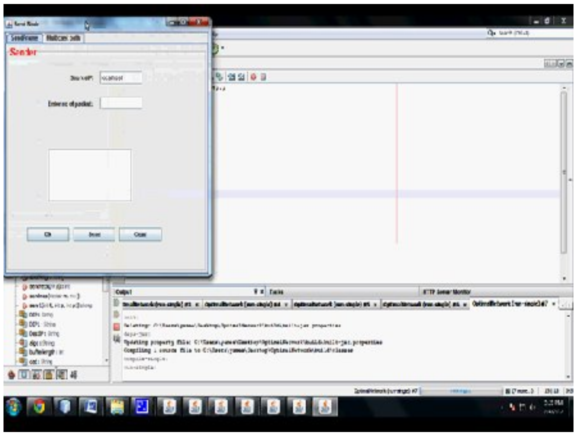

Fig.2.Node Indexing for End-to –End Measurement

Indexing the number of nodes for identification.it helps for easy end-to-end measurement.

Select node and send, packet helps for acknowledgement to the sender.

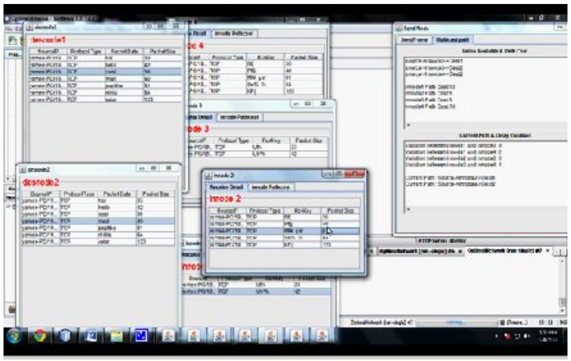

Fig.3. Cost Reduction

III. CONCLUSION

Optimality results are presented 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. In view of this, we construct a potential function for identifying the candidate nodes, one of which should be first checked by an optimal strategy. Due to the difficulty of finding the best node from the set of candidate nodes, we propose several efficient heuristics that are suitable for correcting fault nodes in large-scale overlay networks. We show that the candidate node with the highest potential is actually the best node in at least 95% of time, and that checking first the candidate nodes can reduce the cost of correcting faulty nodes as compared to checking first the most likely faulty nodes.

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