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IMPROVING DELIVERY RATIO FOR APPLICATION – LAYER MULTICAST USING IRP

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***Abstract*:**

Reliability of tree-like multicast overlays caused by nodes' abrupt failures is considered as one of the major problems for the Internet application-layer media streaming service. The previous technologies have some drawbacks. In this paper, we address this problem by designing a distributed and light-weighted protocol named the instantaneous reliability oriented protocol (IRP). This protocol overcome the problems and provides the solution to the problem. IRP reduce the node failures. Unlike most of existing empirical solutions, we first define the overlay reliability problem formally, and propose a protocol containing a node joining algorithm (IRP-Join), a node preemption algorithm (IRP-Preempt), and a node switching algorithm (IRP-Switch) for reactively constructing and repairing the overlay, as well as proactively maintaining the overlay. With the formal problem presentation, we set up a paradigm for solving the overlay reliability problem by theoretically proving the effectiveness of our algorithms. An increasing number of file transfer via Internet applications, rely today on data dissemination as their cornerstone, e.g. audio or video streaming, multi-party games. Moreover, by comparing IRP with existing solutions via simulation-based experiments and real-world deployment, we show that IRP achieves a better reliability, while incurs fewer structural adjustments on the multicast overlays, thus, providing a superior overall performance.

Introduction

With the wide deployments of broad band technologies and due to the insufficient infrastructure support of IP-Multicast, tremendous amount of work has been carried out on building application-layer multicast systems for providing end users the media streaming service. According to their overlay structures, existing works could be classified as tree-like systems and meshlike systems. The former ones include ESM NICE SCRIBE and Zigzags. In these systems, nodes are organized in a spanning tree, and the media data are pushed from parent node to child nodes. For fully utilizing nodes' bandwidths, systems containing multiple trees are also designed, such as CoopNet, Split Stream, and Chunky spread. On the other hand, data driven- based mesh-like overlays have been proposed recently for media multicasting, examples include Cool- Streaming and PRIME, and many successful commercial applications such as PPLive also adopts this mesh-like design. Compared with the tree-like design, the mesh-like overlay is more resilient against node failures, but it incurs additional control overhead with the data-driven technique. In some hybrid systems such as Bullet and mTreebone, a tree-like overlay is used as the backbone network for media streaming, while data driven mesh links are used for enhancing the system's failure resilience.

In this paper, we focus on a typical tree-like application layer multicast system like the one in, and address its reliability issue. The reliability problem arises because when a node on a multicast tree fails, especially when it fails abruptly without notifications, all the nodes receiving media directly and indirectly from it will lose their streaming services. In media streaming, it is unacceptable if such incident happens frequently, hence a well designed protocol is required for avoiding the service interruptions experienced by users caused by node failures.

In recent years, different approaches have been proposed for the tree-like multicast overlay's reliability problem. In particular, the Min-Depth scheme widely adopted and studied tries to construct a stable overlay by building a compact multicast tree on node joining events, and the Preempt-Degree scheme makes the same efforts on node failures. The recently proposed ROST algorithm exploits an age-bandwidth trade-off by switching parent-children pairs on the overlay for enhancing its failure resilience. However, it is noticed that all these existing approaches are empirical, and their effectiveness are testified mainly with experiments. Moreover, there is a lack of theoretical work on formally understanding and presenting the overlay reliability problem, and theoretically verifying the effectiveness of the solutions. Based on these observations, in this study, we will answer two questions: 1) what is overlay reliability ? and 2) how to improve the overlay's

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reliability? We first formally define the overlay reliability problem for the tree-like application-layer multicast overlay, and then present a distributed and light-weighted protocol named the instantaneous reliability oriented protocol (IRP) for improving the overlay's reliability. We also theoretically prove that the protocol is effective with the formal presentation of the overlay reliability problem.

Background And Existing Work

Existing solutions on improving the tree-like application layer multicast overlay's reliability could be classified into two types: proactive ones and reactive ones. In the reactive solutions, adjustments on the overlay's structure are made only on events of node joining and failure, while in the proactive ones, the multicast overlay is periodically adjusted proactively. The empirical and their effectiveness are testified mainly with experiments. Moreover, there is a lack of theoretical work on formally understanding and presenting the overlay reliability problem, and theoretically verifying the effectiveness of the solutions.

Problem Definition:

Existing solutions on improving the tree-like applicationlayer multicast overlay's reliability could be classified into two types: proactive ones and reactive ones. In the reactive solutions, adjustments on the overlay's structure are made only on events of node joining and failure, while in the proactive ones, the multicast overlay is periodically adjusted proactively.

We first look at the reactive solution. In a multicast overlay, when a new node joins, it relies on a bootstrap mechanism for locating its parent. In detail, after contacting a bootstrap node for obtaining a number of online nodes called neighbors, the new joining node selects one among them with spare outgoing bandwidth as its parent. Such a bootstrap mechanism is usually implemented with random sampling techniques such as RanSub and RandPeer. For parent selection, many systems such as NICE, CoopNet, and ZigZag] apply a Min-Depth scheme, where the new joining node selects the neighbor of the minimum depth as its parent. Moreover, in, a systematic comparison is conducted among a number of node joining schemes, and it is found that Min-Depth outperforms other schemes. such as selecting the oldest node or random selection.

When a node on the multicast overlay fails, all its child nodes will lose their connections and need to reconnect to the overlay. One possible solution is that these disconnected nodes rejoin as new nodes. However, this cheme will increase the overlay's depth and degrade its reliability. In, a preemption operation is discussed where the disconnected node follows certain criteria to preempt (i.e., replace) an online node even though this node is connected, and the preempted node rejoins the overlay by following the same procedure. Moreover, Bishop et al. reports that the Preempt-Degree scheme, in which a node with a larger degree (i.e., outgoing bandwidth) preempts a node with a smaller one, outperforms other node preemption schemes such as Preempt-Age (comparing nodes' ages) or No-Preempt. In, it is shown that by actively estimating the nodes' lifetime model, stable overlays could be constructed and maintained with reactive approaches on node joining and failure events.

On the other hand, the recently proposed ROST algorithm belongs to the proactive approach, where a tradeoff between a node's bandwidth and age is exploited. In ROST, each node calculates the product of its age and outgoing bandwidth; when a node finds that its product is larger than the product of its parent, and it has a larger outgoing bandwidth, it makes a switch with its parent node. It is shown that by making this proactive adjustment periodically, nodes with larger bandwidths will get moved gradually to higher positions, and the overlay is of better fault resilience than the bandwidth-optimized overlays and the time-optimized overlays defined in. Recently, Magharei et al. showed that the mesh-like overlay is more stable by comparing a typical mesh-like overlay with a typical multiple-tree overlay with the interior disjoint policy engaged.

Constructing a reliable multicast tree topology is also extensively studied in IP-Multicast. However, in general, the nodes in IP-Multicast are routers that fail infrequently, so the major concern for reliability is to reduce the service disruptions caused by failures of the physical links/nodes on the multicast tree. In most cases, the reliability problem is usually studied together with the goals of satisfying delay constraints and minimizing the costs. For example, took reliability as a QoS requirement in setting up paths between source and destination. Raghavan et al. Bauer and Varma, and Hong et al. addressed the problem of dynamically rearranging the IP-multicast topology for enabling node joining and leaving during the multicast session while preserving the streaming quality. However, as IP-multicast and application-layer multicast have completely different rationales and architectures, existing approaches for improving the IP-Multicast topology's reliability cannot be applied under the context of application- layer multicasting.

Unlike IP-multicast, in an application-layer multicast system, a node is a self-interest agent, which may subscribe and withdraw the streaming service at any time. A node's "lifetime" is defined as the time between its joining and leaving of the multicast overlay. For the application-layer multicasting, when the user behind a node on the overlay quits, the node fails, and all its descendant nodes will lose their

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streaming services. In this work, we consider node failure as the only reason causing loss of streaming service, but ignore the link failure, as a link fails much more infrequently than an application-layer node. For example, the mean time between physical link failures is in tens of days , while an application-layer node's lifetime is only in minutes or hours]. Moreover, application-layer nodes can use techniques such as multihoming to improve the reliability of the unicast path between them.

Problem Identification

Unlike IP-multicast, in an application-layer multicast system, a node is a self-interest agent, which may subscribe and withdraw the streaming service at any time. A node's "lifetime" is defined as the time between its joining and leaving of the multicast overlay. For the application-layer multicasting, when the user behind a node on the overlay quits, the node fails, and all its descendant nodes will lose their streaming services. In this work, we consider node failure as the only reason causing loss of streaming service, but ignore the link failure, as a link fails much more infrequently than an application-layer node. For example, the mean time between physical link failures is in tens of days, while an application-layer node's lifetime is only in minutes or hours. Moreover, application-layer nodes can use techniques such as multihoming to improve the reliability of the unicast path between them.

Proposed Work

Proposed IRP protocol is composed of three algorithms, namely IRP-Join, IRP-Preempt, and IRP-Switch. we conclude that there are two merits for our proposed IRP protocol compared with the existing solutions: first, the protocol improves the overlay reliability nontrivially; second, it achieves better reliability with much fewer structure adjustments., we note that the superiority of IRP is observed under a number of traces with great diversity, suggesting that our setting of NRI is appropriate as long as the nodes' lifetimes are heavy tailed

Present the overlay reliability problem and propose a new solution with theoretical proofs for its effectiveness, this is the first solution with its effectiveness theoretically verified. Moreover, our protocol does not require any detailed knowledge on nodes' lifetime model, and has a superior performance compared with existing solutions. Our work differs from existing works in that in our work, we formally present the overlay reliability problem and propose a new solution with theoretical proofs for its effectiveness. To our best knowledge, this is the first solution with its effectiveness theoretically verified. Moreover, our protocol does not require any detailed knowledge on nodes' lifetime model, and has a superior performance compared with existing solutions

Module description:

IRP Join

The IRP-Join algorithm is very simple. In this algorithm, after obtaining its neighbors from the bootstrap node, a new joining node selects an eligible neighbor node (a node which can support one more child) with the minimum PRI as its parent. If there is no eligible node, the new joining node contacts the bootstrap node again for renewing its neighbor set.

Algorithm

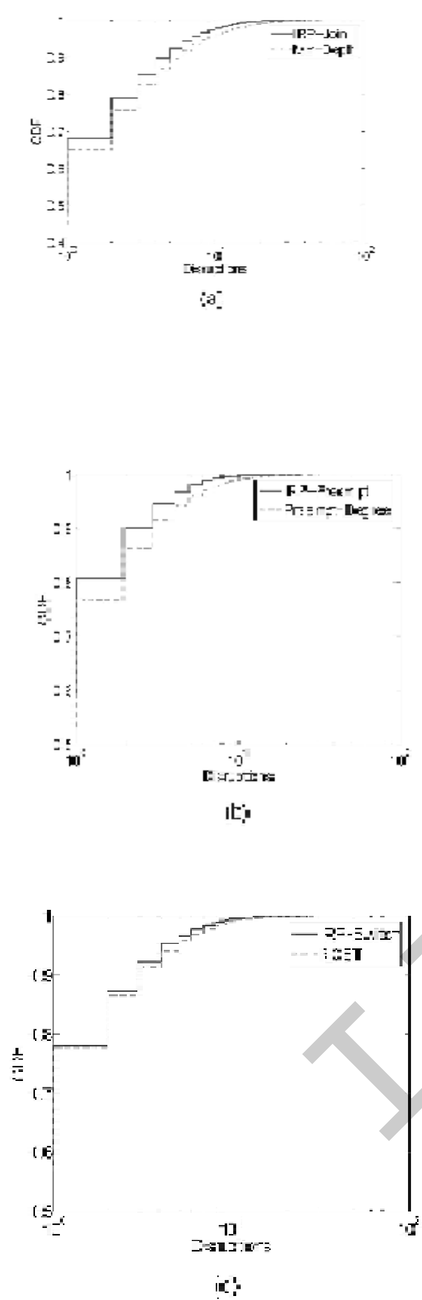
1. IRP-Join
1. Nj contacts the bootstrap node for its neighboring node set R;
2. For each eligible node Ni 2 R, NJ queries for Ni's PRI;
3. Nj connects to the node Ni with the minimum PRI as its parent;
4. Return.

IRP Switch

In our proposed IRP-Preempt algorithm, a disconnected node rejoins the overlay by trying to connect to one of its neighbors as its new parent. Similar to IRP-Join, the disconnected node first tries on the neighbor with the minimum PRI as its potential parent, if the neighbor could support one more child, the disconnected node successfully rejoins the overlay; otherwise, the disconnected node tries to preempt one of the neighbor's current children by comparing their descendant numbers: if the disconnected node has more descendants than the child node, the preemption succeeds, and the preempted node follows the same procedure to rejoin the overlay. If none of the child nodes could be preempted, the disconnected node tries on the next neighbor with the second minimum PRI. The disconnected node tries on all its neighbors until it successfully reconnects to the overlay.

IRP Leave

In this IRP leave module a node can leave from the group or it can leave from the entire network. So that the connected nodes want to join some other group in that network.



Conclusion

In this paper, we address the reliability issue for the treelike application-layer multicast overlays. We first formally presented the overlay reliability problem, and designed a distributed and light-weighted protocol named IRP for constructing, repairing, and maintaining reliable multicast overlays proactively as well as reactively. Concretely, our protocol is composed of three algorithms, i.e., IRP-Join, IRPPreempt, and IRP-Switch, for node joining, node preemption, and node switching, respectively. With the formal presentation of the problem, we theoretically proved that these algorithms are effective. To our best knowledge, this is the first effort for formally understanding and theoretically solving the application-layer multicast overlay's reliability problem. Finally, through experiments based on simulation and PlanetLab deployment, we studied the performance of our solution, and compared the entire protocol and each of its components with its existing solution counterpart. The experiment results indicate that IRP could improve the multicast overlay's reliability nontrivially with fewer adjustments on the overlay's structure. We also explored the necessity of the proactive node switch algorithm, studied the issues of service latency and overlay stretch, and discussed the application of our protocol on multicast overlays containing multiple trees.

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