

Topic Review: Advanced Routing

Review: A Comparative Study of Application Layer Multicast Protocols

The unpublished paper “A Comparative Study of Application Layer Multicast Protocols” by Suman Banerjee and Bobby Bhattacharjee provides a general overview of the current state of application layer multicast protocols. The paper begins with a brief discussion of network layer multicast (specifically, IP multicast) and the problems that have impeded its adoption. It then explains the basic concepts behind application layer multicast protocols, describes certain selected metrics by which the performance of these protocols can be evaluated, and proposes a taxonomy that classifies the protocols by the mechanisms used connect multicast nodes and distribute data. The authors then describe the basic mechanisms of certain specific protocols from each classification. Finally, the paper offers some theoretical analysis of the performance the protocols that are discussed and offers some guidance regarding the situations in which each class of protocol is likely to be most effective.

In general, for a survey or comparative study to advance the state of the art in a particular field, it must do at least one of the following very well:

- Provide a clear and justified direction for future research, typically by some combination of pruning away inferior ideas and empirically demonstrating the benefits of strong ideas
- Offer a new way of thinking about the area of research
- Demonstrate novel methods of evaluation that stimulate new solutions

This paper, while it makes some attempts to do these things, never successfully achieves any of them; and it has a number of serious and recurrent weaknesses that significantly limit its contribution.

The paper’s few strengths are concentrated in the first two sections, in which it describes generic metrics for the evaluation of any application layer multicast protocol, and offers a framework for the classification of these protocols as either “mesh-first”, “tree-first”, or “implicit” – referring to the strategy used by the protocols to construct multicast topologies. However, even in these respects the paper falls short. It describes two broad metrics to evaluate the performance of an application layer multicast protocol: Data path quality (of which “stress” and “stretch” measurements are offered as components), and control overhead. These metrics are discussed in some detail and helpful figures are given to illustrate how a protocol can be evaluated against them. Figure 1 clearly shows a tradeoff between max stress and average stretch, but the authors do not discuss this at all and miss an opportunity to offer guidance regarding which of these metrics should be optimized for under different conditions. Also, the authors then very briefly list several other metrics “of interest”, but offer no description of them or justification for why they chose the metrics they did to discuss in detail. This leaves the reader with no clear understanding of the best way to evaluate application layer multicast protocols. This failing becomes very apparent when, after providing a relatively lengthy discussion of

stress and stretch metrics in the introduction, the paper entirely dismissed them in its brief evaluation section, as being too difficult to compute. One wonders why the authors bothered to discuss these metrics in detail instead of others that might be more useful or practical. Furthermore, the proposed classification of application layer multicast protocols, while potentially beneficial to the field as helping to better conceptualize key ideas and approaches, is lacking justification by the authors. It would have lent some strength to the paper if the authors had described the advantages of their classification system against alternative ways of organizing these protocols.

Nearly three quarters of the paper is devoted to the sections that describe examples of each of the three types of protocols, mesh-first, tree-first, and implicit. These sections do provide good high-level information regarding the function of the protocols that are described. However, the descriptions lack either technical depth or precision (or both) and leave significant questions unanswered. For example, the paper mentions that all application layer multicast protocols designate a particular host to be the rendezvous point (RP), which is used to aid new members in joining multicast groups. However, other than a brief mention for the Scribe protocol, the paper offers no details regarding the mechanism by which an RP is selected or discovered. This seems like a critical component to the proper function of any of the protocols.

There is also a notable lack of critical analysis of the protocols that are presented. The paper does not seriously evaluate the pros and cons of the major classes of protocols or the benefits and challenges of any specific protocol, beyond a brief discussion of the theoretical complexity of the topologies they generate. For example, according to the description of the Yoid protocol, a new member selects its parent in the data delivery path by querying the root to see if its degree is filled. If it is filled, the new member then selects the "closest" child and probes it to see if its degree is filled. It repeats process this down the tree until a node is found with available degree, which is then selected to be the parent of the new member. This process seems to have the potential to yield highly imbalanced trees and construct significantly suboptimal paths since the truly "closest" node may be down an entirely different branch of the tree from the root. This paper offers no such in depth discussion of the issues, strengths, or weaknesses of the specific protocols it describes.

Finally, I found the title of this paper to be somewhat misleading, as it is more of a shallow survey than a comparative study. It offers little practical evaluation of the protocols that are discussed and does not provide a solid basis for comparison, despite its implied goals. The authors performed no independent empirical evaluations of any protocols, and besides the small amount of theoretical evaluation, did little more than loosely summarize information culled from various other sources. It is perplexing why the authors did not provide more detailed descriptions or in depth analyses of the protocols they selected -- judging by the relatively large font size and prodigious use of whitespace, they were not hindered by page limit restrictions.

Regarding they style and quality of the writing, I did find the paper relatively easy to read, though I suspect this was due partially to its lack of technical depth. In retrospect, the paper is organized in a fairly straightforward manner; however, the authors neglect to explicitly state any goals or offer any outline of how the paper will proceed in achieving them. This leaves the reader with an impression of

having been taken haphazardly through the main points of the paper, without clear direction or focus. As if to encapsulate the general shortcomings of the paper as a whole, the conclusions section is little more than a rehash of the abstract, and offers no actual conclusions other than an unsubstantiated claim that “all application layer multicast schemes can take advantage of network-layer multicast support where available”. It would have been great if paper had included a discussion on how application layer multicast protocols might work with and benefit from network layer multicast protocols, but this one sentence at the end of the paper is all that is given.

In summary, I found this to be a very weak paper that makes little contribution to the state of the art. I am not surprised that it has not been published.