CS540 - Paper Review Report # VI

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Title: Random Early Detection Gateways for Congestion Avoidance

Author: Sally Floyd and Van Jacobson, Lawrence Berkeley Laboratory

In paper, Random Early Detection Gateways, an effective means to avoid congestion in packet switched environment or networks, has been proposed. RED Gateways has two main roles: Calculating the average queue size and Notifying congestion connections. They are designed to support TCP and other transport layer congestion control protocols that respond to congestion through marked packets (either dropped or with the congestion bit set). Unlike end-node congestion control mechanisms in which the transport protocols (TCP) of an Internet controls congestion, RED gives gateways the ability to relatively prevent congestion by detecting incipient congestion by computing the average queue size. i.e. Gateways keep track of the average size (length) of the packet queues in their buffer. If the size exceeds a preset threshold, then subsequent packets are marked, with a specific probability of being dropped(), or dropped(Packets with probabilities that exceed a given maximum probability are dropped) by the gateway. When the dropping of packets happens, the window should be reduced and it becomes possible only when the gateway notifies a certain connection. This serves as a signal to the TCP layer responsible for that packet to reduce the amount of packets it is sending across that link. In turn, this may prevent a possible congestion within a given router as the number of packets it receives is reduced. It was also mentioned that even if the transport protocol is not cooperating (it still floods the network even with congestion), the RED algorithm can still control the average queue length since it can drop the non-cooperating connection's packets.

The authors have also done comparison between their work and other early models of early detection congestion avoidance mechanisms and show how each performed in various scenarios. The two most discussed mechanisms were Early Random Drop and Drop Tail gateways. The Early Random Drop gateway is almost the same as RED but it uses a fixed probability (i.e. does not adjust to network throughput) in determining which connection to notify. i.e. it drops the packets when the queue size exceeds a certain drop level, not the average queue size. While for Drop Tail, on the other hand, since packets are dropped from several connections, global synchronization is introduced. Global synchronization is where multiple nodes receive the congestion notice so they all decrease their throughput at the same time, thus falling below optimal utilization of the network – a scenario that

must be avoided and has long been studied. Design guidelines, description of RED algorithm and simple simulation work together with evaluation of RED gateways and their implementation is also included within the paper. The authors have also mentioned a lot of topics open for further research.

Overall, the paper presents RED, a new mean for congestion in detail. But one issue regarding the paper is that the algorithm seems to have been specifically targeted for TCP/IP networks. Will it work with other transport layer protocols other than TCP? How the gateway determines the best average queue size? How early to start dropping packets? How to set parameters? How to ensure fair bandwidth sharing when flows with different packet sizes share a link?

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Title: Dynamics of Random Early Detection

Author: Dong Lin & Robert Morris, Division of Engineering and Applied Sciences, Harvard University

Random Early Detection (RED), one of the most commonly used Active Queue Management (AQM) algorithms, drops incoming packets with a dynamically computed probability when the average number of packets queued exceeds a preset threshold value. By dropping these packets, before the gateway's buffers are completely exhausted, RED prevents congestion. RED does not requires per-flow state; it should be easy to add to an existing IP gateway and have little impact on its packet forwarding efficiency. Although RED provides low average queuing delay and high throughput at the same time, but effectiveness of RED is highly sensitive to the RED parameters setting.

In the paper, Flow Random Early Drop (FRED), a modified version of RED that provides selective dropping based on per-active-flow buffer counts to impose on each flow a loss rate that depends on the flow's buffer, is proposed.

The authors first discuss about the Internet traffic types: Non-adaptive, Robust and Fragile, according to the way the traffic handles congestion. Then they talk about RED gateways: they way they drop packets when congestion happens for the above mention traffic types and their limitations. Detail description on FRED like how it works, how to calculate the average queue length, its algorithm and its key features: protecting fragile flows, managing heterogeneous robust flows and managing non-adaptive flows, are also discussed in the paper.

Even though FRED is more likely to accept packets from new connections even under congestion and it serves as a selective binary feedback congestion avoidance algorithm but It has some concerns. How to allocate buffers fairly when there are more flows of packet but the gateway buffers are full? How to handle misbehaving users?

Title: REM: Active Queue Management

Author: Sanjeewa Athuraliya and Steven H. Low, California Institute of Technology, Victor H. Li and Qinghe Yin, CUBIN, University of Melbourne

Random Exponential Marking (REM), is an active queue management scheme, uses decoupling congestion measure from performance measure, such as loss, queue length or delay, technique to achieve high utilization and negligible loss and delay. Its motive is to achieve maximum utilization with minimum delay and packet loss. It works on two principle (a) Match Rate Clear Buffer: In which user rate is compared with network capacity. I.e. high utilization is not achieved by keeping large backlogs in the network, but by feeding back the right information for users to set their rates. Simulation results demonstrate that REM can maintain high utilization with negligible loss or queuing delay as the number of users increases, has been presented. (b) Sum Prices: Here outgoing links are summed and the marking probability is directly proportional to sum of link prices (congestion measures).

The paper first talks about the key questions that the design of active queue management algorithms must answer followed by an introduction about Random Early Detection(RED) and its limitations. It then, discusses about REM: REM basics, how to stabilize both the input rate around link capacity and the queue around a small target regardless of the number of users sharing the link, to use the sum of the link prices along a path as a measure of congestion in the path and to embed it in the end-to-end marking probability that can be observed at the source, modularized features, issues related to performance: stability and utility functions, Congestion and Performance Measures. To compare the performance of REM and RED, with both Reno and NewReno, with a single link and multiple links, with various numbers of sources, link capacities, simulation in the ns-2.1b6 simulator has been conducted.

In the paper an alternative approach for queue management has been proposed. Some limitations of the of the paper includes: it shows comparison between only two classes of algorithms(RED and REM and it is also. simulation based work not actually implemented.