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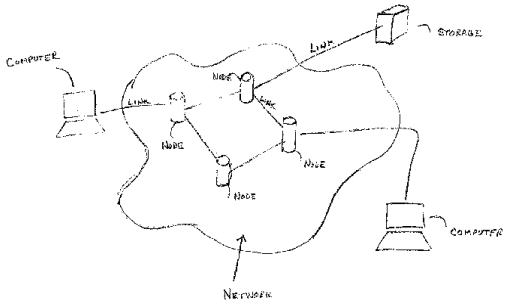
(54) METHODE ET APPAREILLAGE DE GESTION DE FILE D'ATTENTE
(54) METHOD AND APPARATUS FOR QUEUE MANAGEMENT

(57)

A method, apparatus, and computer program product for determining a drop probability for use in a congestion control module located in a node in a network is disclosed. A weight value for determining a weighted moving average of a queue in a node is first systematically calculated. The weighted moving average is calculating and an average queue size for the node is determined based upon the weighted moving average. A control function associated with the congestion control module is evaluated using the average queue size to determine the drop probability. The weight value may be calculated by first determining a sampling period for measuring the queue size. Next, a time period for which samples significantly contribute to the average queue size is calculated. The weight is determined based upon the sampling period and the time period. In a further embodiment, the control function is calculated based upon a queue function where the queue function is calculated based upon predetermined system parameters. The control function may be selected based upon a queue policy for management of the queue. From the queue policy a threshold value which lies along the queue function curve is determined. This point provides a minimum value for the maximum point of the control function so as to avoid oscillations within the buffer. A maximum point may then be selected which resides outside of the curve for the queue function. The control function may then be selected so that the control function crosses through the maximum point. Thus, when the congestion control module drops packets based upon the drop probability determined by the control function the queue will not oscillate.



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(72) FIROIU, VICTOR, US
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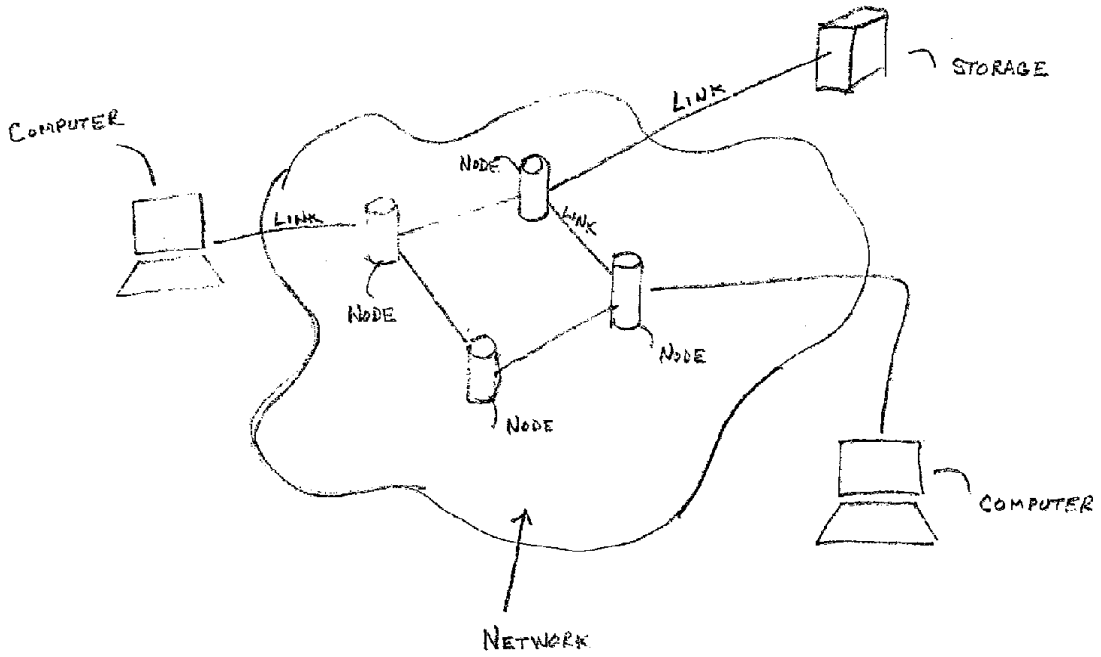
(54) **METHODE ET APPAREILLAGE DE GESTION DE FILE D'ATTENTE**

(54) **METHOD AND APPARATUS FOR QUEUE MANAGEMENT**



(57) A method, apparatus, and computer program product for determining a drop probability for use in a congestion control module located in a node in a network is disclosed. A weight value for determining a weighted moving average of a queue in a node is first systematically calculated. The weighted moving average is calculating and an average queue size for the node is determined based upon the weighted moving average. A control function associated with the congestion control module is evaluated using the average queue size to determine the drop probability. The weight value may be calculated by first determining a sampling period for measuring the queue size. Next, a time period for which samples significantly contribute to the average queue size is calculated. The weight is determined based upon the sampling period and the time period. In a further embodiment, the control function is calculated based upon a queue function where the queue function is calculated based upon predetermined system parameters. The control function may be selected based upon a queue policy for management of the queue. From the queue policy a threshold value which lies along the queue function curve is determined. This point provides a minimum value for the maximum point of the control function so as to avoid oscillations within the buffer. A maximum point may then be selected which resides outside of the curve for the queue function. The control function may then be selected so that the control function crosses through the maximum point. Thus, when the congestion control module drops packets based upon the drop probability determined by the control function the queue will not oscillate.

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ABSTRACT OF THE DISCLOSURE

A method, apparatus, and computer program product for determining a drop probability for use in a congestion control module located in a node in a network is disclosed. A weight value for determining a weighted moving average of a queue in a node is first systematically calculated. The weighted moving average is calculating and an average queue size for the node is determined based upon the weighted moving average. A control function associated with the congestion control module is evaluated using the average queue size to determine the drop probability. The weight value may be calculated by first determining a sampling period for measuring the queue size. Next, a time period for which samples significantly contribute to the average queue size is calculated. The weight is determined based upon the sampling period and the time period. In a further embodiment, the control function is calculated based upon a queue function where the queue function is calculated based upon predetermined system parameters. The control function may be selected based upon a queue policy for management of the queue. From the queue policy a threshold value which lies along the queue function curve is determined. This point provides a minimum value for the maximum point of the control function so as to avoid oscillations within the buffer. A maximum point may then be selected which resides outside of the curve for the queue function. The control function may then be selected so that the control function crosses through the maximum point. Thus, when the congestion control module drops packets based upon the drop probability determined by the control function the queue will not oscillate.

METHOD AND APPARATUS FOR QUEUE MANAGEMENT

PRIORITY

This application claims priority from United States Provisional Application 60/137,082 entitled "Apparatus and Method of Design and Configuration of Active Queue Management in Routers and Switches" filed on June 2, 1999 which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The invention generally relates to networks and, more particularly, the invention relates to the management of a queue at a node in a network.

BACKGROUND OF THE INVENTION

Congestion occurs in a network when resource demands exceed capacity. In prior art communications networks, resource demands exceed capacity when data is sent on a path from a sender to a recipient and a node on the path cannot send data as quickly as it is received. In this case, the throughput of the node decreases and may drop to zero. When the throughput drops at the node, received packets build up in the node's memory, referred to as a buffer, increasing the number of accumulated packets forming a queue until the buffer is full and overflows. As the buffer overflows, data at the receiver may be delayed or the data may be lost. Such a state is generally a transient condition in a network as users of the network vie for resources during peak time periods. In the past, nodes in high-speed networks have been forced to include large buffers in an attempt to avoid overflow during periods of congestion. As a result of increasing buffer size, defined as accumulated packets waiting to be serviced, the average queue size increases. The average queue size for a buffer is the average number of packets present in the buffer.

One technique for avoiding large queues and large network delays is Random Early Detection (RED). RED is designed to accompany transport-layer congestion control protocols such as TCP and operates as a mechanism for regulating the amount of information that is sent to a node by decreasing the number of acknowledgment packets that are sent to the sender. The congestion control mechanism in TCP is a closed control

system that reacts to unacknowledged packets by re-sending the unacknowledged packets and reducing the transmission rate. Systems that implement RED detect congestion by computing the average queue size as data is received into a buffer. When the average queue size exceeds a preset threshold, the node refuses to service i.e. "drops" a percentage of packets as determined by a control function.

The queue sizes determined by the RED technique, in combination with TCP congestion control, are subject to large size oscillations. Using the RED technique, parameters defining the control function are set by a system's administrator, without a methodology for determining values for the parameters. As such, the control function may be unstable and fail to adequately regulate the feedback to the TCP congestion control. The large oscillations that result under such circumstances in one node can propagate to other nodes and cause erratic behavior in the network. Because RED does not define a methodology for calculating the parameters, system administrators have used trial and error techniques. These trial and error techniques do not provide for a controllable network.

SUMMARY OF THE INVENTION

A method, apparatus, and computer program product for determining a drop probability for use in a congestion control module located in a node in a network are disclosed. A weight value for determining a weighted moving average of a queue in a node is first systematically calculated. The weighted moving average is calculating and an average queue size for the node is determined based upon the weighted moving average. A control function associated with the congestion control module is evaluated using the average queue size to determine the drop probability. The weight value may be calculated by first determining a sampling period for measuring the queue size. Next, a time period for which samples significantly contribute to the average queue size is calculated. The weight is determined based upon the sampling period and the time period. In a further embodiment, the control function is calculated based upon a queue function where the queue function is calculated based upon predetermined system parameters. The control function may be selected based upon a queue policy for management of the queue. From the queue policy a threshold value which lies along the queue function curve is determined. This point provides a minimum value for the maximum point of the control function so as to avoid oscillations within the buffer. A maximum point may then be selected which resides outside of the curve for the queue function. The control function may then be selected so that the control function crosses

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