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Ravi et al.

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(54) **DYNAMIC BANDWIDTH SELECTION FOR EFFICIENT TRANSMISSION OF MULTIMEDIA STREAMS IN A COMPUTER NETWORK**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).
Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(51) **Int. Cl.⁷** **G06F 15/167; G06F 15/173**

(52) **U.S. Cl.** **709/233; 709/216; 709/225**

(58) **Field of Search** 370/232, 233, 370/234, 236; 709/203, 207, 212, 216, 217, 218, 219, 223, 224, 225, 231, 232, 233, 102, 104, 105; 707/10

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Primary Examiner—Zarni Maung

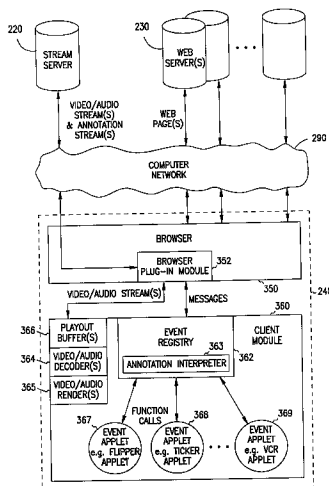
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(57) **ABSTRACT**

An efficient transmission protocol for transmitting multimedia streams from a server to a client computer over a diverse computer network including local area networks (LANs) and wide area networks (WANs) such as the internet. The client computer includes a playout buffer, and the transmission rate is dynamically matched to the available bandwidth capacity of the network connection between the server and the client computer. If a playtime of the playout buffer, which is one measure of the number of data packets currently in the playout buffer, drops below a dynamically computed Decrease Bandwidth (DEC_BW) threshold, then the transmission rate is decreased by sending a DEC_BW message to the server. Conversely, if the number of packets remaining in the playout buffer rises above a dynamically computed Upper Increase_Bandwidth (INC_BW) threshold and does not drop below a Lower INC_BW threshold for at least an INC_BW wait period, then the transmission rate is incremented. The transmission rate can be selected from among a predetermined set of discrete bandwidth values or from within a continuous range of bandwidth values. In one variation, in addition to responding to changes in network connection capacity, the client computer also determines an average client computational capacity. Accordingly, if the average client computational capacity is less than the network capacity, the lower of the two capacities is the determining one, thereby avoiding a playout buffer overrun.

42 Claims, 18 Drawing Sheets



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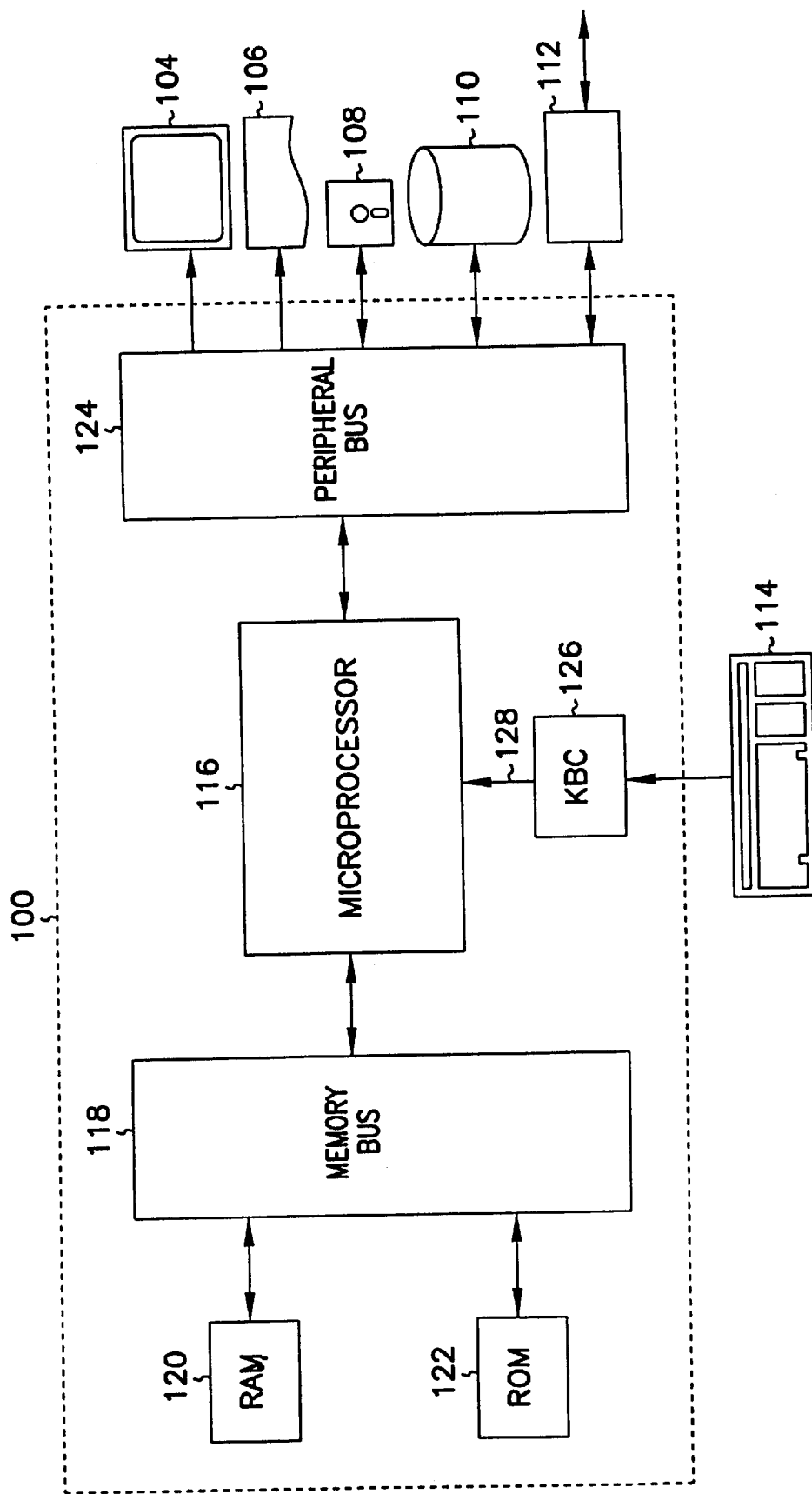


FIG. 1

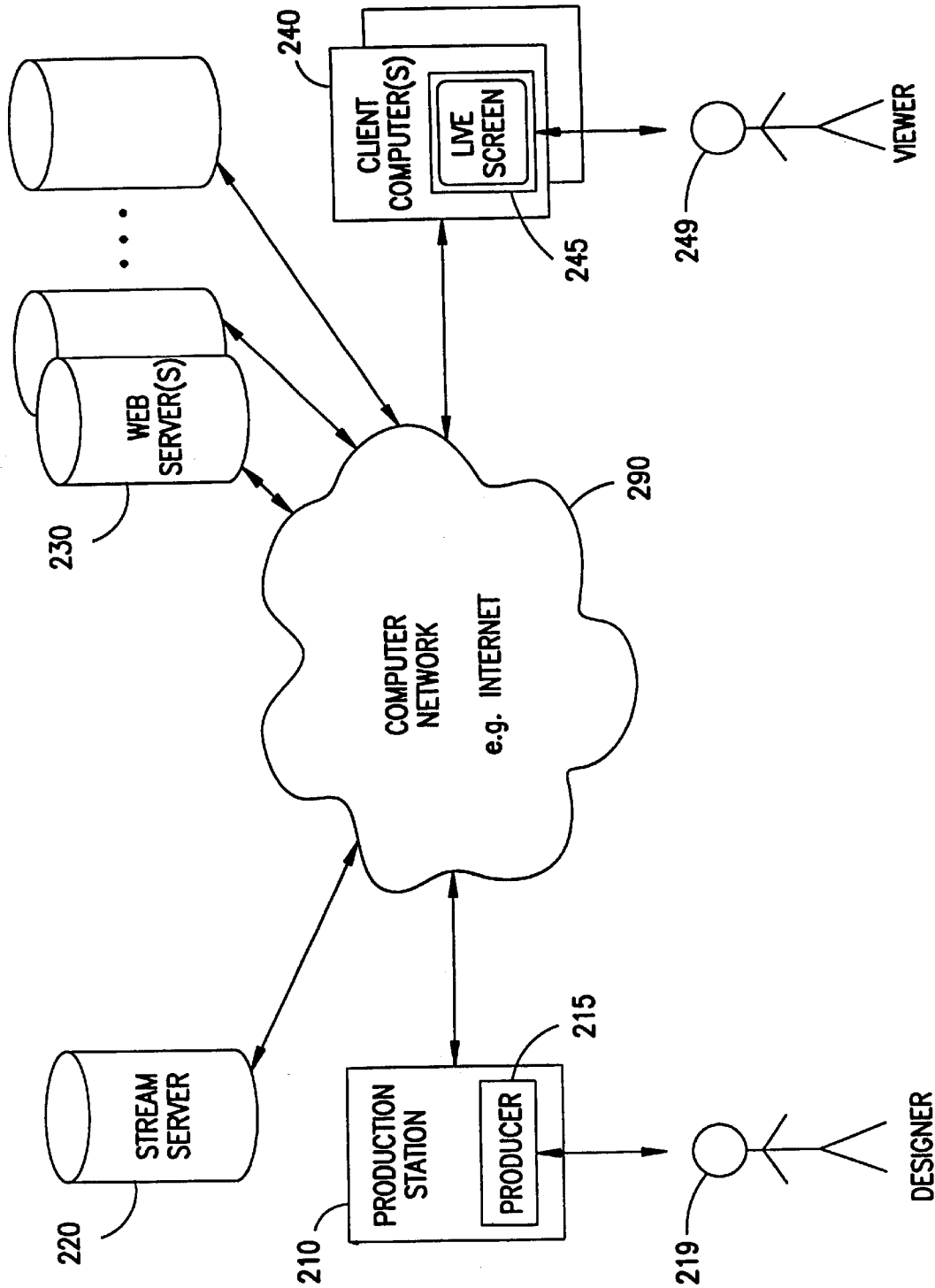


FIG. 2

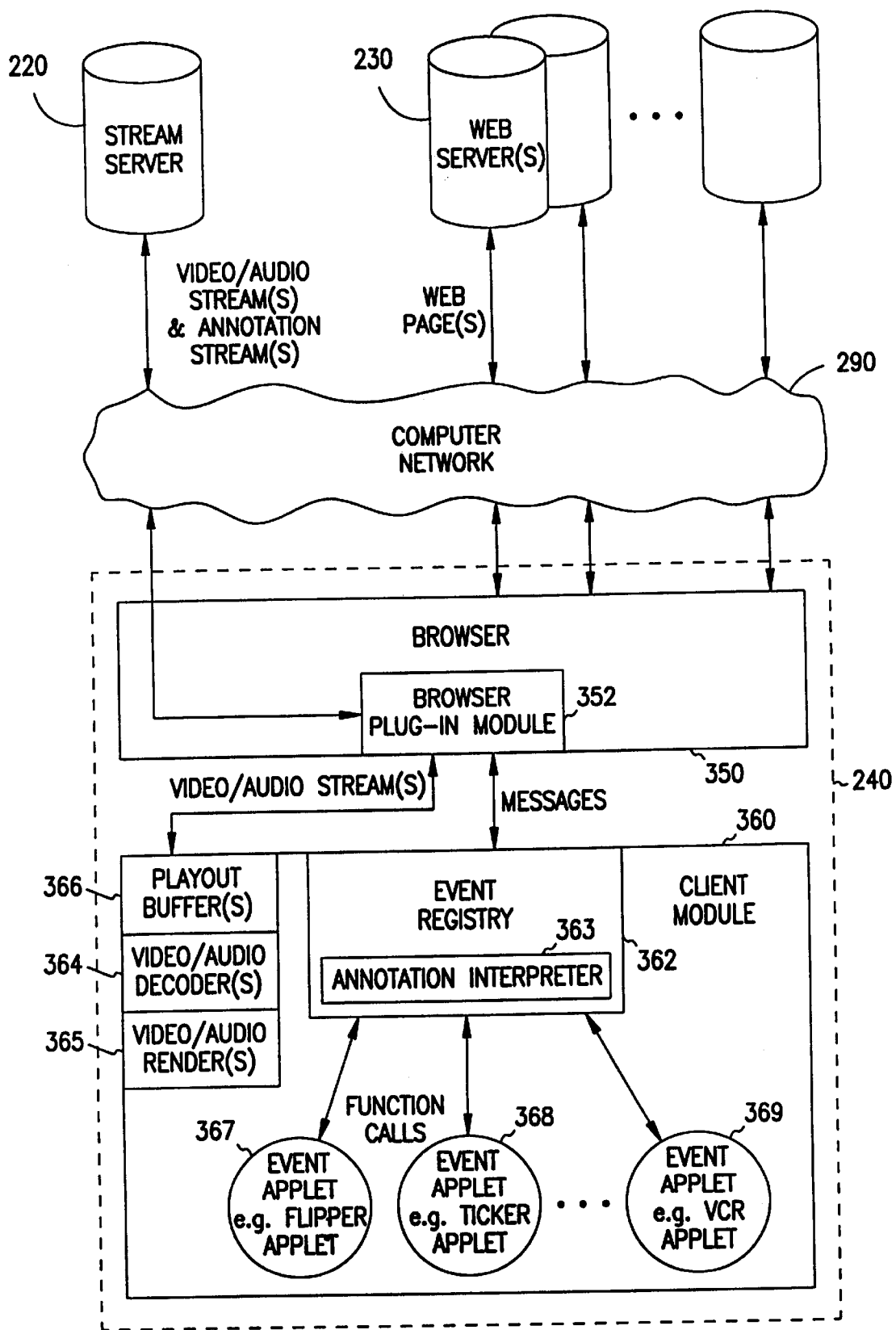


FIG. 3

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