ACK. We used the transmission order in an ACK to find the associated packet in order to measure per packet RTT.

4.3 Detection of Lost Packets

Upon arrival of a normal or duplicated ACK, TCP sequentially compared the cumulative ACK number with the bytes of the already sent SKBs in WAITLIST. The SKBs having bytes less than or equivalent to the cumulative ACK number were considered to be successfully arrived. If the bytes of an SKB did not belong to the cumulative ACK number, SACK blocks were used to ack the SKB. If the bytes of the SKB were less than the largest byte in the SACK blocks and were not acked, the dupCnt in the SKB increased by one. If the dupCnt reached three, the SKB was marked as LOST. WAITLIST scanning stopped until the next SKB reached the value pointed by sk_send_head. The recognition of a lost packet triggered the congestion control as described in Section 2.2.

5 Experimental Results

5.1 Testbed Setup

To evaluate the performance of LE, we set up a testbed as shown in Figure 8, consisting of three linux-based PCs with kernel version 2.6.17. The two outer PCs were used to mimic a sender and a receiver, while the middle one emulated a network. We used the Netem [29] network emulator, which enabled us to control packet drop rates and round trip delays. To measure performance, we used the iperf software tool [28]. In the emulation, we fixed RTT to 20msec and varied the packet drop rate from 0 to 10%. We limit the packet drop rate up to 10% because TCP-RR is likely to malfunction as the packet loss rate becomes more than 10% while TCP-Westwood affords to achieve a transmission rate more than 10% and even up to 20%. Thus, considering a realistic packet drop rate for the fair comparison between TCP-Westwood and TCP-RR, we have used 10% as the maximum packet drop rate.