Performance Modeling of Queuing Techniques for Enhance QoS Support for Uniform and Exponential VOIP based Traffic Distribution

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ABSTRACT
In the near future there will be demand for seamless service across different types of network, so it's a significant issue of how to guarantee the quality of service (QoS) and support a variety of services. One important generalization of the Next Generation Network is, it's a queue of network. It is expected that traffic in NGN will undergo both quantitative and qualitative changes. Such networks can model problems of contention that arise when a set of resources is shared. With the rapid transformation of the Internet into a commercial infrastructure, demands for service quality have rapidly developed. This paper gives a comparative analysis of three queuing systems FIFO, PQ and WFQ with different traffic distribution. It includes constant, uniform and exponential traffic distribution for VOIP. Packet end to end delay, traffic drop and packet delay variation is evaluated through simulation. Results have been evaluated for uniform and exponential traffic distribution. Result shows WFQ has better quality comparing with other techniques in a voice based services and having minimum traffic drop. Simulation is done using OPNET.

Categories and Subject Descriptors
B.4.4 [**Performance Analysis and Design Aids]**: Data communication –Simulation.

General Terms
Performance, Design, Evaluation.

Keywords
QoS-Quality of service, NGN-Next generation network, FIFO, PQ, WFQ, VOIP.

1. INTRODUCTION
It is desirable to impose some traffic-control policy at a network node which depends only on the external traffic loads on the input and output links, but not on the detailed addressing or distribution of packets from inputs to outputs. It should be possible to guarantee the grade of-service of an input-output connection by controlling the aggregate loads on the input and output. There are three type of traffic distribution possible. It is constant, uniform and exponential. Exponential distribution produces heavy traffic as compared to uniform distribution. Hence the amount of traffic dropped is more in exponential distribution[15].

To offer better quality of service in a network a lot of parameter should be considered such as bandwidth, latency, delay, jitter and packet loss etc. These issues have been discussed extensively in past [12]. There are two types of networks.

- Open Queuing network: It is characterized by one or more sources of job arrivals and correspondingly one or more sinks that absorb jobs departing from the network.
- Close Queuing network: In this type of network job neither enters nor depart from the network. The probability of transition between service centers and the distribution of job service time characterized the behavior of jobs within the network. For each center the no. of servers the scheduling discipline and the size of the queue must be specified. We assume that the scheduling is FCFS and that each server has a queue of unlimited capacity.

Output of a queuing system and various algorithms on performance evaluation has been discussed extensively in past through many research papers [4][6][13].

2. VARIOUS QUEUING TECHNIQUES
We treat a number of elementary queuing models. Attention is paid to methods for the analysis of these models, and also to applications of queuing models on 3G and 4G network.Various queuing disciplines can be used to control which packets get transmitted and which packets which packets get dropped. The queuing disciplines are:

1. First-in-first-out (FIFO) queuing.
2. Priority queuing (PQ)
3. Weighted-Fair queuing. (WFQ)

FIFO is an acronym for First in First Out. This expression describes the principle of a queue or first-come first serve behavior: what comes in first is handled first, what comes in next waits until the first is finished etc. Thus it is analogous to the behavior of persons "standing in a line" or "Queue" where the persons leave the queue in the order they arrive. First In First out (FIFO) is the most basic queuing discipline. In FIFO queuing all packets are treated equally by placing them into a single queue, then servicing them in the same order they were placed in the queue. FIFO queuing is also referred to as First Come First Serve (FCFS) queuing [10]. Although a single FIFO queue seems to provide no QoS features at all, it actually does affect drop, delay, and jitter. Because there is only one queue, the router need not classify traffic to place it into different queues and router need not worry about how to decide from which queue it should take the next packet—there is only one choice. Due to this single queue uses FIFO logic, the router need not reorder the packets inside the queue. With a longer queue, however, the average delay increases, because packets may be enqueued behind a larger number of other packets. In most cases when the average delay increases, the average jitter increases as well [3].

Priority Queuing assigns multiple queues to a network interface with each queue being given a priority level. A queue with higher priority is processed earlier than a queue with lower priority. Priority Queuing has four preconfigured queues, high medium, normal and low priority queue. Queues are serviced in strict order of queue priority, so the high queue always is serviced first, then the next-lower priority and so on. If a lower-priority queue is being serviced and a packet enters a higher queue, that queue is serviced immediately. This mechanism is good for important traffic, but can lead to queue starvation. If packets arrive in the high queue then priority queuing drops everything its doing in order to transmit those packets, and the packets in other queue is again empty. When a packet is sent out an interface, the priority queues on that interface are scanned for packets in descending order for priority. The high priority queues is scanned first, then the medium priority queue and then so on. The packet at the head of the highest queue is chosen for transmission. This procedure is repeated every time when a packet is to be sent. The maximum length of a queue is defined by the length limit. When a queue is longer the limit packets are dropped [1] [16].

The idea of the fair queuing (FQ) discipline is to maintain a separate queue for each flow currently being handled by the router. The router then services these queues in a round robin manner. WFQ allows a weight to be assigned to each flow (queue). This weight effectively controls the percentage of the link's bandwidth each flow will get. WFQ is a generalization of fair queuing (FQ) [11]. Both in WFQ and FQ, each data flow has a separate FIFO queue.

3. NETWORK DESIGN AND CONFIGURATION

Various performance modeling on queuing network and mathematical analysis of getting exact solution has been presented via various research papers in past [2] [5]. The following network design has been taken into consideration to evaluate network performance on various queuing network. At the first step single traffic is used for each of the functions such as Ftp, Video Conferencing and VOIP which is shown in Fig. 3.

Fig. 4 shows a heavy traffic load condition and it uses three routers. In both case packet end to end delay has been measured for different queuing discipline. Performance based on queuing network has been discussed in past using various queuing policy but failed to achieve wide acceptance due to various complexity [7] [8] [9].

The bellow configurations applied in the Opnet Modeler and simulated to get results.

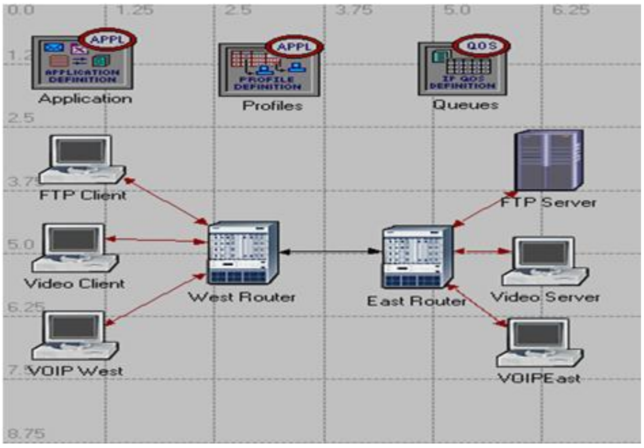

Fig 3. Network architecture for FIFO, PQ and WFQ with two routers.

As shown in Fig 3, the network model consists of two routers having three kinds of traffic sources, FTP traffic, VoIP traffic and Video Conferencing traffic. The link connecting the two routers is the bottleneck in the communication. The capacity of this link is 1.54 Mbps whereas all the other links have a capacity of 10Mbps. The following network model is modified by adding one more router to simulate heavy traffic load which is shown in Fig 4. One more router along with three clients is added to the network to increase the traffic load. Different queuing discipline in the routers can affect the performance of the applications and the utilization of the network resources.

Routers need to be configured for those three Queuing disciplines. The configurations are given Fig. 5.Exponential distribution produces heavy traffic as compared to uniform distribution. Hence the amount of traffic dropped is more in exponential distribution. But still it is less as compared to FIFO and PQ. In case of uniform distribution only one packet is dropped for WFQ.

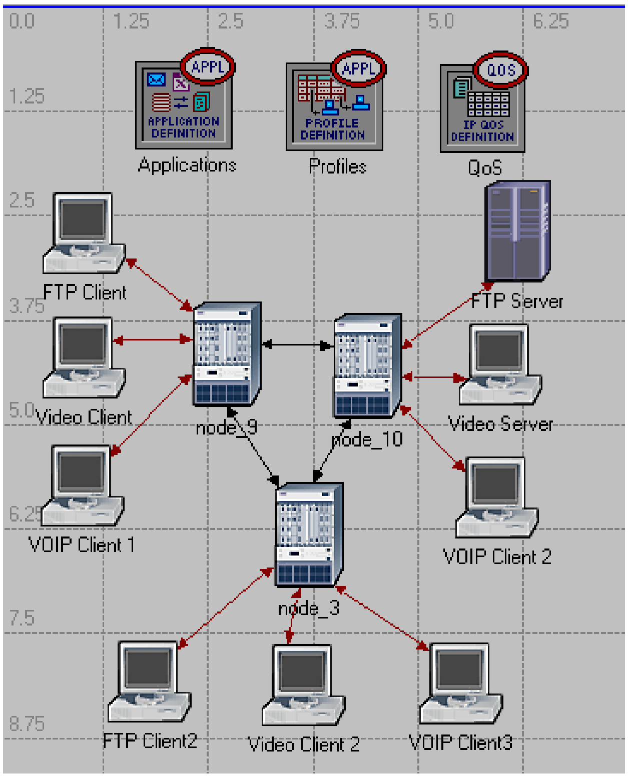

Fig 4. Network architecture for FIFO, PQ and WFQ with three routers.

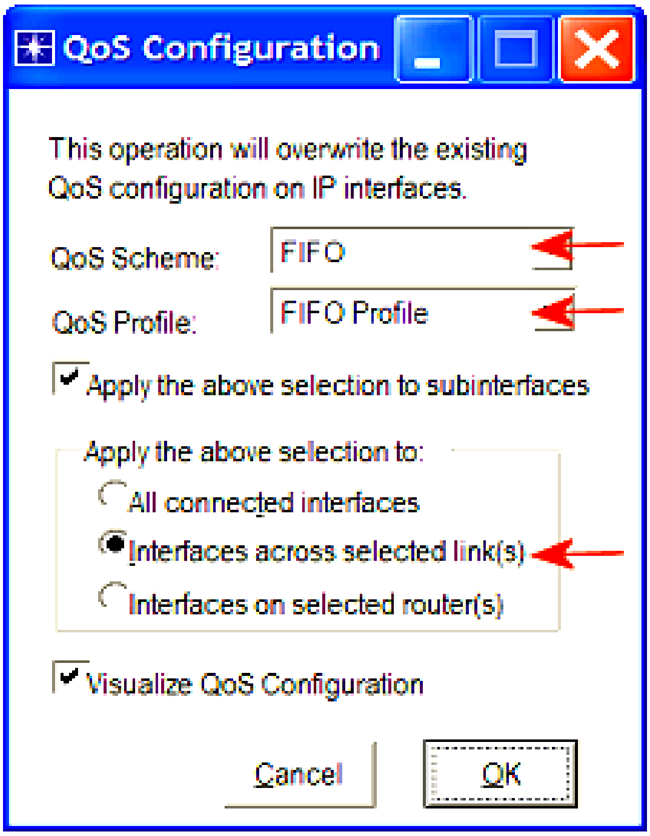

Fig 5.Router Configuration

4. SIMULATIONS RESULTS AND ANALYSIS

Simulation has been done using OPNET software for every queuing scheme and packet end to end delay and traffic dropped is measured for variable bandwidth. It is tested for voice based traffic.

Fig 6, 7 shows individual traffic drop in case of voice transmission for both the network model. Individual traffic drop is nearly zero for WFQ scheme. Individual traffic drop is always higher in case of FIFO scheme.

Fig 8, 9 shows packet end to end delay in case of voice transmission. Packet end to end time delay is nearly zero for both PQ and WFQ scheme. Packet end to end delay is always higher in case of FIFO scheme.

4.1 Uniform Distribution Analysis

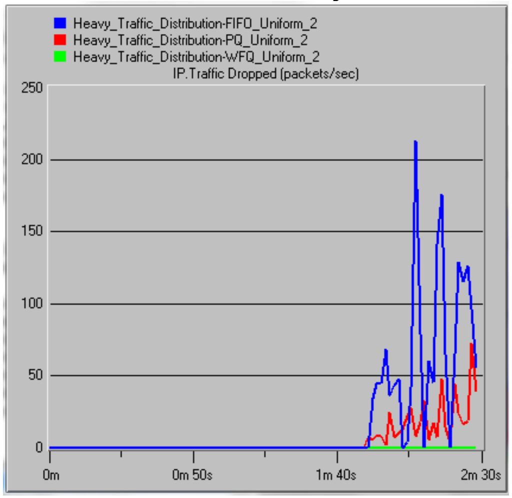

Fig. 6. Individual Traffic drop for FIFO, PQ and WFQ for two router configuration network model.

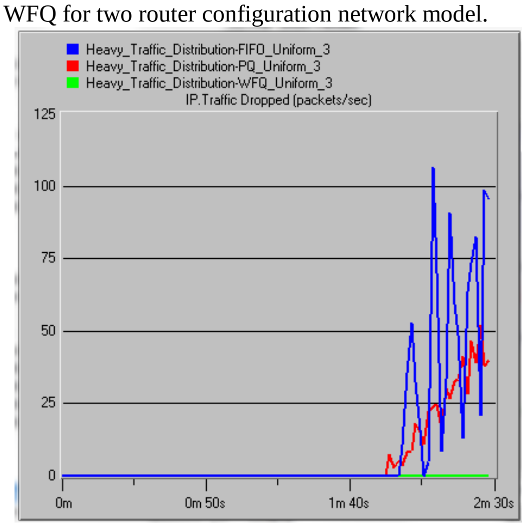

Fig.7. Individual Traffic drop for FIFO, PQ and WFQ for three router configuration network model.

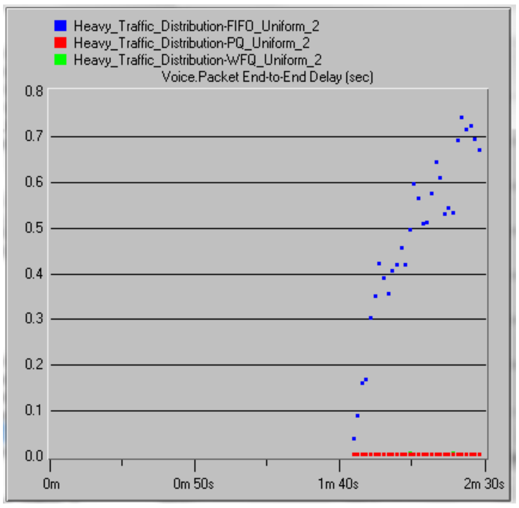

Fig. 8 Packet end to end delay for FIFO, PQ & WFQ for two router configuration model.

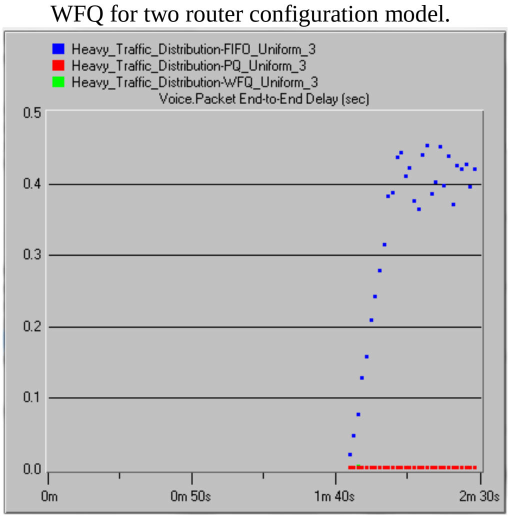

Fig. 9 Packet end to end delay for FIFO, PQ & WFQ for three router configuration model.

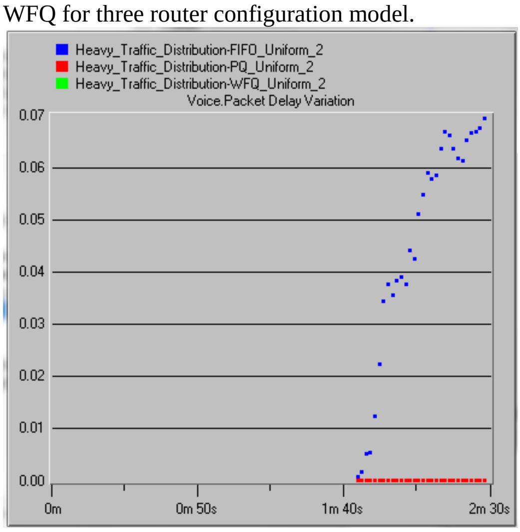

Fig. 10. Packet delay variation for FIFO, PQ & WFQ for two router configuration model.

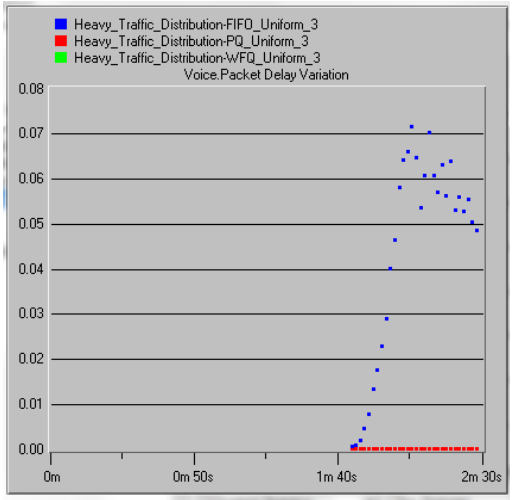

Fig. 11. Packet delay variation for FIFO, PQ & WFQ for three router configuration model.

Fig 10, 11 shows packet delay variation of VOIP transmission for two router and three router configuration model. Packet delay variation is nearly zero for both PQ and WFQ scheme. Packet delay variation is always higher in case of FIFO scheme.

4.2 Exponential Traffic Distribution Analysis

As Exponential distribution produces heavy traffic as compared to uniform distribution so the amount of traffic dropped is more in exponential distribution as shown in Fig 12, 13 for both the network model. Individual traffic drop is less for WFQ scheme. Individual traffic drop is always higher in case of FIFO scheme.

Fig 14, 15 shows packet end to end delay in case of voice transmission. Packet end to end time delay is nearly zero for both PQ and WFQ scheme. Packet end to end delay is always higher in case of FIFO scheme.

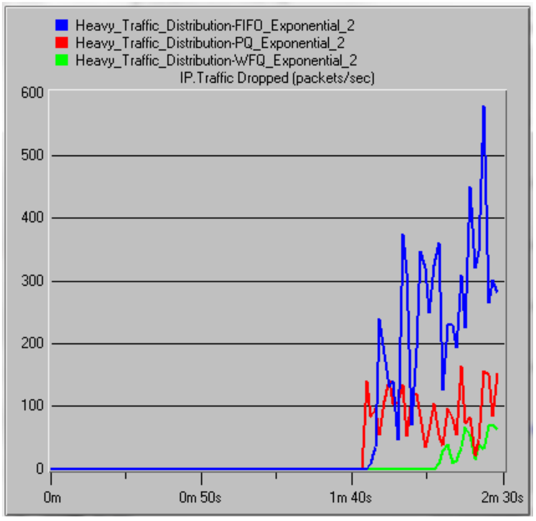

Fig. 12. Individual Traffic drop for FIFO, PQ and WFQ for two router configuration network model

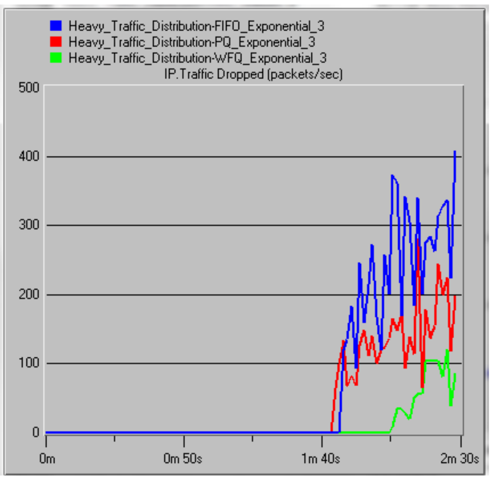

Fig.13. Individual Traffic drop for FIFO, PQ and WFQ for three router configuration network model.

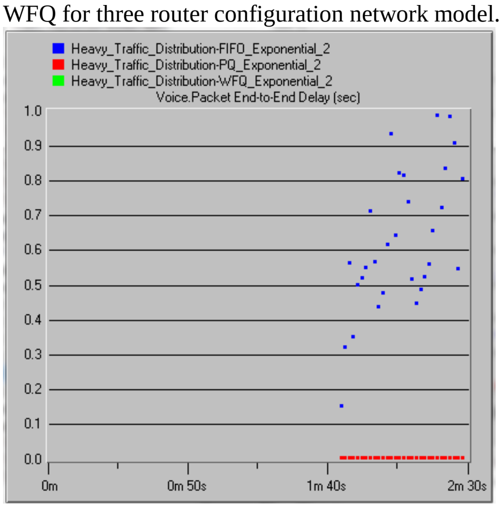

Fig. 14 Packet end to end delay for FIFO, PQ & WFQ for two router configuration model.

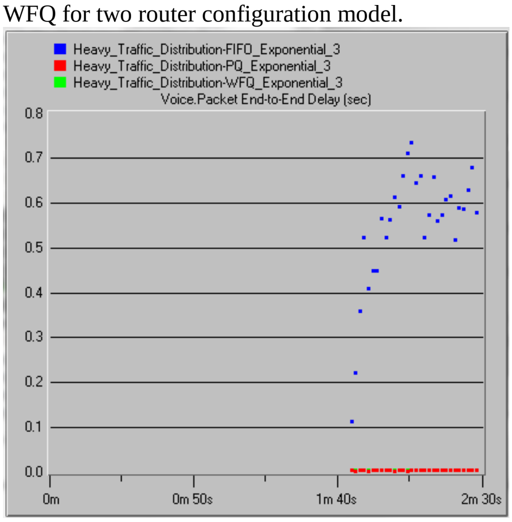

Fig. 15 Packet end to end delay for FIFO, PQ & WFQ for three router configuration model.

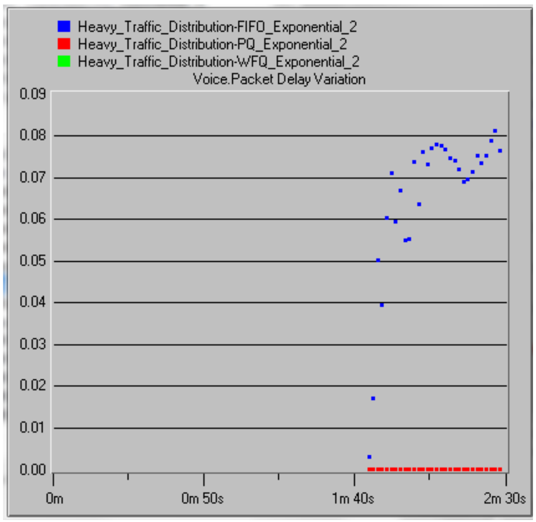

Fig. 16. Packet delay variation for FIFO, PQ & WFQ for two router configuration model.

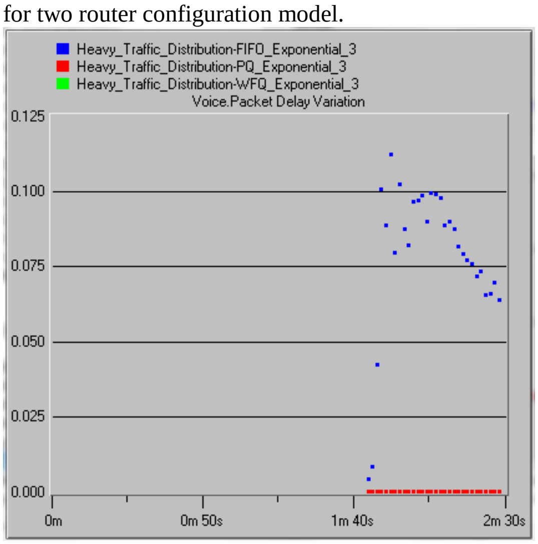

Fig. 17. Packet delay variation for FIFO, PQ & WFQ for three router configuration model.

Packet delay variation is always higher in case of FIFO scheme. Fig 16, 17 shows packet delay variation of VOIP transmission for two router and three router configuration model. Packet delay variation is nearly zero for both PQ and WFQ scheme.

5. CONCLUSION

Generally internet traffic is bursty in nature. Due to this reason in this current research work two distributions uniform and exponential has been consider which generate bursty data. It has been observed after comparing the detail statistics of the result that packet end to end delay is always higher in case of FIFO scheme for VOIP traffic distribution. PQ scheme gives better result in some cases as packet end to end delay in case of video based content delivery over the network. However WFQ gives best result among them. Result shows that traffic drop and packet delay variation is very less in case of WFQ scheme. Results are useful for performance modeling for VOIP based uniform and exponential traffic distribution.

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