

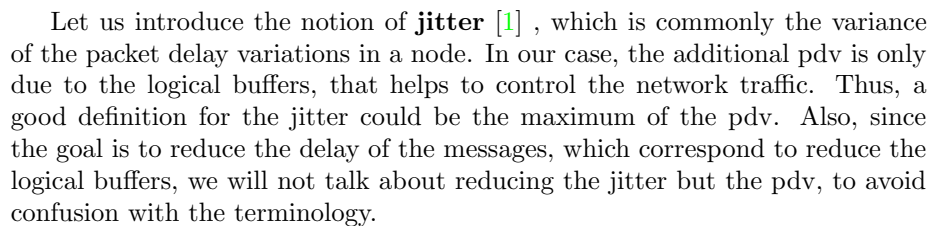
We define by **delay** of a datagram d in a node u_i of a route r , the time taken by the datagram to go from u_0 , the first vertex of the route to u_i through r . It is then equal to $DL(d, u_i, r) = t(d, u_i, r) - t(d, u_0, r)$. Thus, the delay of a datagram in the node u_i is equal to $DL(d, u_i, r) = t(d, u_i, r) - t(d, u_0, r) = \lambda(u_i, r) + \sum_{k=0}^{i-1} (b(d, u_k) + l(d, u_k, r))$. This delay is composed of three factors:

1. $\lambda(u_i, r)$: it is the **physical delay** of the route. This time is not alterable.
2. $\sum_{k=0}^{i-1} b(d, u_k)$: those values correspond to some **physical buffers** induced by the potential speedup or slowdown of the different links of the route used.
3. $\sum_{k=0}^{i-1} l(d, u_k, r)$: are the **logical buffers**, chosen by the solution proposed to solve the problem. Those buffers are chosen by some algorithmic solutions in order to control the traffic in every node, and thus avoid collisions.

As a reminder, a stream is a sequence of datagram. Each period, the sequence of datagrams $\{d_0, \dots, d_{k-1}\}$, is sent on a route. The sequence of datagram is the same in every period: the same number of datagram which are of the same size are sent at the same tic in the period. For instance if the sequence $\{d_0, \dots, d_{k-1}\}$ is sent at the first period P on the route r at times $\{\theta_r(d_0), \dots, \theta_r(d_{k-1})\}$ then the datagrams $\{d_k, \dots, d_{2k-1}\}$ will be send in the second period at times $\{\theta_r(d_k), \dots, \theta_r(d_{2k-1})\}$, with $\theta_r(d_i) = \theta_r(d_i + k) \bmod P, \forall i \in [0, \dots, k-1]$. We say that two datagrams d_i and d_{i+k} are associated. The size in tics of two associated datagrams is always the same

The **packet delay variation** (pdv) [2] is the variation of the delay between two datagram. In our study, we allow some datagrams to be buffered in some nodes of the route, thus, the pdv between d_0 and d_i (with $i < k$) can be greater than 0. Formally, we denote the packet delay variation between two datagrams d_i and d_j in a node u on a route r by $\text{pdv}(d_i, d_j, u, r) = |DL(d_i, u, r) - DL(d_j, u, r)| \geq 0$.

Note that the pdv between two associated datagrams is always equal to zero, since the logical delays are deterministic, computed on a period and then applied to all the next periods.



- [1] F. Guillemin, P. Boyer, A. Dupuis, and L. Romoeuf, "Peak rate enforcement in ATM networks," in *[Proceedings] IEEE INFOCOM '92: The Conference on Computer Communications*, (Florence, Italy), pp. 753–758 vol.2, IEEE, 1992.
- [2] C. Demichelis and P. Chimento, "IP Packet Delay Variation Metric for IP Performance Metrics (IPPM)."