

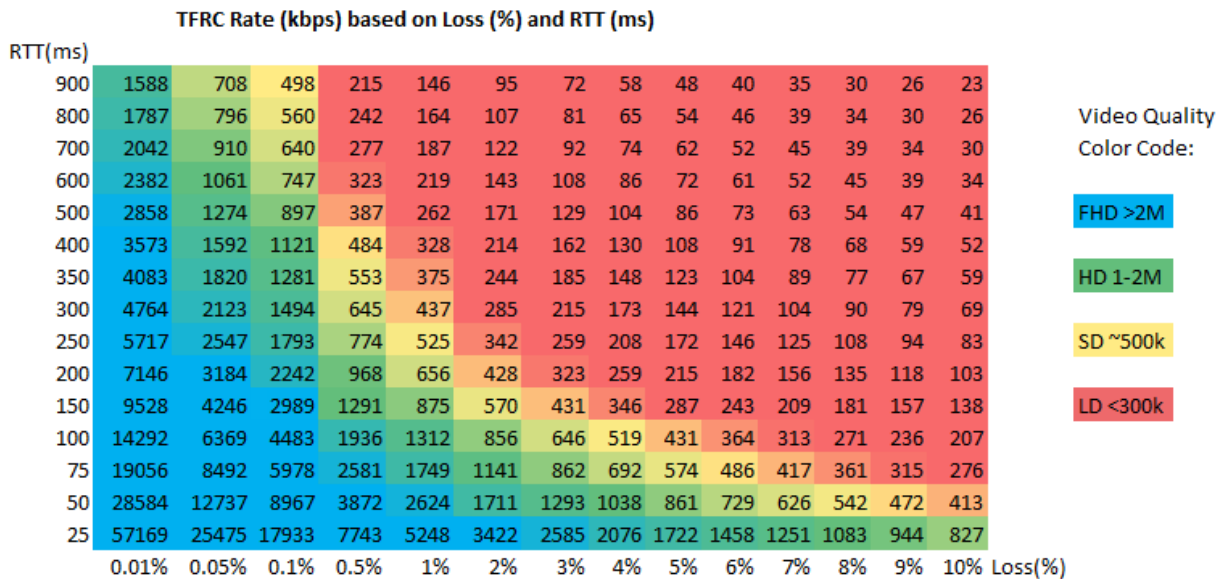
Fairness Considerations for Congestion Control for Interactive Real-Time Communication (IRTC)

Mo Zanaty
Cisco Systems

In response to the call for papers for the IAB/IRTF Workshop to be held on July 28, 2012 in Vancouver, Canada, the following fairness considerations, particularly to TCP, should be discussed in the workshop and subsequent work toward solutions.

1. TCP Friendly Rate Control (TFRC) [RFC 5348] is the most-often referenced, but not-so-often deployed, model of fairness for IRTC traffic competing with TCP flows. However, TFRC has some drawbacks, some of which are inherent to TCP itself.

a. The throughput TFRC can achieve is limited by the loss event rate and round trip time. The consequence for TFRC senders is they will be unable to send high quality media (HD or Full HD) at moderate loss rates and RTTs, which are not uncommon in real world scenarios such as intercontinental links, wireless links, or links with large buffer delays. The figure below illustrates this limitation. (TFRC parameters used are $b=1$, $t_{RTO}=4RTT$, $MSS=1460$.)



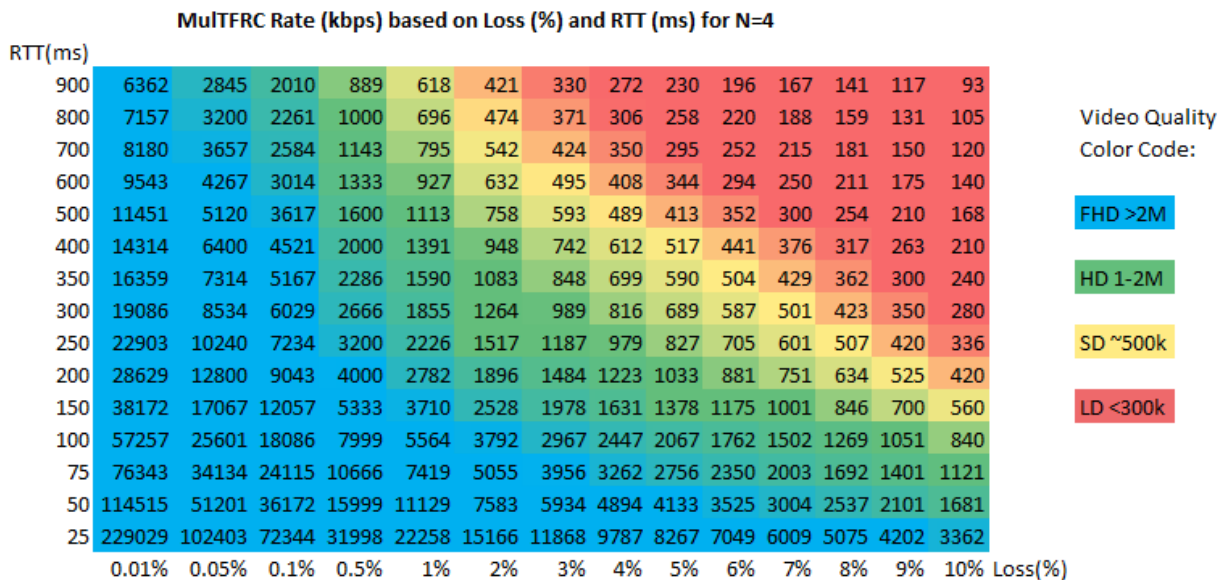
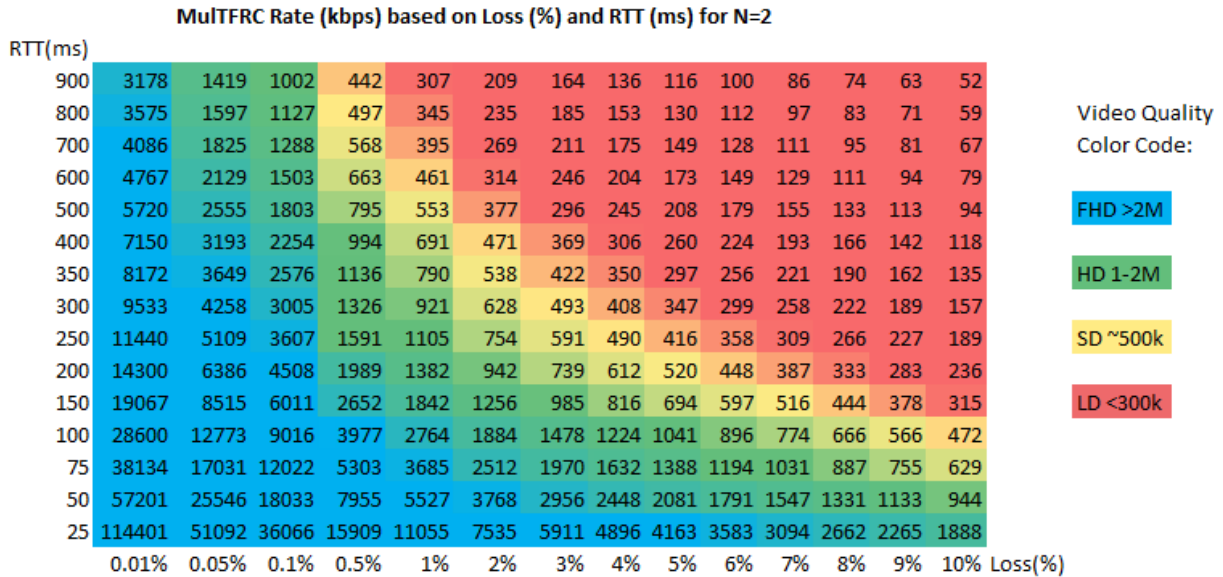
b. Another drawback is that TFRC models a relatively old TCP: Reno without SACK. Modern TCPs (CTCP, BIC, CUBIC), which some studies show to be more predominant on the Internet than classical Reno, may or may not be modeled well by TFRC. IRTC should be fair to which TCP?

c. The mechanics of TFRC require high frequency feedback, which is not usually suitable for RTCP even under AVPF rules [RFC 4585]. Lowering the feedback frequency can impact fairness.

d. A more fundamental argument against TCP friendliness in general, not just specifically TFRC, is the questionable assumption of fairness via equal flow rates between a single TCP flow and a media flow which may even contain multiplexed streams. A typical webpage results in 10+ TCP flows. Many background processes have many open TCP connections, some of which are actively flowing.

In this context, it may be more fair to allow the media flow to weight itself more heavily than a single TCP flow, if it is the primary foreground activity. This argues for weighted fairness with application specified weights.

2. MultFRC [draft-irtf-iccr-g-multfrc] can model weighted fairness with N TCP flows, where N can be fractional and/or <1. Most of the TFRC issues remain, but the model is better than N \times TFRC, and claims to improve on TFRC even for N=1. The figures below illustrate N=2 and N=4, where high quality media can be sent for much larger ranges of loss rates and RTTs. (MultFRC parameter j=1.)



a. However, it should be noted that MulTFRC is close to NxTFRC (within 30%) at random, non-bursty ($j=1$) loss rates below 10% as shown in the figure below. This brings into question whether the added complexity of MulTFRC over NxTFRC is justified. Note that there is rather severe oscillation beyond 10%.

MulTFRC vs. NxTFRC relative rate (%) based on Loss (%) and Number of Flows (N)

| N | 0.01% | 0.05% | 0.1% | 0.5% | 1% | 2% | 3% | 4% | 5% | 6% | 7% | 8% | 9% | 10% | 20% | 40% | 80% | Loss(%) |
|----|-------|-------|------|------|----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|-----|---------|
| 50 | 0% | 1% | 1% | 4% | 7% | 11% | 15% | 17% | 19% | 18% | 15% | 10% | 0% | -14% | -80% | -51% | 32% | |
| 20 | 0% | 1% | 1% | 4% | 7% | 11% | 15% | 17% | 19% | 18% | 16% | 11% | 2% | -11% | -80% | -51% | 32% | |
| 10 | 0% | 1% | 1% | 4% | 6% | 11% | 15% | 18% | 19% | 19% | 17% | 13% | 5% | -8% | -80% | -51% | 32% | |
| 6 | 0% | 1% | 1% | 3% | 6% | 11% | 15% | 18% | 20% | 20% | 19% | 15% | 8% | -3% | -80% | -51% | 32% | |
| 5 | 0% | 1% | 1% | 3% | 6% | 11% | 15% | 18% | 20% | 20% | 19% | 16% | 9% | -1% | -80% | -51% | 32% | |
| 4 | 0% | 0% | 1% | 3% | 6% | 11% | 15% | 18% | 20% | 21% | 20% | 17% | 11% | 2% | -80% | -51% | 32% | |
| 3 | 0% | 0% | 1% | 3% | 6% | 11% | 15% | 18% | 20% | 22% | 21% | 19% | 14% | 6% | -80% | -51% | 32% | |
| 2 | 0% | 0% | 1% | 3% | 5% | 10% | 14% | 18% | 21% | 23% | 24% | 23% | 20% | 14% | -80% | -51% | 32% | |
| 1 | 0% | 0% | 0% | 2% | 4% | 8% | 13% | 17% | 21% | 24% | 27% | 29% | 30% | 30% | -80% | -51% | 32% | |

MulTFRC rate is close to NxTFRC rate (within 30%) when loss <10%.

Severe oscillation when loss >10%.

3. In summary, some form of application-specified weighted fairness is essential, either via MulTFRC, NxTFRC, or other algorithms. Also, the known issues with TFRC should also be addressed before using it as a basis for a fairness model.