Given no QoS support in the routers, is it possible to provide QoS using an overlay network?
$p$: Bounded Delay

$q$: Bandwidth

$b$: Bounded Loss Rate

Virtual Link Abstraction

Move packet dropping decision from the network to the overlay node.
Choose the maximum in any subset of \( \frac{1}{N} \) samples. Choose the receiver with \( \max \) loss samples at the same time.

\[
\hat{b} = dp(d)f \, d \hat{f} \quad \text{such that} \quad \frac{u}{\gamma-u} = \lambda
\]

Problem Formulation: Let \( \gamma < \gamma_0 \), else error rate is 0.

- If probability of error in a window, \( \frac{u}{\gamma-u} < d \), then error rate for the window is \( d \).
- Consider a Reed Solomon Coding\((k',n-k)\).
- Use FEC coding to recover lost packets in the network.

Achieving Controlled Loss
Node Architecture

- Allocates capacity of the virtual link to the individual flows.

- Traffic Management Module
  
  - Adaptive Regulator: Regulates the rate of the traffic
  
- Controlled Loss Virtual Link Module
  
  - Coder: Performs Reed-Solomon(k,n-k) coding on the packets

Diagram:

- Virtual link (overlay) link
- Control information
- Traffic module
- Controlled-loss module
- Coder module
- Overlay (RON) node
- Bundle arrival
\[ \frac{d^* \times \frac{\text{RTT}}{N \times N}}{Y} = q \]

Set

- For a given value of N, Overlay Round-trip RTT and bundle loss rate p`

\[ N \text{- TCP pipe (for fairness)} \]

\[ J \star u = y - u \text{ and } J \star q = u \]

Set u

- Not Fair to other flows in periods of congestion.

- Can offer more stable end2end bandwidth guarantees.

- ISP can assure fixed bandwidth of Peering Internap.

Motivations and Limitations:

- Fixed Capacity q

Define J as the maximum time period for reconstructing lost packets.

Computing Other Parameters
The target loss rate is met except in cases of excessive load when the loss rate is very high. (At 9 Mbps, loss rate is 10%)
Note that the overhead can have an error of 2% in just the rounding off.

The overhead is close to the 99.7th percentile which is the optimal value.
model.
Other types of loss modeling do not work well - Bernoulli model, Gilbert delay bounds are not strong. Increasing the number of samples helps in better estimates for overhead.

- TCP + Impulses
- Self-Similar Traffic
- Long-lived TCP + Short-lived TCP

across a variety of traffic models.
Have implemented and tested Controlled Loss Virtual Link abstraction

Conclusions