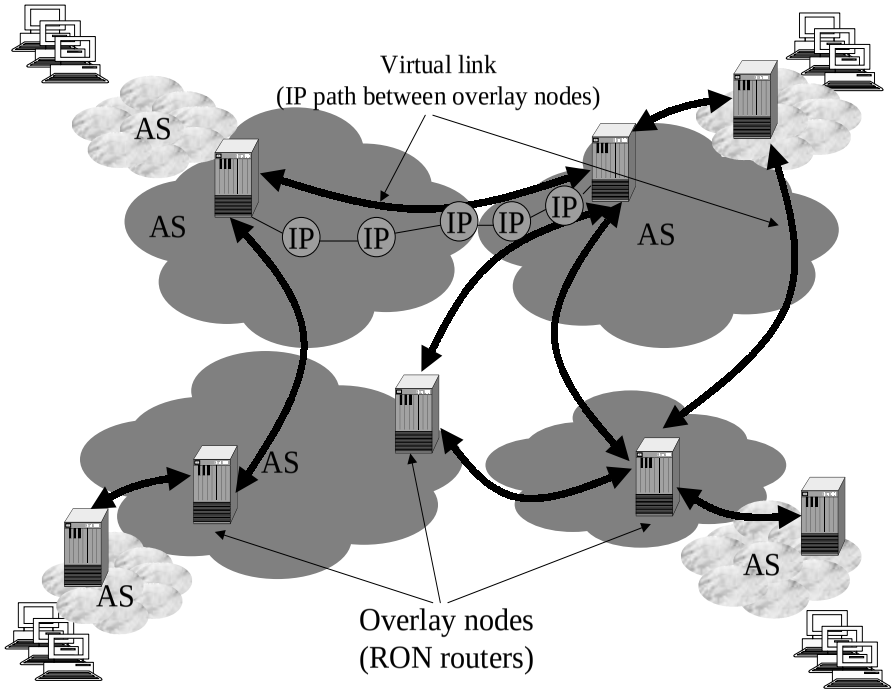
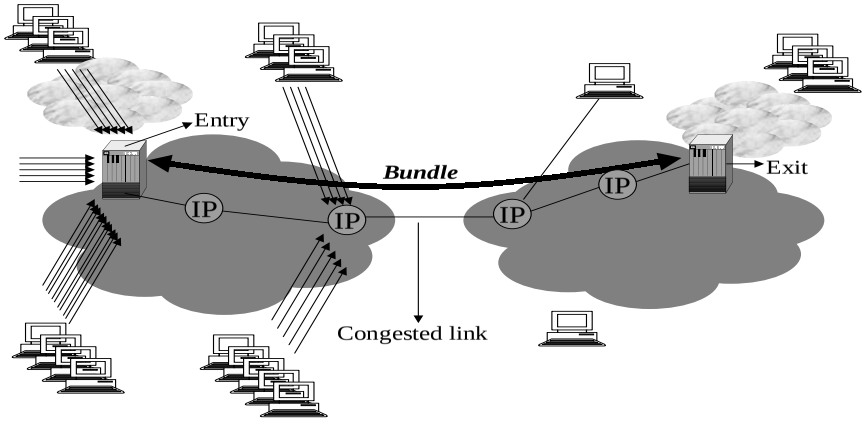
Research Question



- **Given no QoS support in the routers, is it possible to provide QoS using an overlay network?**

Controlled Loss Virtual Link

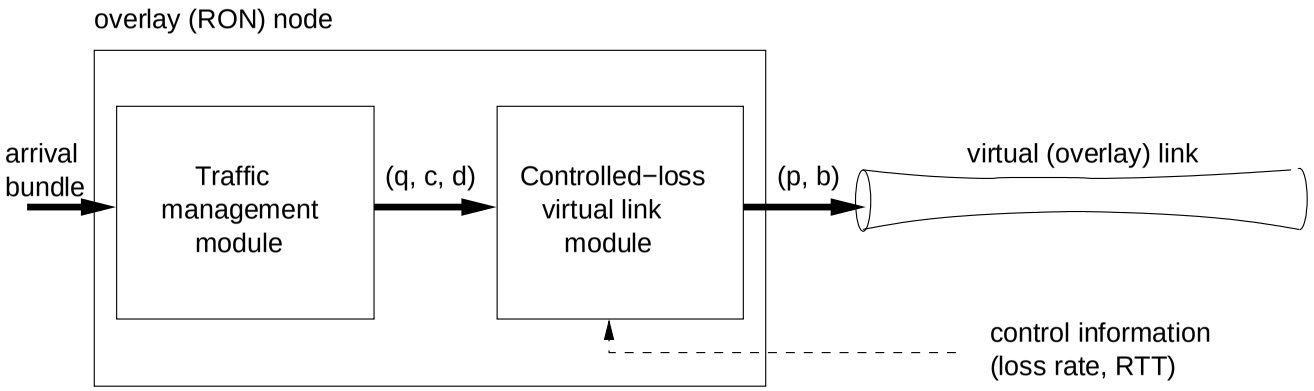


- Move packet dropping decision from the network to the overlay node.
- Virtual Link Abstraction
  - Bounded loss rate q
  - Bandwidth b
  - Bounded Delay d

Achieving Controlled Loss

- **Use FEC coding to recover lost packets in the network.**
- **Consider a Reed Solomon Coding(k,n-k)**
  - **If probability of error in a window, $p > \frac{n-k}{n}$, then error rate for the window is p, else error rate is 0.**
- **Problem Formulation:**
  - **Let $f(p)$ be stationary loss distribution. Given just N samples from f, estimate redundancy factor $r = \frac{n-k}{n}$ such that:**
    - **Eqn:** $\int_r^1 pf(p)dp = q$
- **Solution: Choose $N = 2/q$ loss samples at the receiver with p_{max} as the sample maximum. Choose the maximum in any subset of $N_1 = \frac{p_{max}}{q - \frac{1}{N+1}}$ samples.**

Node Architecture

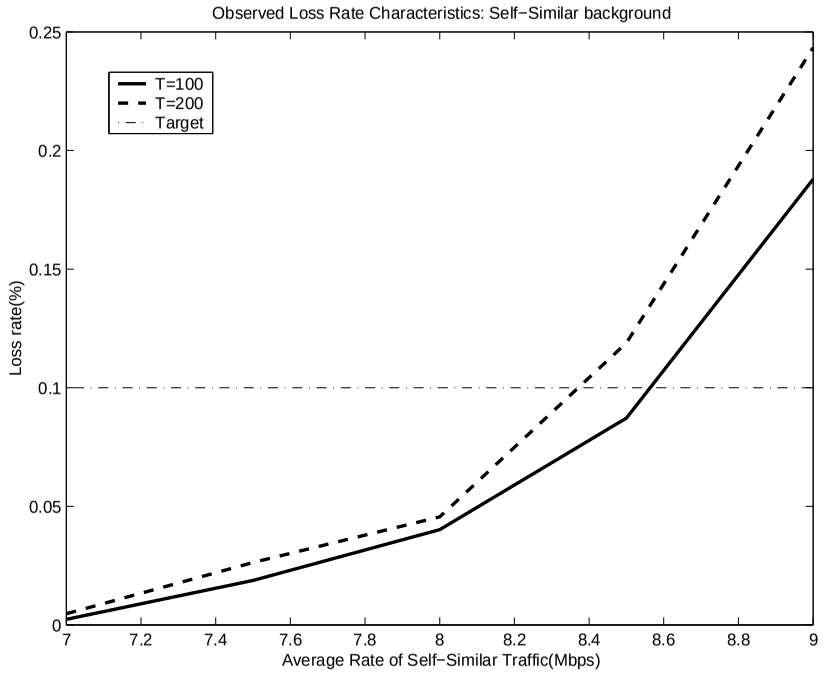


- **Controlled Loss Virtual Link Module**
  - **Coder: performs Reed-Solomon(k,n-k) coding on the packets**
  - **Adaptive Regulator: Regulates the rate of the traffic**
- **Traffic Management Module**
  - **Allocates capacity of the virtual link to the individual flows.**

Computing Other Parameters

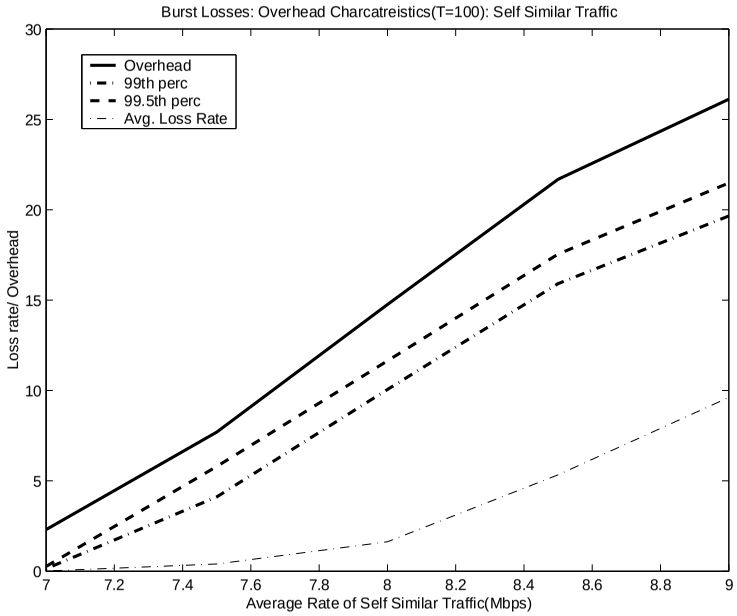
- **Define T as the maximum time period for reconstructing lost packets.**
- **Fixed Capacity b**
  - **Motivations and Limitations:**
    - **ISP can assure fixed bandwidth of b(E.g. InterNap)**
    - **Can offer more stable end2end bandwidth guarantees.**
    - **Not Fair to other flows in periods of congestion.**
  - **Set $n = b * T$ and $n - k = n * r$**
- **N-TCP pipe (for fairness)**
  - **For a given value of N, Overlay round-trip RTT and bundle loss rate p, set $b = \frac{N \times K}{RTT \times \sqrt{p}}$**

Loss Rate Characteristics: Self Similar Traffic



- **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%)**

Overhead Characteristics: Self Similar Traffic



- **The overhead is close to the $99.5th$ percentile which is the optimal value.**
- **Note that the overhead can have an error of 2% in just the rounding off factor.**

Conclusions

- Have implemented and tested Controlled Loss Virtual Link abstraction across a variety of traffic models.
  - Long-Lived TCPs
  - Long-Lived TCPs +Short-lived TCPs
  - Self Similar Traffic
  - TCP +Impulses
- Increasing the number of samples helps in better estimates for overhead.
- Delay bounds are not strong.
- Other Types of Loss modeling do not work well - Bernoulli model, Gilbert model.