Enhanced Traffic Management in IP Networks

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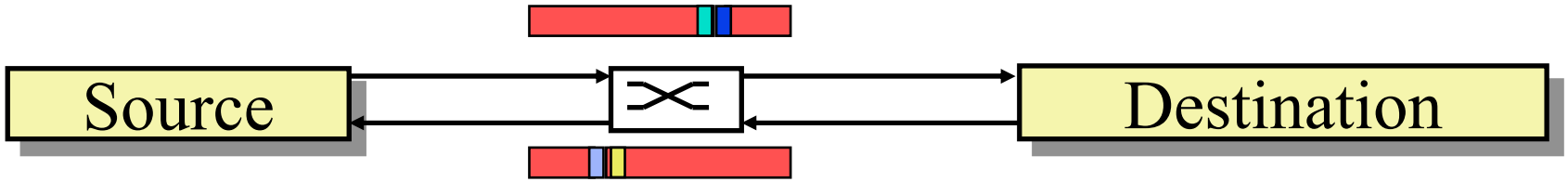
These slides are available at:

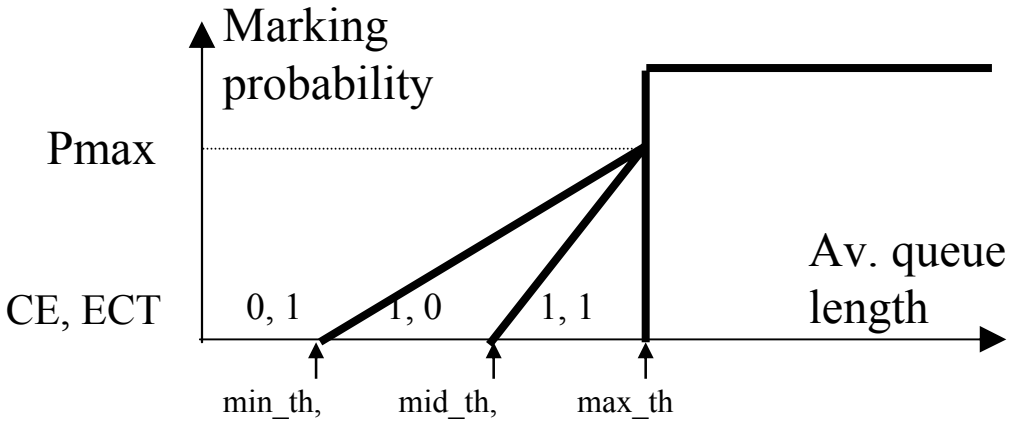
http://www.cis.ohio-state.edu/~durresi/talks/NSF_01_03.html/

Multilevel ECN



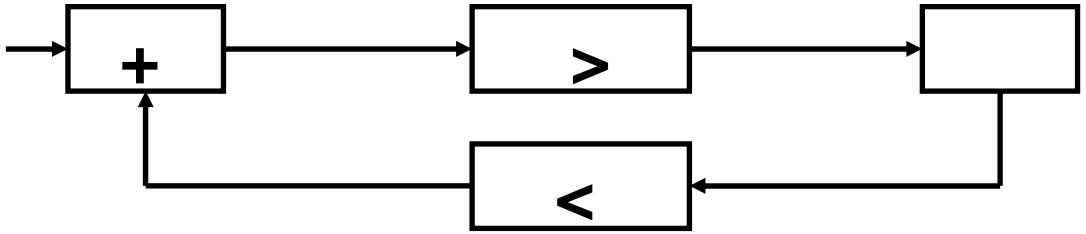
- More levels - more information about congestion - more accurate reaction from TCP source
- Better Congestion Control:
  - More Effective use of network resources
  - Less Losses
  - Less Delay
- Adaptive MECN better than Adaptive RED
- Use Control Theory Analysis to set parameters in MECN

MECN



Congestion State	cwnd change
No congestion	Increase ‘cwnd’ additively
Incipient congestion	Decrease multiplicatively by β_1
Moderate congestion	Decrease multiplicatively by β_2
Severe congestion	Decrease multiplicatively by β_3

Modeling MECN



$$\dot{W}(t) = \frac{1}{R(t)} - \frac{W(t)}{\beta_1}\frac{W(t - R(t))}{R(t - R(t))}P_1(t - R(t)) - \frac{W(t)}{\beta_2}\frac{W(t - R(t))}{R(t - R(t))}P_2(t - R(t))$$

$$\dot{q}(t) = \left[\frac{N(t)}{R(t)}W(t) - C\right]^+$$

- Guidance in setting parameters
- Sensitivity – How fast the system reacts
  - Higher Sensitivity – less jitter
- Delay Margin – Stability of the system
  - Higher Delay Margin – more throughput

Performance vs. Stability

- Sensitivity – How fast the system reacts
  - Higher Sensitivity – less jitter

$$Sensitivity = \frac{1 + K_{MECN}}{1 + K_0}$$

- Delay Margin – Stability of the system
  - Higher Delay Margin – more throughput

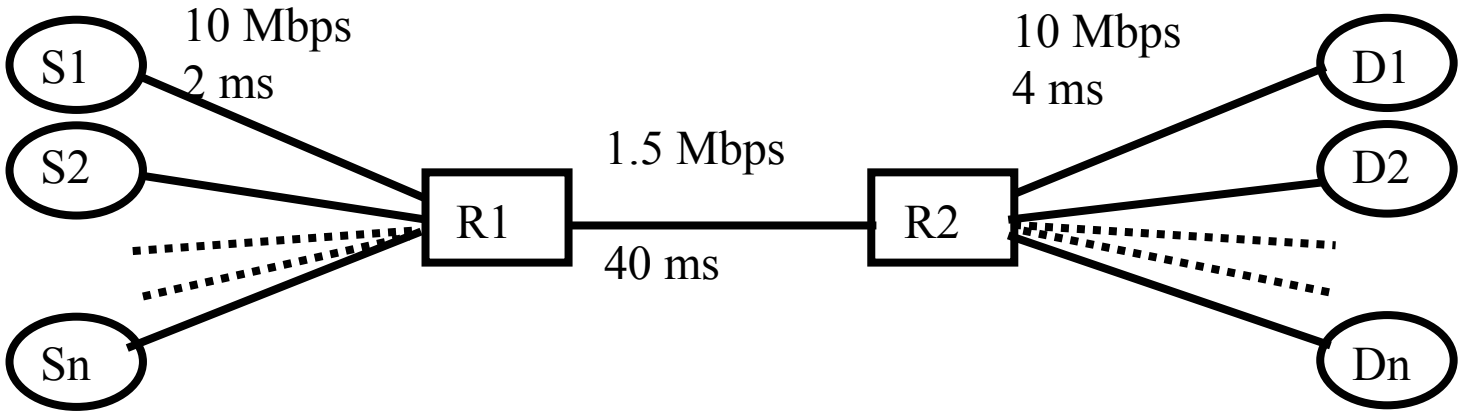
$$DM(w_g) \approx \frac{\pi - \tan^{-1}\left(\frac{w_g}{K}\right)}{w_g} - R_0$$

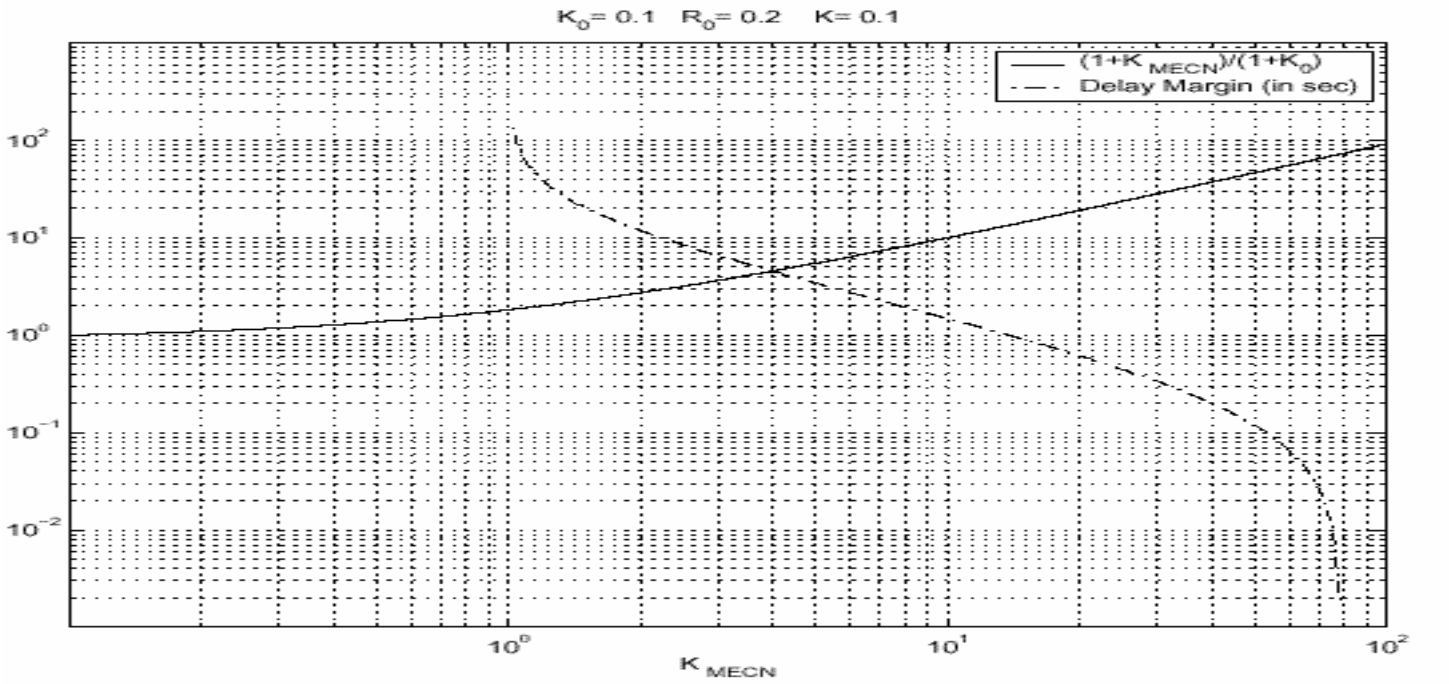
where:

$w_g = K\sqrt{K_{MECN}^2 - 1}$,

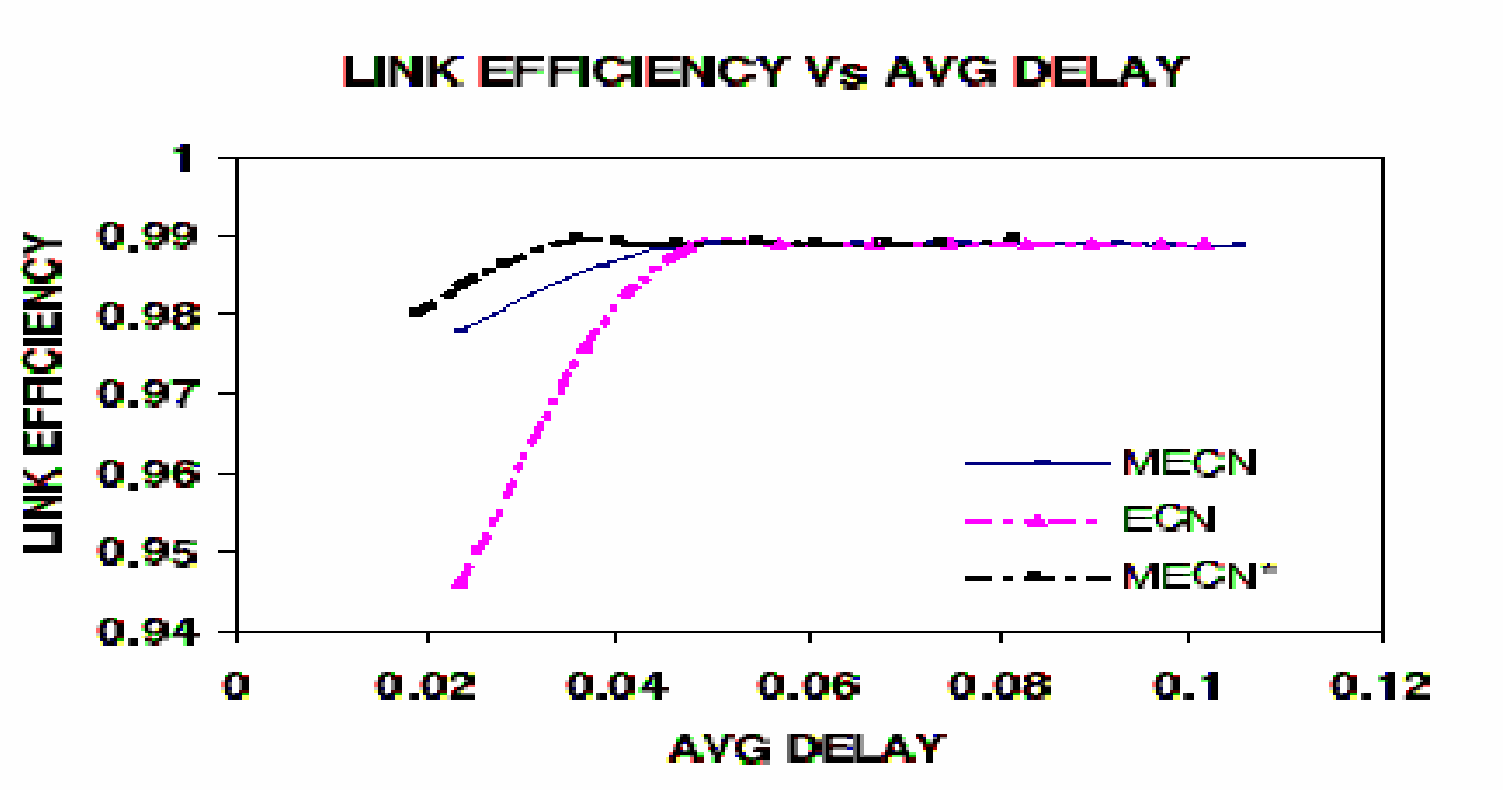
$K = -C\ln(1-\alpha)$, α - is the queue averaging weight

Simulations





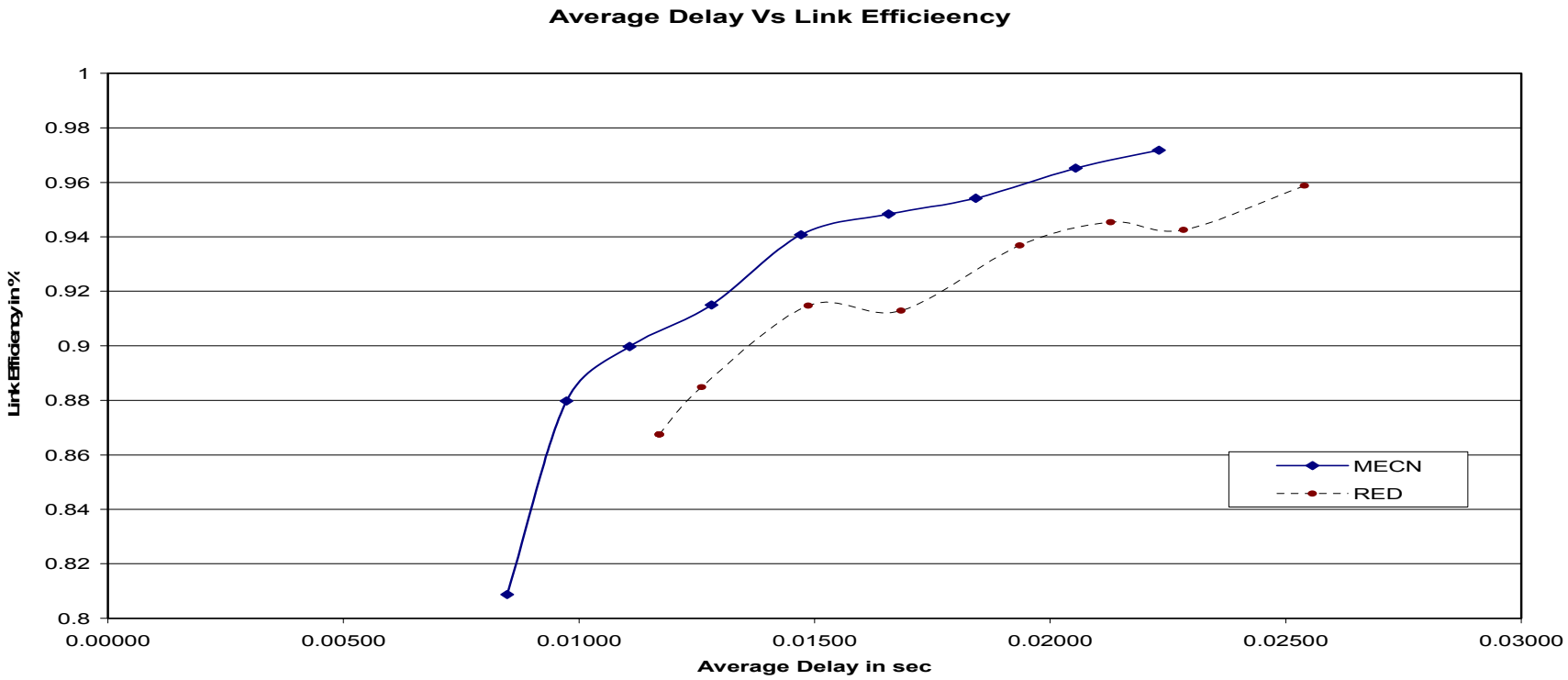
MECN performance



- Our analysis methodology is a complete framework to compare and optimize congestion control schemes

Adaptive MECN

- Change the parameters automatically depending on the traffic

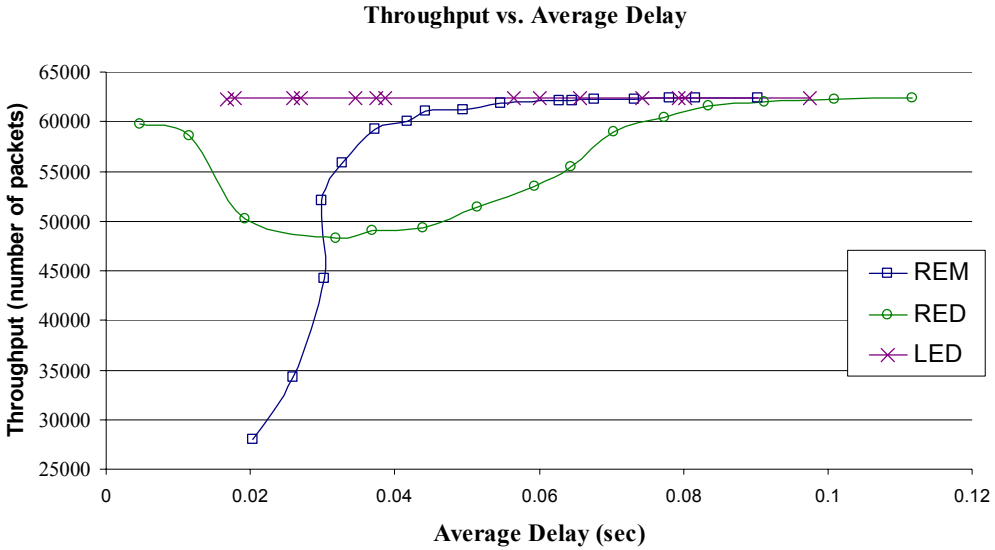


Load Early Detection - LED

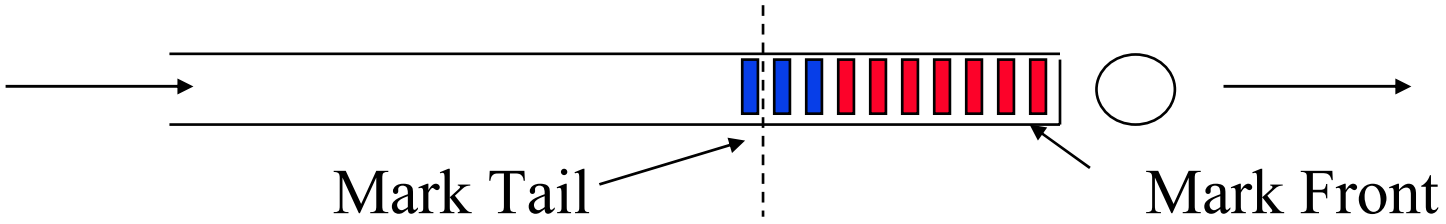
- Load is a better metric to measure congestion than the queue length

  Load = (bytes received)/(bytes processed)

- We have proved theoretically that LED outperforms RED
  - LED is advanced by 90º compared to RED
- LED parameter setting is simple

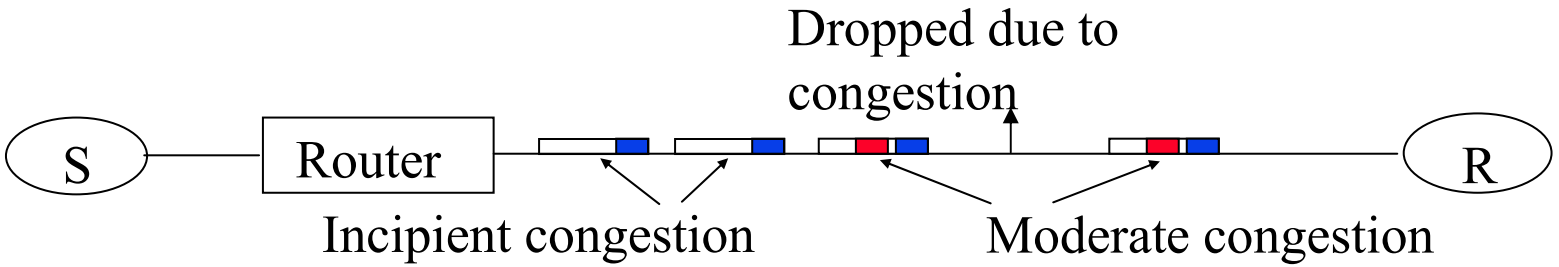


Mark Front

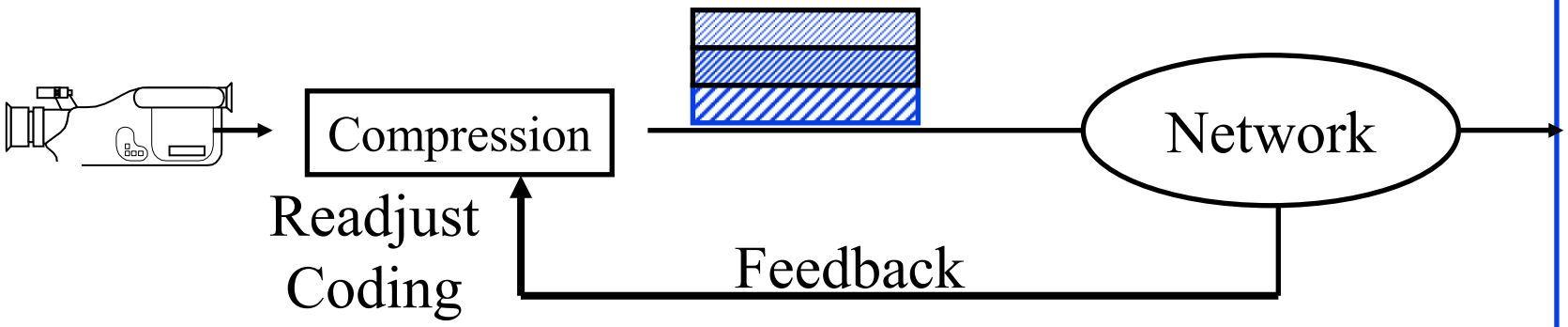


- Current ECN marks packets at the tail of the queue:
  - congestion signals suffer the same delay as data;
  - when congestion is more severe, the ECN signal is less useful
- With Mark Front the feedback information arrives faster
- Simulation Analysis has shown that mark front strategy
  - reduces the buffer size requirement for no loss
  - increases link efficiency,

Related Projects



- MECN used to improve performance of TCP on wireless – help distinguish congestion loss from wireless loss



- MECN used in layered video over networks – Network marks with Multilevel ECN each layer

Some Other Projects

- Routing for Ad-Hoc Wireless
  - Performance and security
- IP Trace back
- Optical Networking
  - Measure online the Quality of Optical Signals and Consider Optical impairments
  - Routing and Protection taking into account all impairments
- Free Space Optical + Wireless = Flexible bandwidth on battlefield
- Real-Time traffic – Load balancing and routing
- Traffic modeling – to be used in network dimensioning, possibly in routing
- Satellite networking: Diffserv, ECN, MPLS, Real-time