

## Active Queue (Buffer) Management

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## Overview



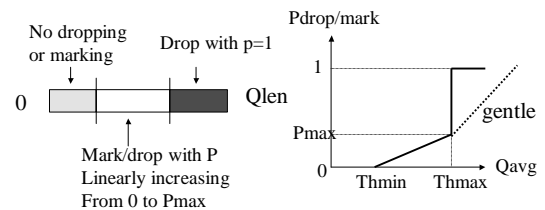
- Drop Tail
- PPD/EPD
- RED
- RED Variants
- ECN

## Routers



- Drop tail: drop when buffer is full
- Problem: Partial packets
  - Partial packet discard (PPD)
  - Early packet discard (EPD): do not admit new packets beyond threshold to leave space for partial packets
- Random Early Detection (RED): between  $maxh$  and  $minh$ , drop with  $p = f(\text{avg } Q)$
- Potential advantages: early detection (TCP), avoid synchronization, punish misbehaving flows, avoid unfairness against bursty sources

## Random Early Detection (RED)

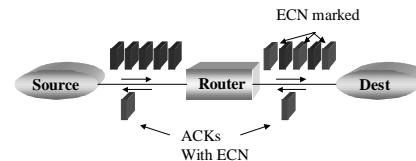


## RED Variants



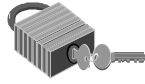
- Gentle RED (Rosolen, Bonaventure 1998)
- Flow RED (Lin, Kung) compare  $Q_i$  to  $Q_{ave}/N$ 
  - Per flow state required. Also BRED
- SRED: estimate number of active flows
- ARED: variable  $p_{max}$ , BLUE: variable  $p_{drop}$
- WRED, RIO (parameters): diffserv
- ECN (RFC 2481 (sec7), CCR 10/94):
  - 4 bits: ECN capable and CE bit to signal congestion, ECN-echo, CWR
  - In addition to timeout and 3 dupacks

## Explicit Congestion Notification (ECN)



- React to ECN only once per RTT (like loss event in TFRC)
- Advantage: Packet drops avoided, no need to wait for a Timeout
- React to ECN similar to packet drop to preserve TCP-friendliness, but not drastically

## Key Points



- RFC 2309
- See [www.aciri.org/floyd/red.html](http://www.aciri.org/floyd/red.html) for links to papers discussing RED, RED variants, RED modeling, simulations and measurements

**Thank You!**



**Questions?**