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Edge-Based Differentiated Services

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Outline

- Overview
- TCP fairness
- FEC and parameter settings
- Problems of TCP fairness
- Conclusions and future work

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Goals

- Service differentiation without network support
- Not better or worse efforts, simply different
- Application chooses most appropriate control
- Non-blocking, variable rate for elastic traffic
  - Responds fast to changes in available capacity
  - Rate sharing between flows
- Blocking, fixed rate for streaming traffic
  - Consistency for admitted session
  - Responds slowly to changes in available capacity

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EBDS Operation

- Elastic traffic use TCP
- Streaming traffic use probe-based admission control
- Sender probes path to receiver at peak rate, r_{pr}
  - Receiver selectively acknowledges packets
- UDP traffic is elastic as an aggregate
  - Flows come and go and might be blocked
  - Accepted calls provide consistent quality
    - In contrast to TCP friendly rate control
- Traffic control gives differentiation and error control gives isolation
  - FEC for streaming traffic
  - Tradeoff between source throughput and redundancy for channel protection

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Fairness

- Threshold is set to not allow higher UDP than TCP rate

$$x_r = MSS\sqrt{\frac{w_r}{RTT^2 p}} \quad => \quad tcp\_eq = \frac{MSS^2 w_r}{RTT^2 U_{rate}^2}$$

- Also defines fairness between different UDP sessions

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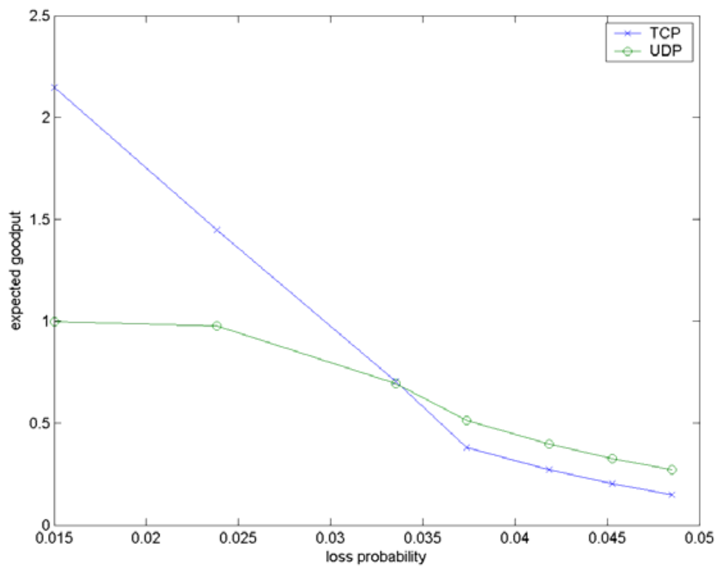
TCP fairness evaluation

- Load increased by higher number of UDP sessions
- “TCP constant” set to 1.0
- Different “shape” of TCP and UDP throughput
  No ideal fairness

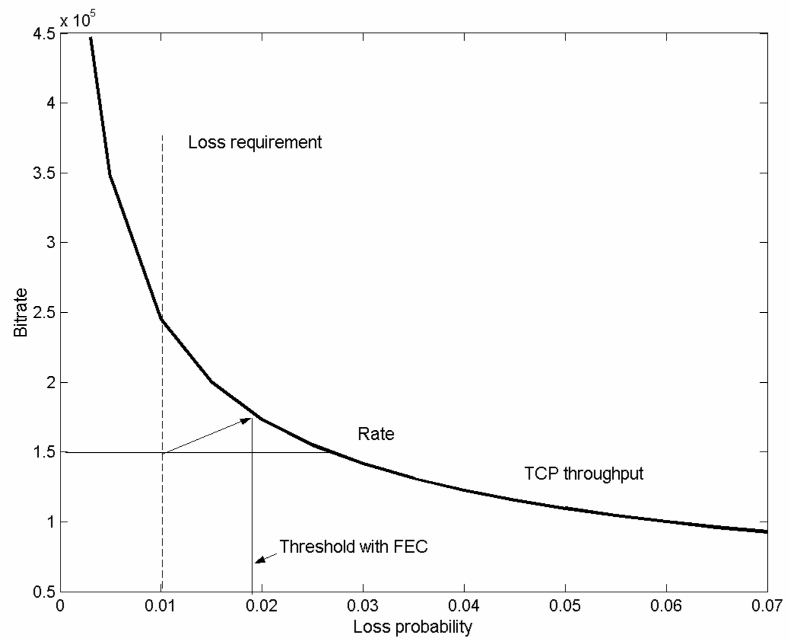


Isolation by FEC

- Add redundancy if the rate of a streaming flow is lower than the TCP rate

$$tcp\_eq = \frac{MSS^2 w_r}{RTT^2 U_{rate}^2}$$

- Increases the acceptance probability



Fairness between real-time sessions

- Threshold and redundant packets calculated before probing
- Sessions get the required loss rate
- Sessions with high demands are likely to be blocked

Class	Rate (kb/s)	Loss req. %	Block lgth.	Thr. %	Red. pkts	Block prob. %	Failed %
0	500	0.5	40	0.8	2	98	0
1	500	2	-	1.4	0	80	0
2	300	0.5	10	1.8	2	55	0
3	300	0.5	40	2.2	3	29	0.4
4	300	2	10	2.1	1	34	0
5	300	2	40	2.3	2	24	0
6	100	0.5	10	10.2	5	0	0.1
7	100	2	10	11.7	4	0	0

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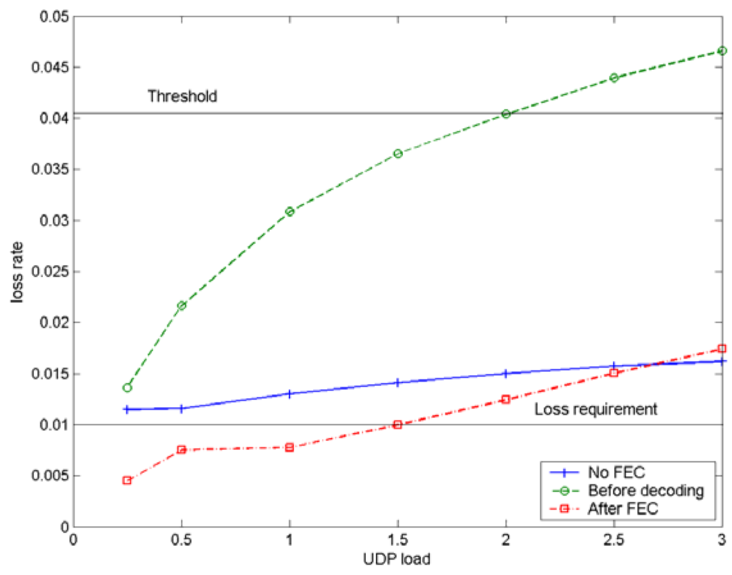
FEC gain

- FEC keeps loss under requirement for reasonable load
- Non-deterministic admission process



Multiple links

- Blocking higher for multiple bottlenecks

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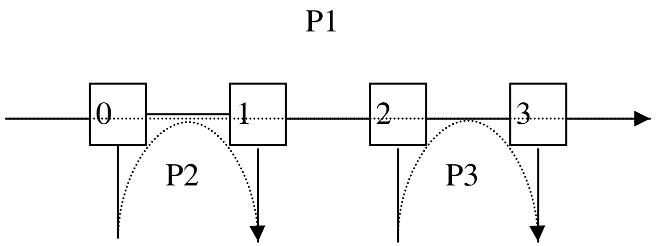

Path	P1	P2/P3
Blocking %	46	0
Loss rate %	3.4	1.6
Failed %	14	0.1
TCP (Mb/s)	4.4	6.8

Required probe length

- Probes shorter than 1 second no good
- Depends on RTT, #sessions, buffer size etc

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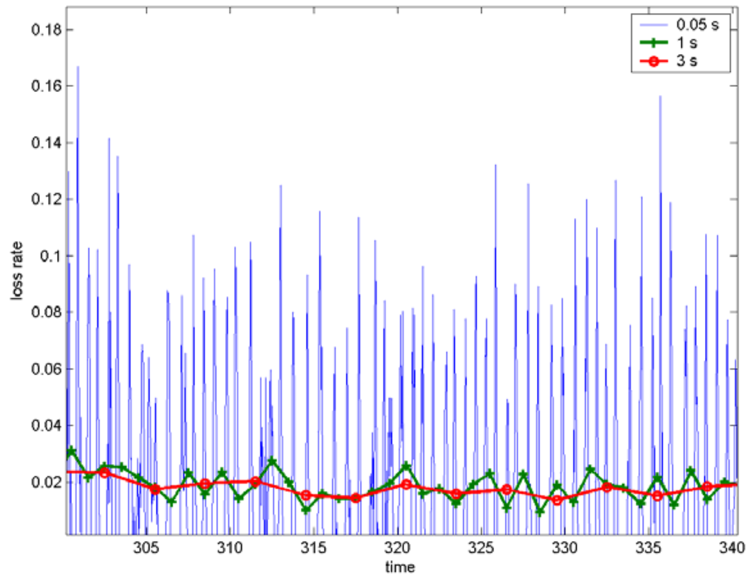

Impact of session and probe length

- Long probes give better estimates
- Fewer failed sessions for long probes
- Caveat: depends on traffic pattern

Class	Probe length	Session length	Blocking	Fail rate
0	1	20	30	2.5
1	1	60	35	1.5
2	1	100	33	1
3	1	140	29	1.5
4	1	180	38	0.6
5	3	20	21	1.8
6	3	60	22	0.5
7	3	100	20	0.5
8	3	140	21	0.7
9	3	180	19	0.5

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Relevance of delay

- Paths with longer delay get worse blocking rate than paths with high loss
- Due to TCP fairness – TCP throughput RTT dependent

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	P2-50ms	P2–100ms	P1–50ms	P1-100ms
Blocked %	0	30	4	100
Loss %	1.1	1.1	2.5	-
Failed %	0	0	2.3	-
TCP Mb/s	5.9	2.5	3.8	1.8

Delay compensation

- Compare with TCP segment size proportional to RTT
- No RTT dependence

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	P2-50ms	P2–100ms	P1–50ms	P1-100ms
Blocked %	0	0	37.3	37.9
Loss %	1.3	1.3	2.8	2.7
Failed %	0	0	1.6	1.5
TCP Mb/s	5.4	2.3	3.6	1.7

Conclusions

- Fairness between applications with different requirements
- Simple deployment
- Promising results

Future work:

- Evolution from TCP fairness to other quality of service provisioning

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