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Performance of TCP/IP with MEDF Scheduling

4. Würzburger Workshop
"IP Netzmanagement, IP Netzplanung und Optimierung"

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Motivation

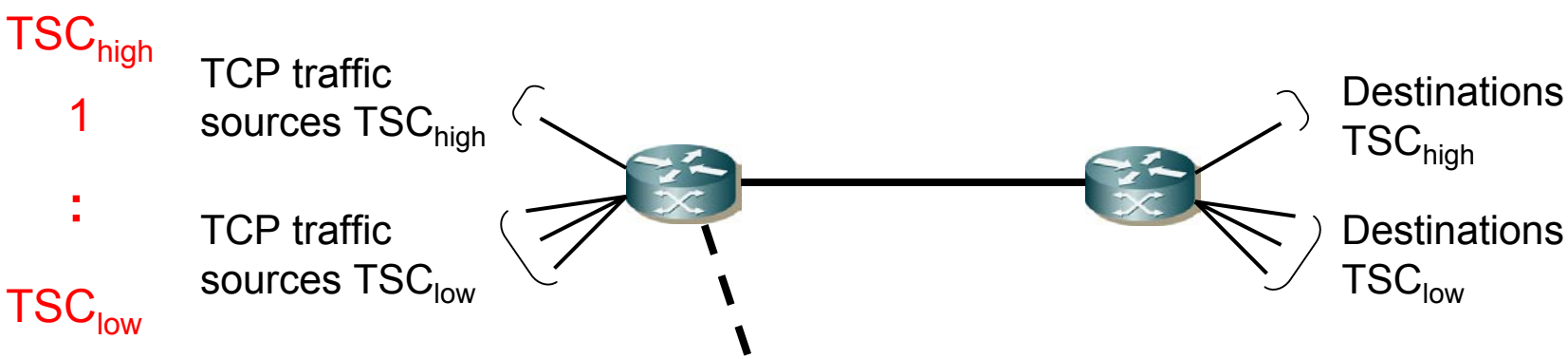
- Best effort traffic only in today's Internet
  → No prioritization

- Static Priority (SP) for high priority Transport Service Class (TSC)
  → Starvation of low priority traffic

- Differentiated Services Architecture (DiffServ) implements appropriate per hop behavior to differentiate between TSCs
  - Common recommendations:
    - Weighted Round Robin (WRR)
    - Deficit Round Robin (DRR)
    - …
  - Fixed share of bandwidth for different TSCs

Motivation

Anticipated traffic mix:

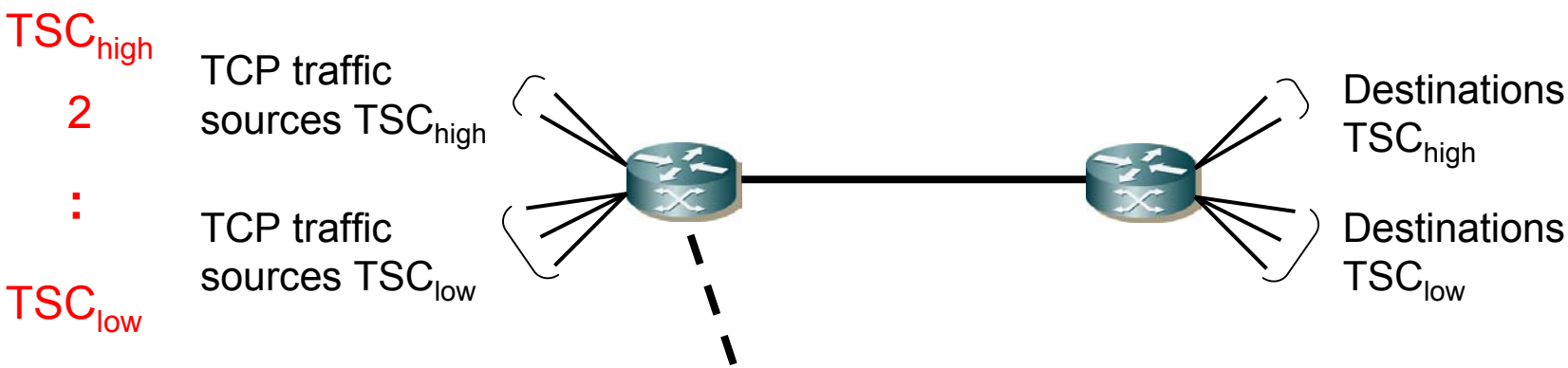


Fixed bandwidth share TSC_{high}:TSC_{low} = 2:3 (class based)

→ Bandwidth per flow TSC_{high}:TSC_{low} 2:1

Motivation

Current traffic mix:



Fixed bandwidth share TSC_{high}:TSC_{low} = 2:3 (class based)

→ Bandwidth per flow TSC_{high}:TSC_{low} 1:1

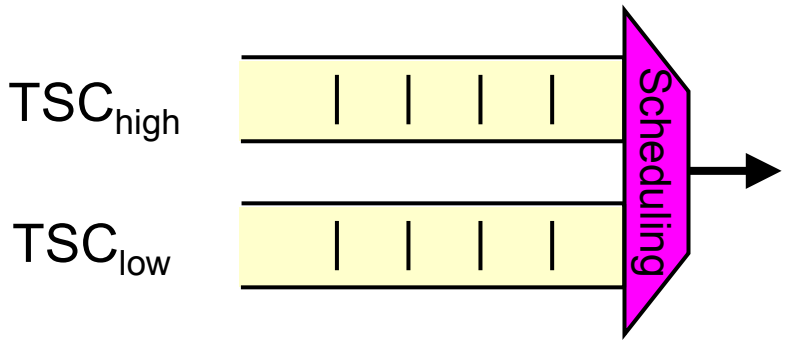
Motivation

- Problem:
  - Conventional scheduling algorithms:
    - No priority
    - Starvation of low priority flows
    - Fixed bandwidth shares

      Knowledge of traffic mix required to provision adequate Quality of Service

Is there a way to introduce traffic-mix-independent per-flow-prioritization?

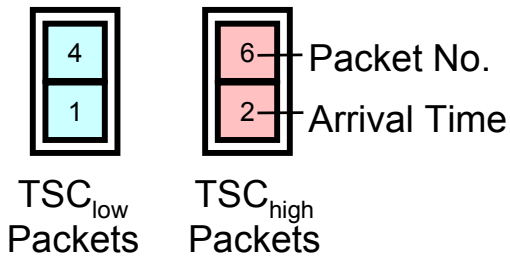
Modified Earliest Deadline First (MEDF)



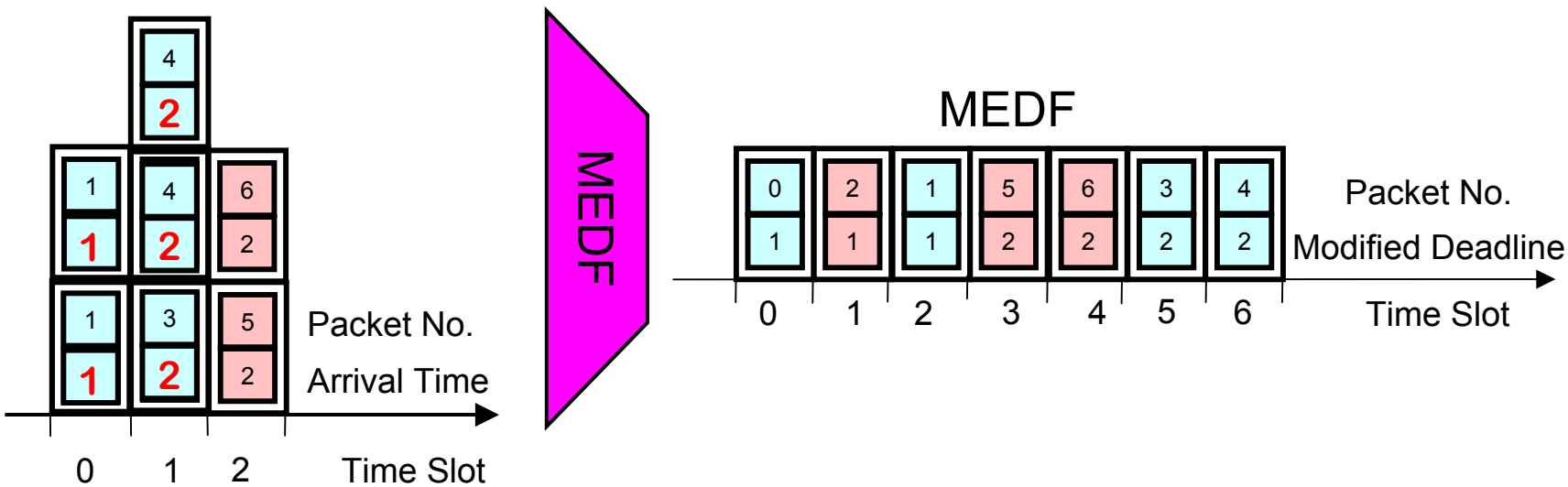
- MEDF description
  - One queue per TSC
  - Packets equipped with a time stamp
    - Deadline=ArrivalTime+M_{TSC}
    - Delay advantage: M_{high}=0, M_{low} >0,
  - Scheduling decision
    - Take packet with the earliest deadline among all queues

- Difference to EDF
  - Simple implementation, no searching / sorting required

Modified Earliest Deadline First

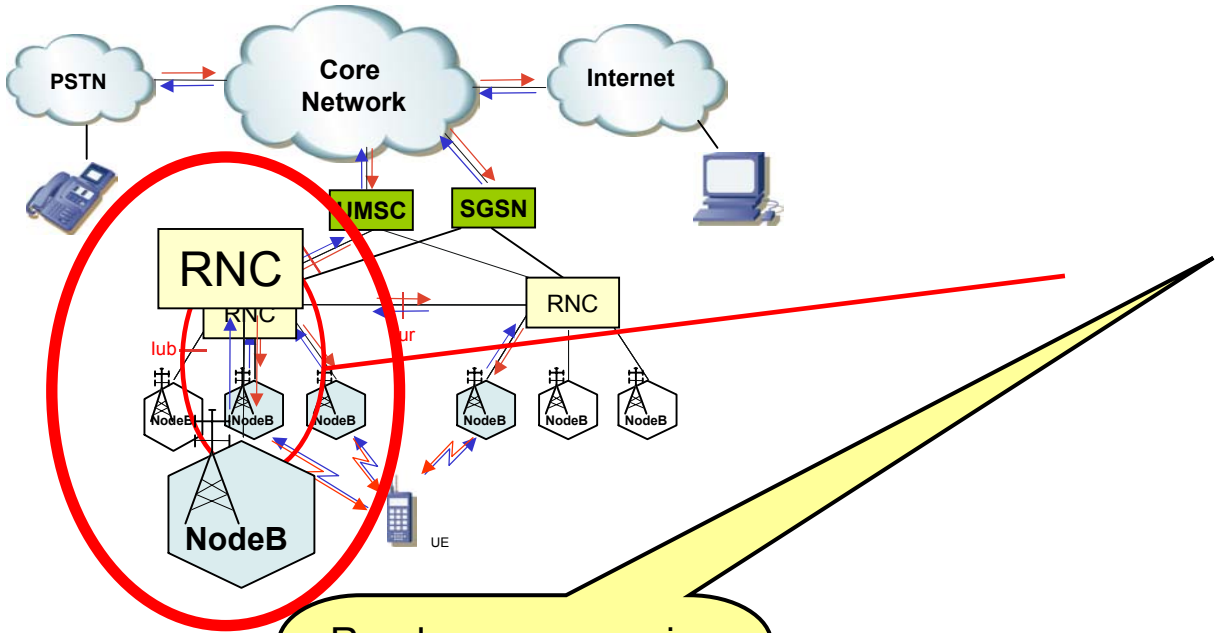


$M_{high} = 0, M_{low} = 1$

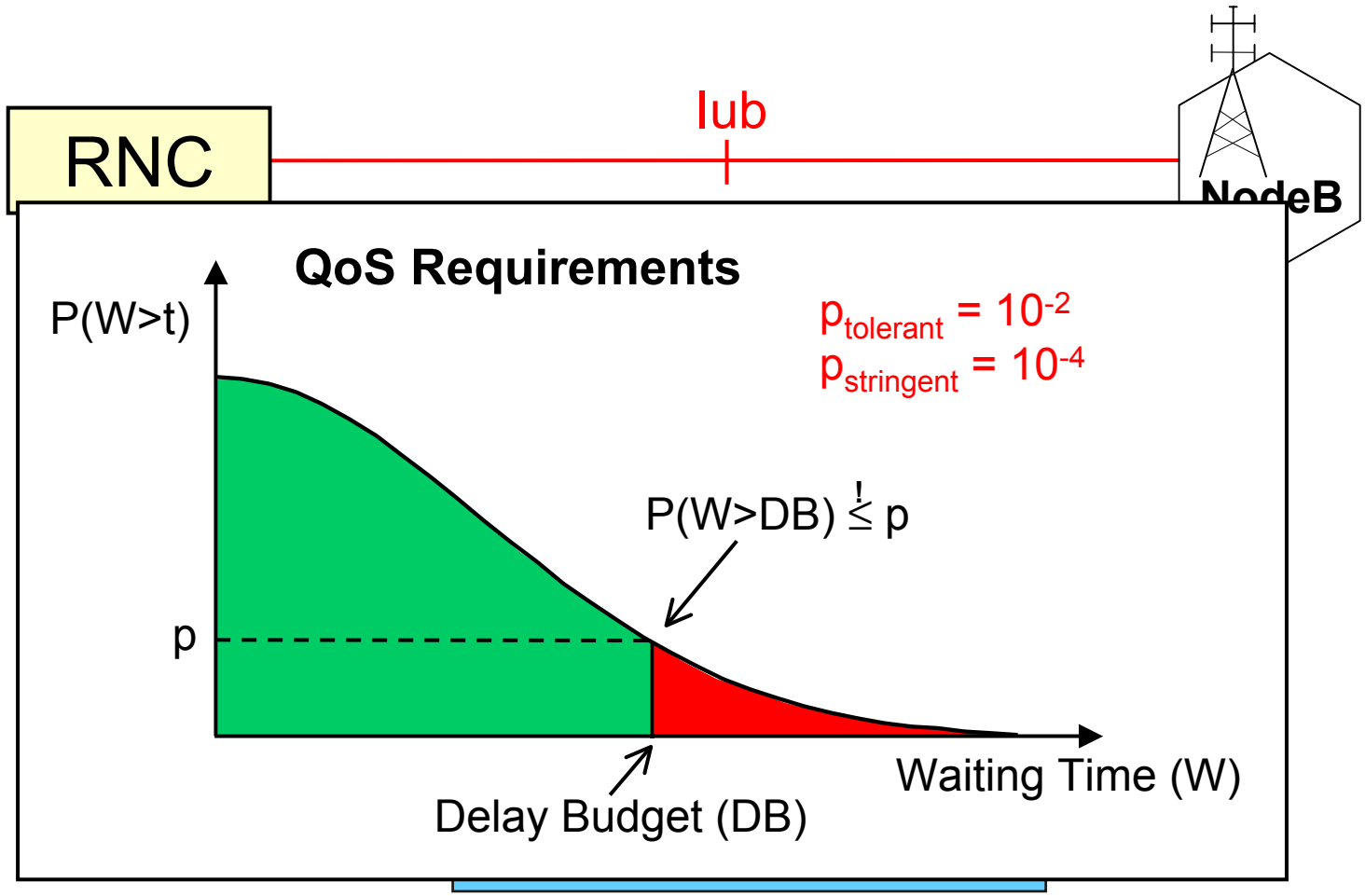


MEDF: Service Differentiation in the UTRAN

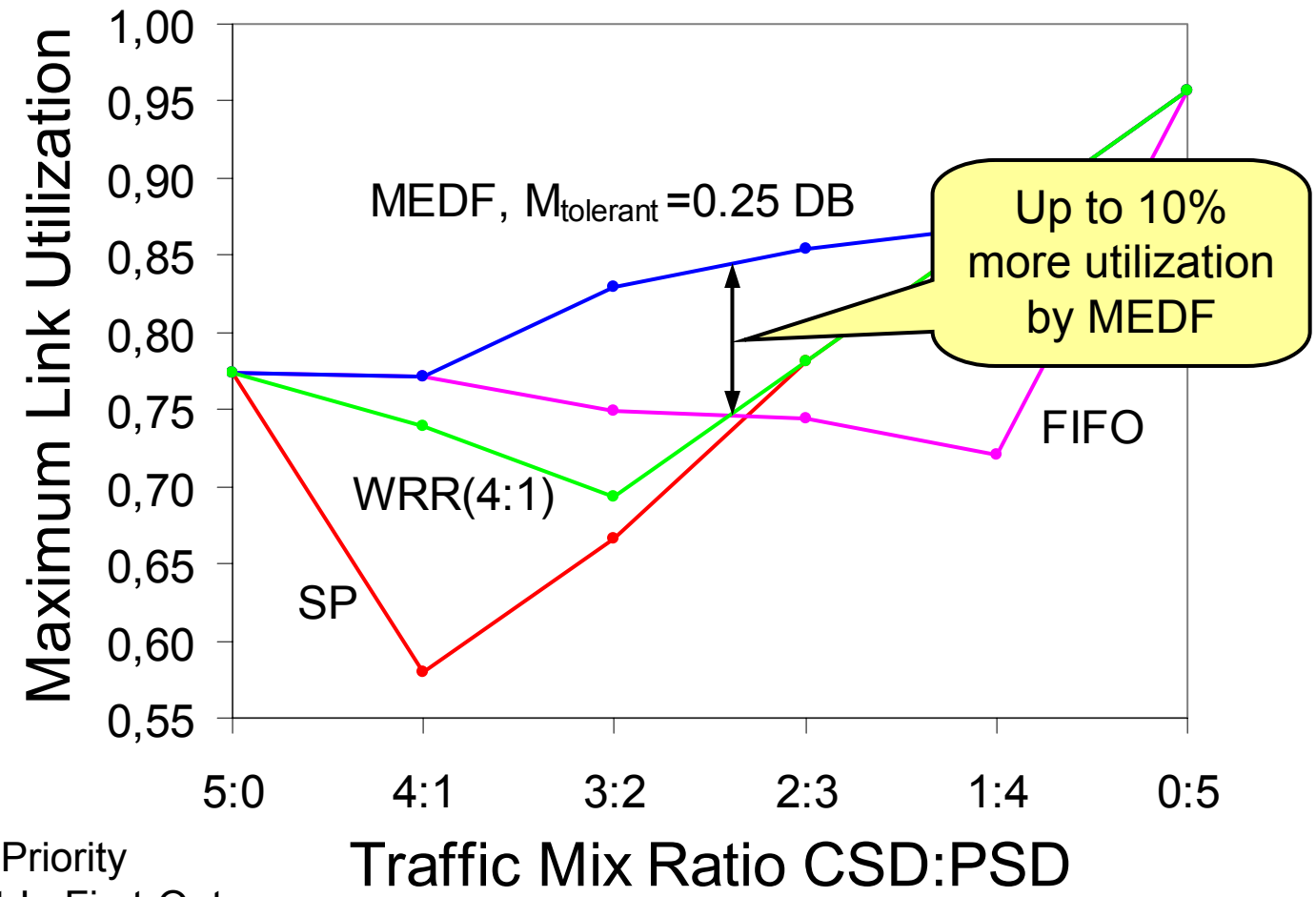
- UMTS Terrestrial Access Network (UTRAN)



Model of the Transport Network Layer (TNL)



Performance of MEDF Scheduling in the UTRAN



SP: Static Priority
FIFO: First-In First-Out
WRR(n:m): Weighted Round Robin with Weights (n:m)

Motivation

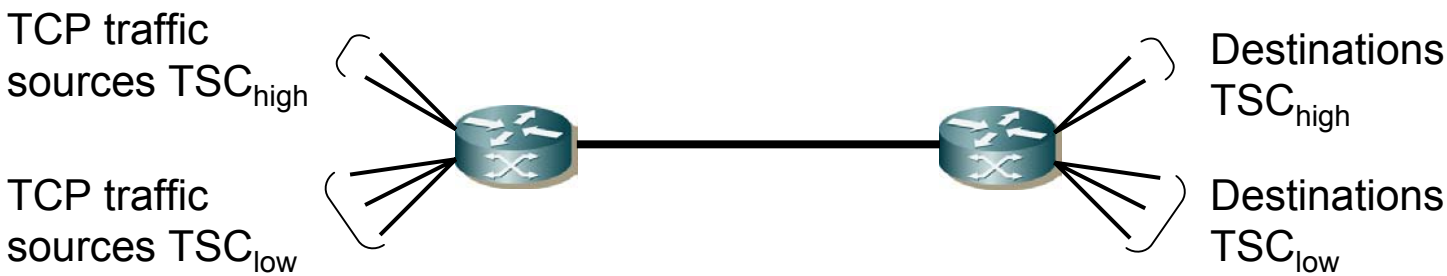
- Features of MEDF (verified for the UTRAN application)
  - Best performance
  - Degree of prioritization of stringent TSC over tolerant TSC on the packet level

  independent of the current traffic mix

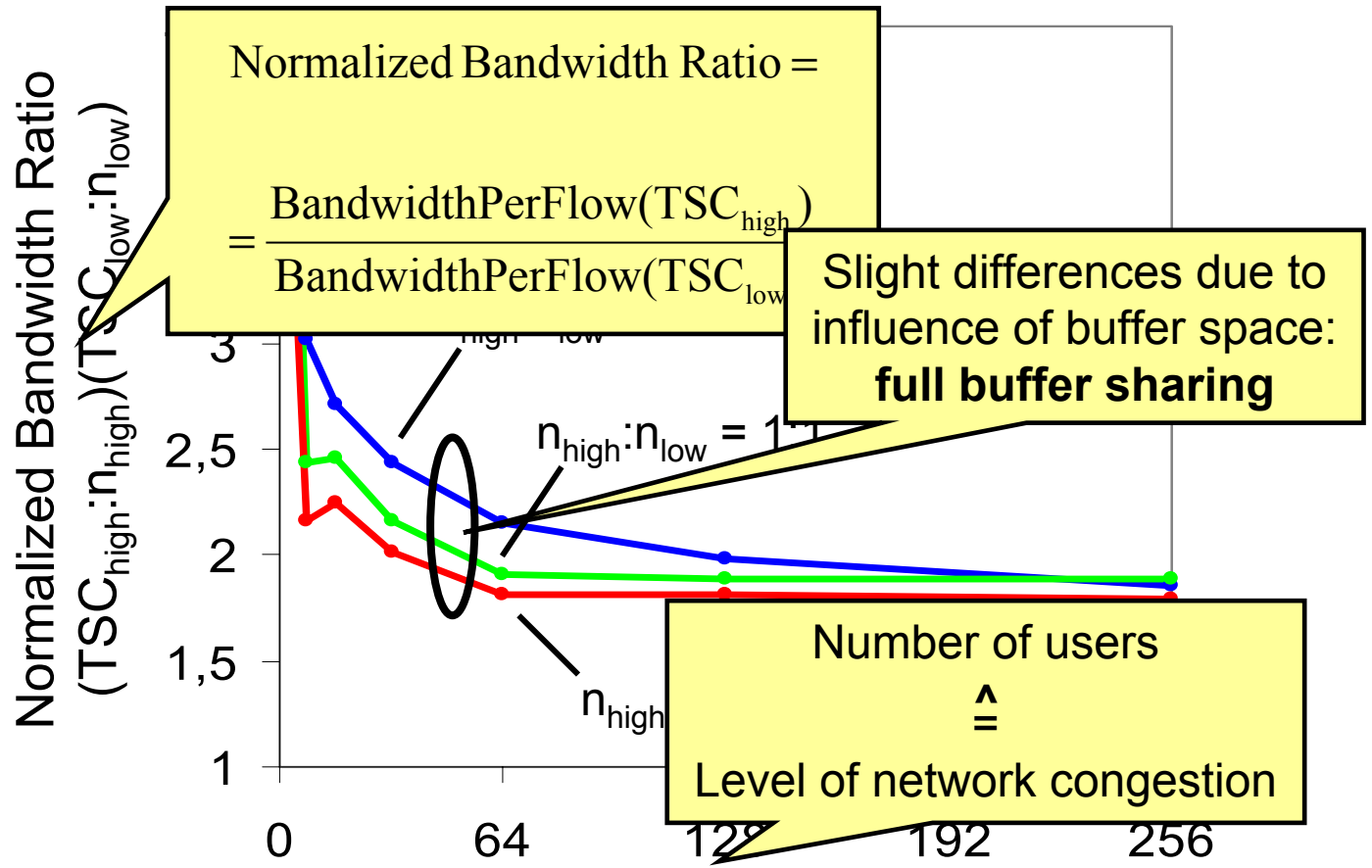
Can MEDF be used to introduce traffic-mix-independent per-flow-prioritization?

MEDF: Single Link Simulation Environment

- TCP adapts its rate to
  - Packet loss p_{loss} (→ space priority)
  - Round Trip Time RTT (→ time priority → MEDF)
- Network Simulator 2
- Classical dumbell topology to isolate MEDF characteristics



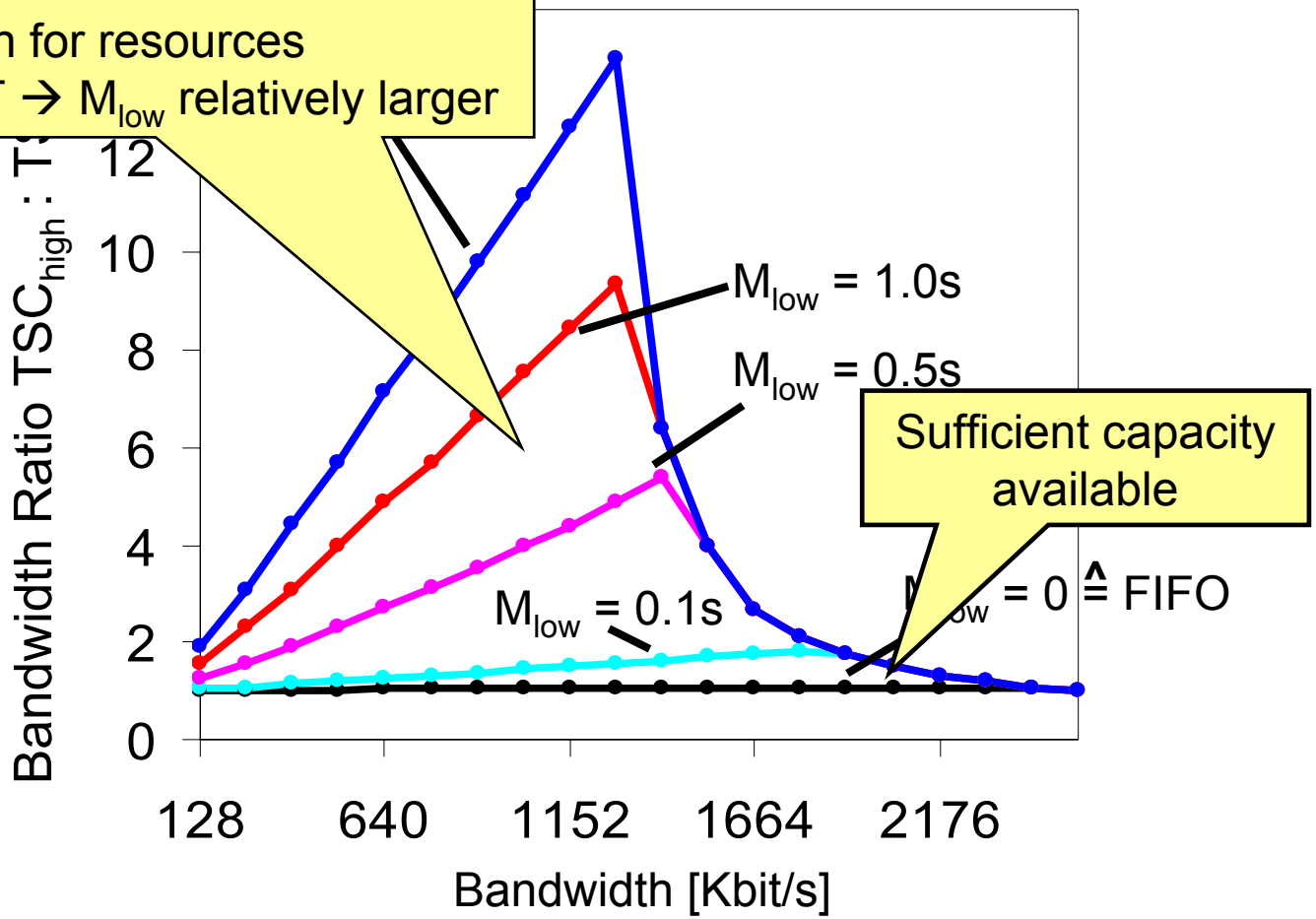
MEDF Analysis: Traffic Mix



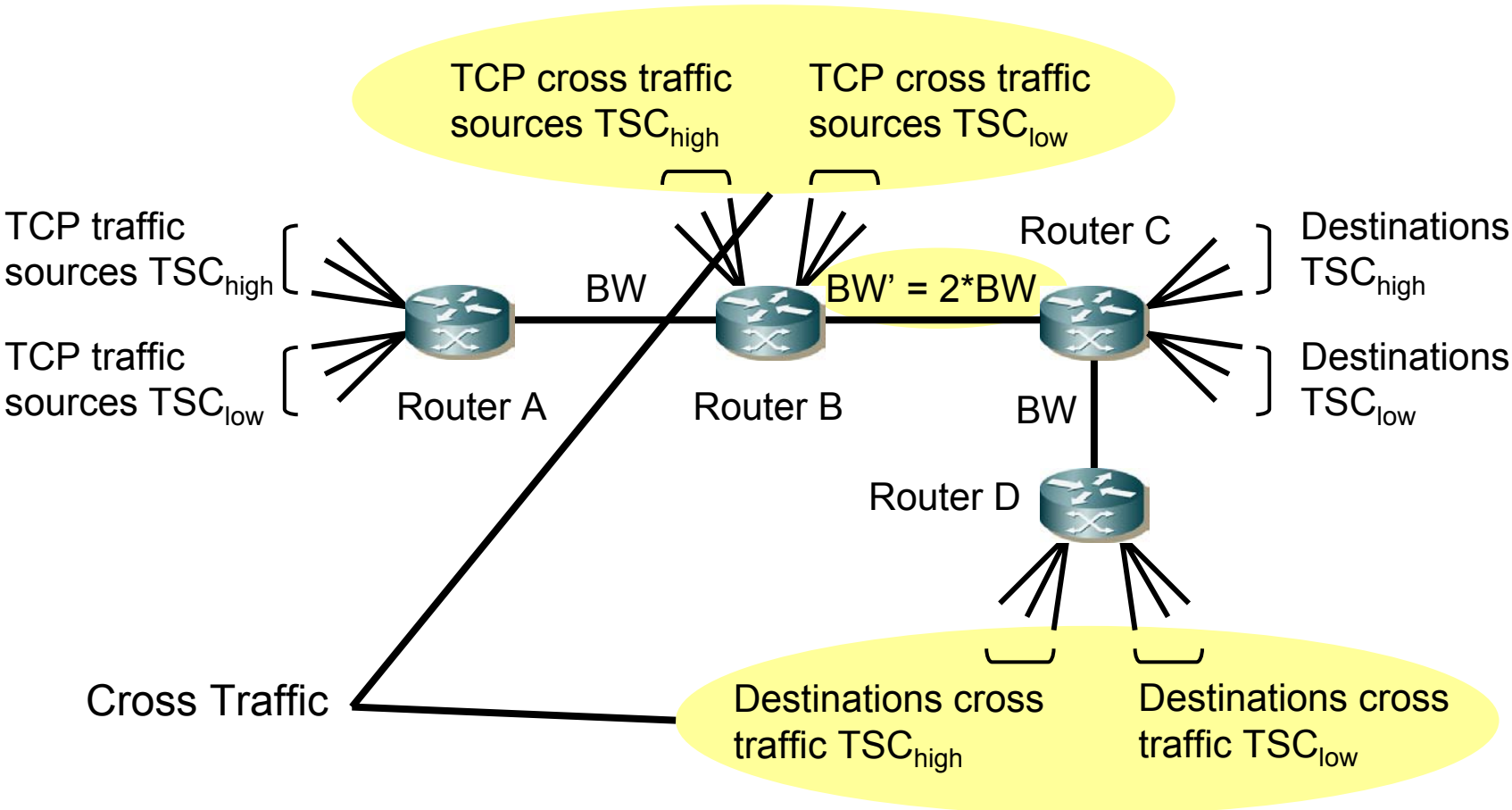
→ MEDF offers traffic-mix-independent per-flow-prioritization

MEDF Analysis: M_{low} parameter

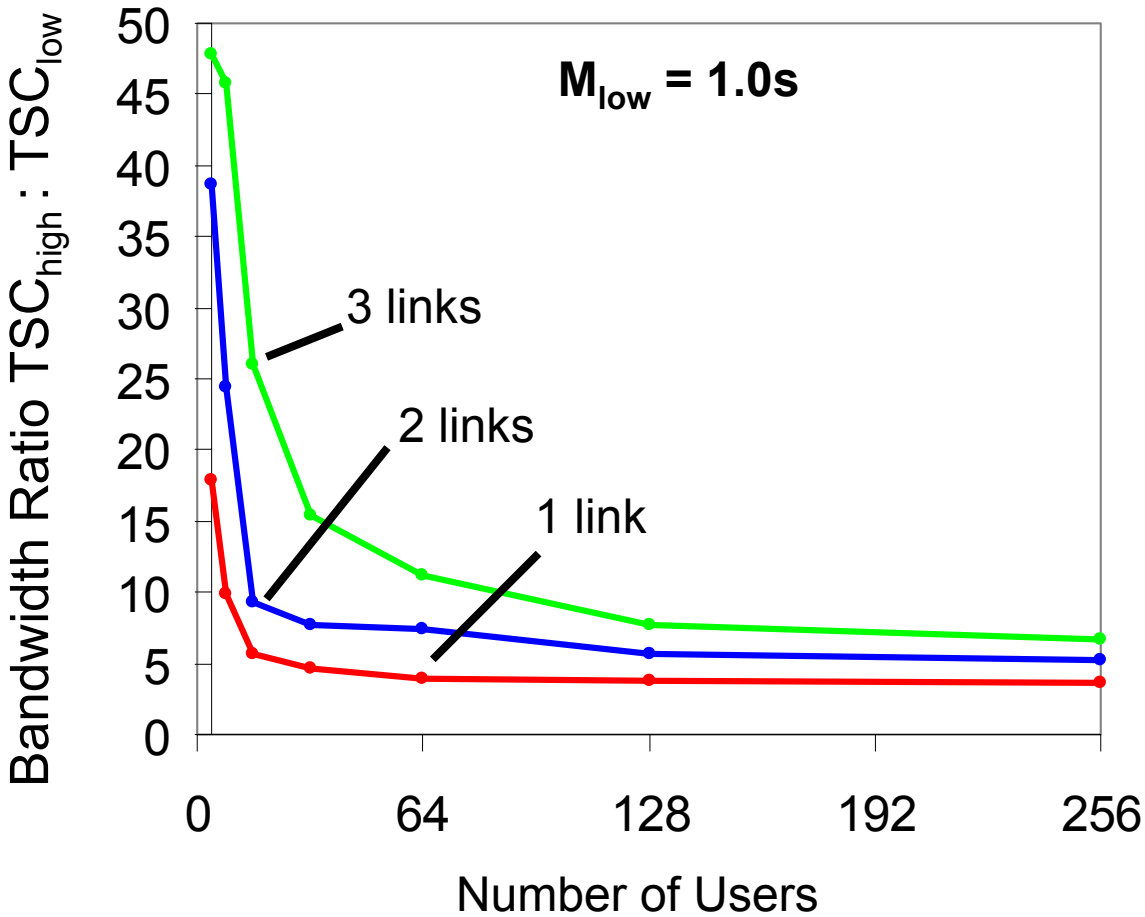
Increase due to
-Less competition for resources
-Decreasing RTT → M_{low} relatively larger



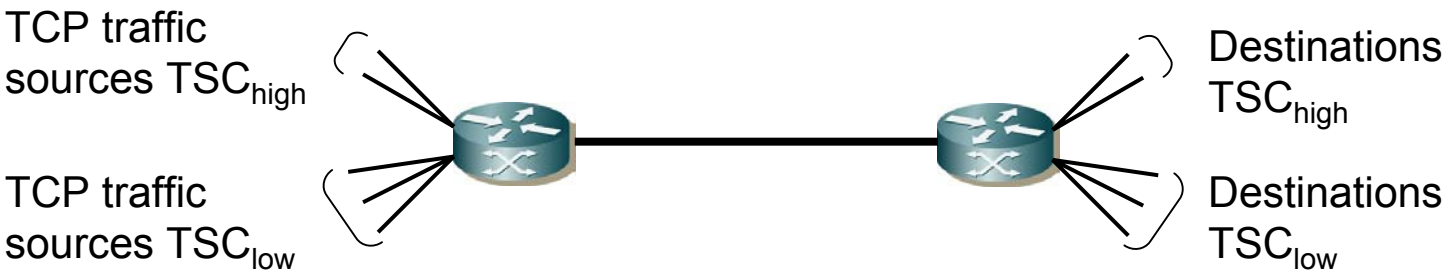
MEDF: Multi-Link Simulation Environment



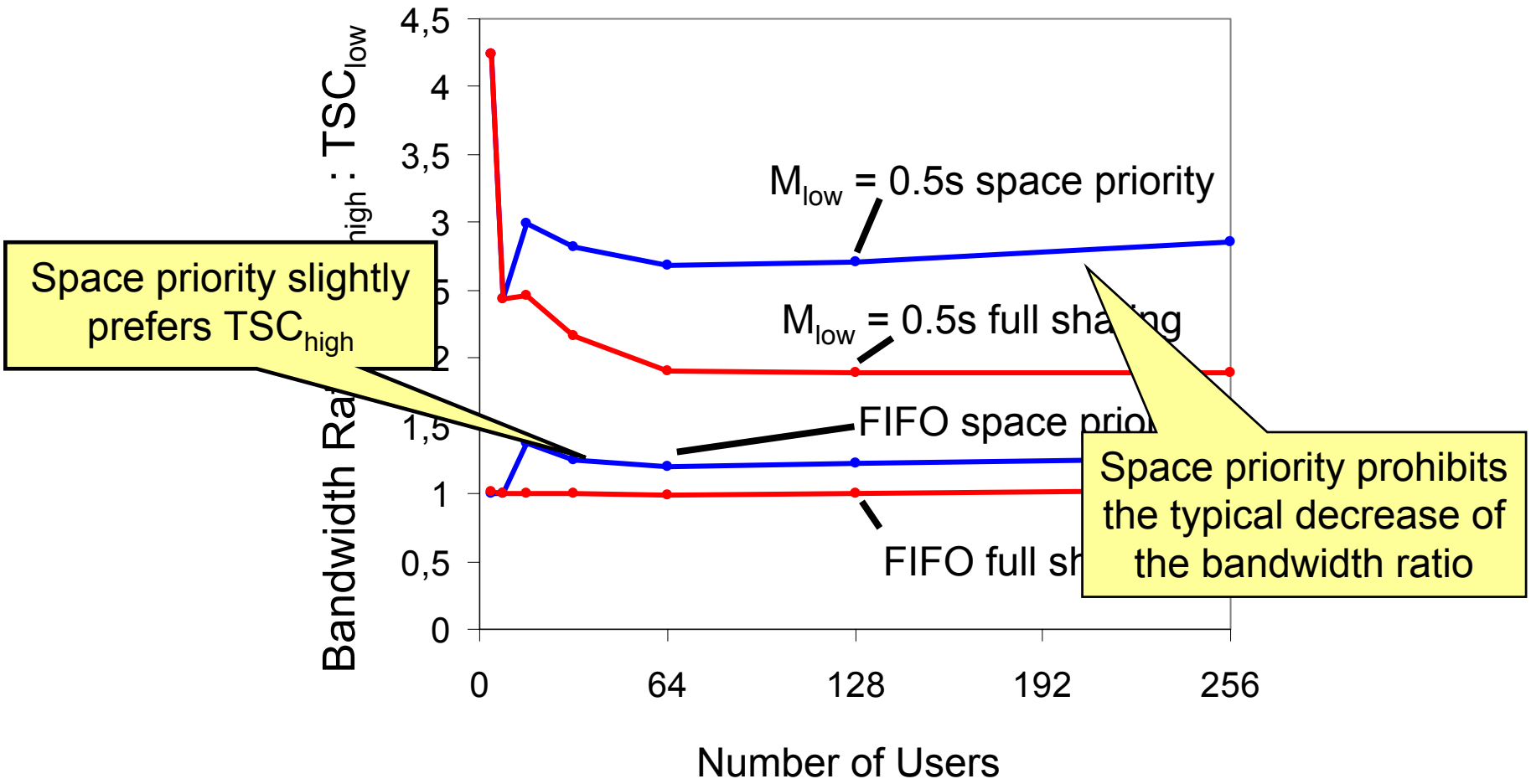
MEDF Analysis: Multiple Links



→ Relative delay advantage increases with the number of links


TCP traffic
sources TSC$_{high}$
TCP traffic
sources TSC$_{low}$
Destinations
TSC$_{high}$
Destinations
TSC$_{low}$

MEDF Analysis: Buffer Space Priority



Summary

- Problem
  - Conventional scheduling disciplines:
    - No prioritization or starvation or fixed bandwidth shares per TSC or
    - traffic mix required for adequate QoS provisioning (not available)
- Solution
  - MEDF
    - traffic-mix-independent per-flow-prioritization in TCP/IP networks
    - Single parameter: delay advantage M_{low}

Conclusion

- Results
  - Effective prioritization of TCP traffic
  - Impact of delay advantage M_{low}
  - Comparison with buffer management strategies
- MEDF
  - Simple and parameterizable prioritization in TCP/IP networks without starvation
  - Application in Differentiated Services network

Q&A