Effect of Number of Drop Precedences in Assured Forwarding

draft-goyal-dpstdy-diffserv-02.txt

Mukul Goyal, Arian Durresi, Raj Jain

The Ohio State University

Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/

These slides are on the Internet at

http .htm

- Key Variables
- Buffer Management Classification: Types of RED
- Traffic Types and Treatment
- Level of Reserved Traffic
- Two vs Three: Best Results
- Summary

Key Variables

First Class

Business Class

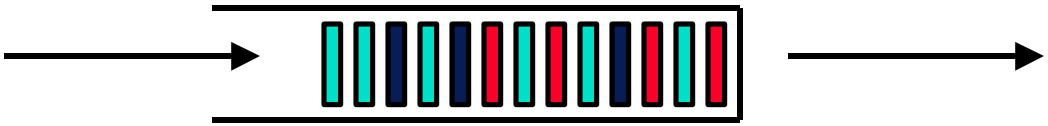
Coach Class

Key Variables

- **Bandwidth Management**:
  - Number of colors: One, Two, or Three
  - Percentage of green (reserved) traffic: Low, high, oversubscribed
- **Buffer Management**:
  - Tail drop or RED
  - RED parameters, implementations
- **Traffic Types and their treatment**:
  - Congestion Sensitivity: TCP vs UDP
  - Excess TCP vs Excess UDP
- **Network Configuration**:

  Our goal is to identify results that apply to all configs.

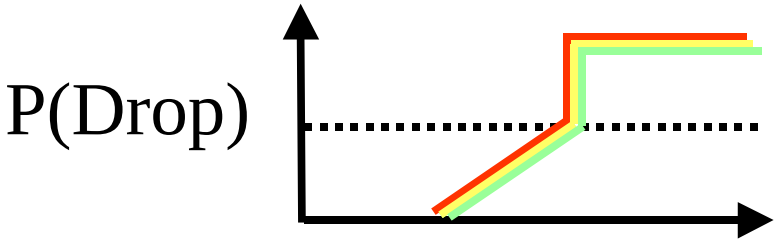
Buffer Management Classification



- Accounting (queued packets):
  Per-color, per-VC, per-flow, or Global
  Multiple or Single
- Threshold: Single or Multiple
- Four Types:
  - Single Accounting, Single threshold (SAST)
  - Single Accounting, Multiple threshold (SAMT)
  - Multiple Accounting, Single threshold (MAST)
  - Multiple Accounting, Multiple threshold (MAMT)

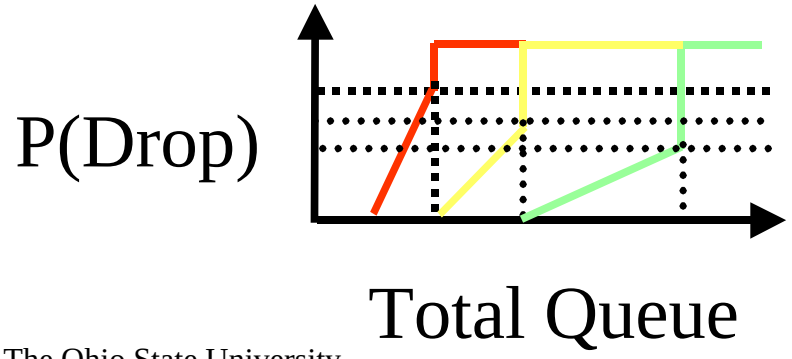
Types of RED

- Single Accounting Single Threshold (SAST): Color-blind Random Early Discard (RED)



Used in present diffserv-unaware routers

- Single Accounting Multiple Threshold (SAMT): Color-Aware RED as implemented in some products

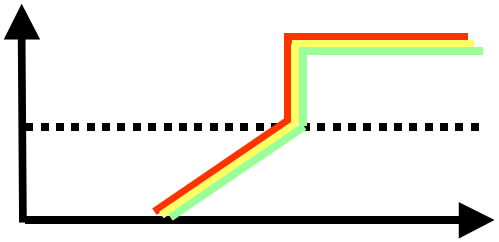


Used in this study

Types of RED (Cont)

- Multiple Accounting Single Threshold (MAST):

P(Drop)

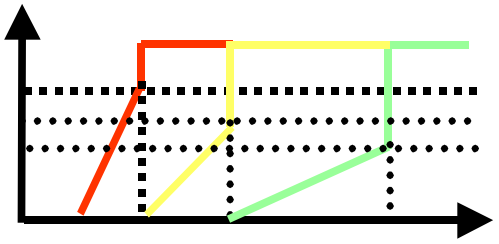


G, G+Y, G+Y+R Queue

Used in our previous study

- Multiple Accounting Multiple Threshold (MAMT):

P(Drop)

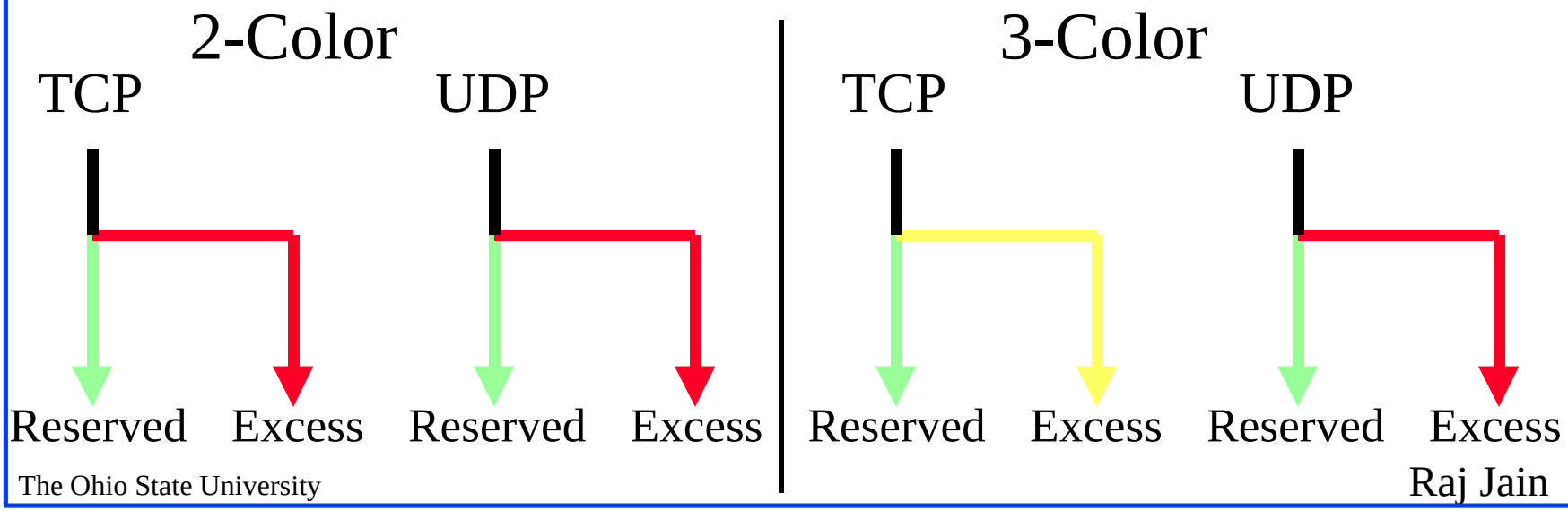


R, Y, G Queue

Conclusion:
More Complexity
⇒ More Fairness

Traffic Types and Treatment

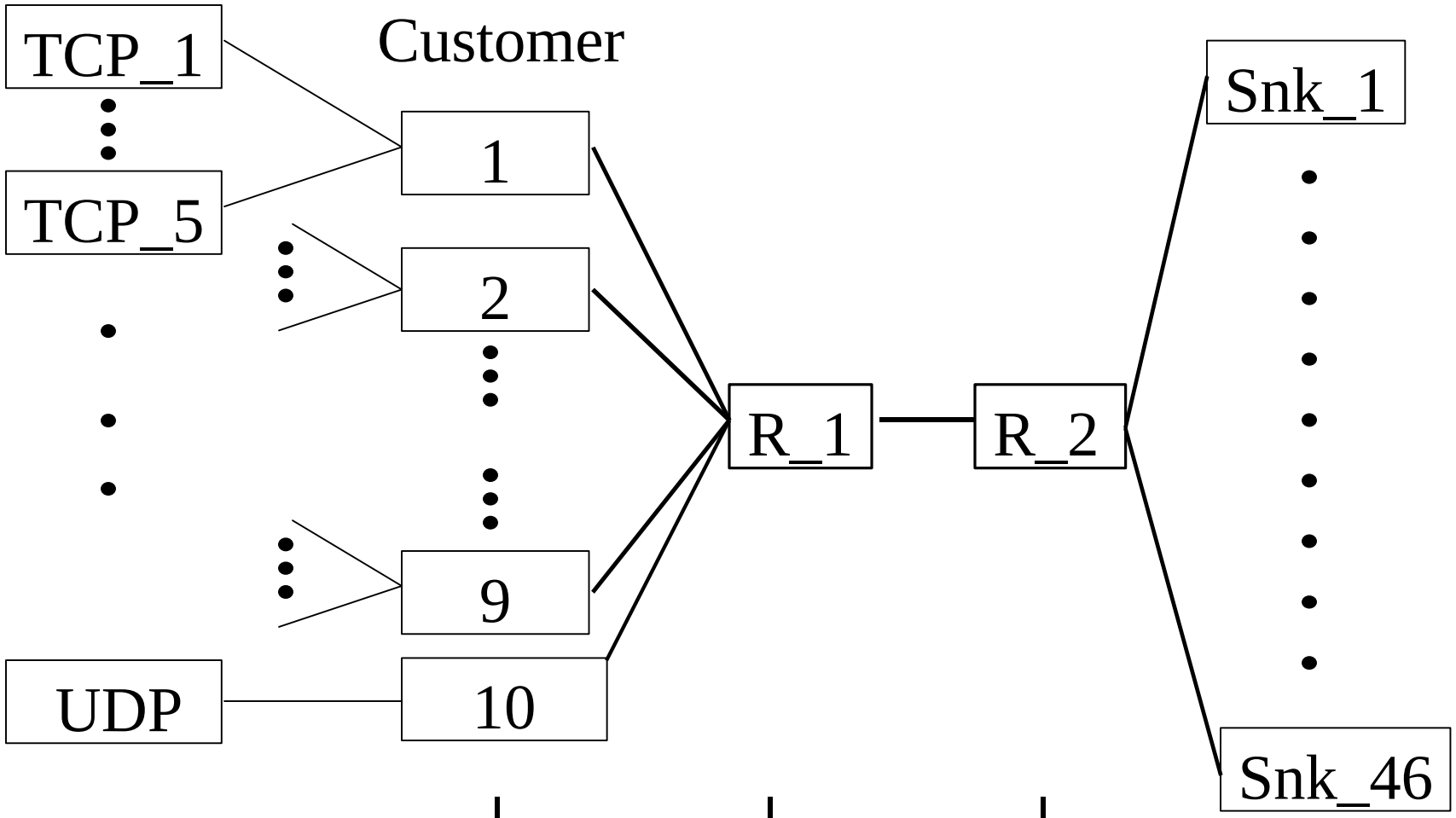
- Both TCP and UDP get their reserved (green) rates
- Excess TCP competes with excess UDP
- UDP is aggressive
  ⇒ UDP takes over all the excess bandwidth
  ⇒ Give excess TCP better treatment than excess UDP



Level of Reserved Traffic

- Percentage of reserved (green) traffic is the most important parameter
- If the green traffic is high
  ⇒ No or little excess capacity
  ⇒ Two or three colors perform similarly
- If the green traffic is low
  ⇒ Lots of excess capacity
  ⇒ Behavior of TCP vs UDP impacts who gets excess
  ⇒ Need 3 colors + Need to give excess TCP yellow + Need to give excess UDP red colors

Simulation Configuration



Link Parameters

	Link B/W	Link Delay	Drop Policy
Between TCP_i/UDP & Customer _i	10 Mbps	1 μs	DropTail
From Customer_i to R_1	1.5 Mbps	5 μs	DropTail w marker
From R_1 to Customer_i	1.5 Mbps	5 μs	DropTail
From R_1 to R_2	1.5 Mbps	30 ms	RED_n
From R_2 to R_1	1.5 Mbps	30 ms	DropTail
Between R_2 & Snk_i	1.5 Mbps	5 μs	DropTail

Simulation Parameters

- S*ingle* A*ccounting* M*ultiple* T*hreshold* RED
- RED Queue Weight for All Colors: w = 0.002

$$Q_{avg} = (1\text{-}w)Q_{avg} + w\,Q$$

- Maximum Queue Length (For All Queues): 60 packets
- TCP flavor: Reno
- TCP Maximum Window: 64 packets
- TCP Packet Size: 576 bytes
- UDP Packet Size: 576 bytes
- UDP Data Rate: 1.28Mbps

Two Color Simulations

Simulation Configuration	Green Token Generation Rate [kbps]	Green Token Bucket Size (in Packets)	Maximum Drop Probability {Green, Red}	Drop Thresholds {Green, Red}
1 Through 1152	12.8, 25.6, 38.4, 76.8, 102.4, 128, 153.6, 179.2	1, 2, 4, 8, 16, 32	{0.1,0.1} {0.1,0.5} {0.1,1} {0.5,0.5} {0.5,1} {1,1}	{40/60,0/10} {40/60,0/20} {40/60,0/5} {40/60,20/40}

Three Color Simulations

Simulation Config.	Green Token Gener. Rate [kbps]	Green Token Bucket Size in Packets	Yellow Token Bucket Size in Packets	Max Drop Probability {Green, Yellow, Red}	Drop Thresholds {Green, Yellow, Red}	Yellow Token Gener. Rate [kbps]
1 Through 2880	12.8, 25.6, 38.4, 76.8	1, 2, 4, 8, 16, 32	1, 2, 4, 8, 16, 32	{0.1,0.5,1} {0.1,1,1} {0.5,0.5,1} {0.5,1,1} {1,1,1}	{40/60,20/40, 0/10} {40/60,20/40, 0/20}	128, 12.8

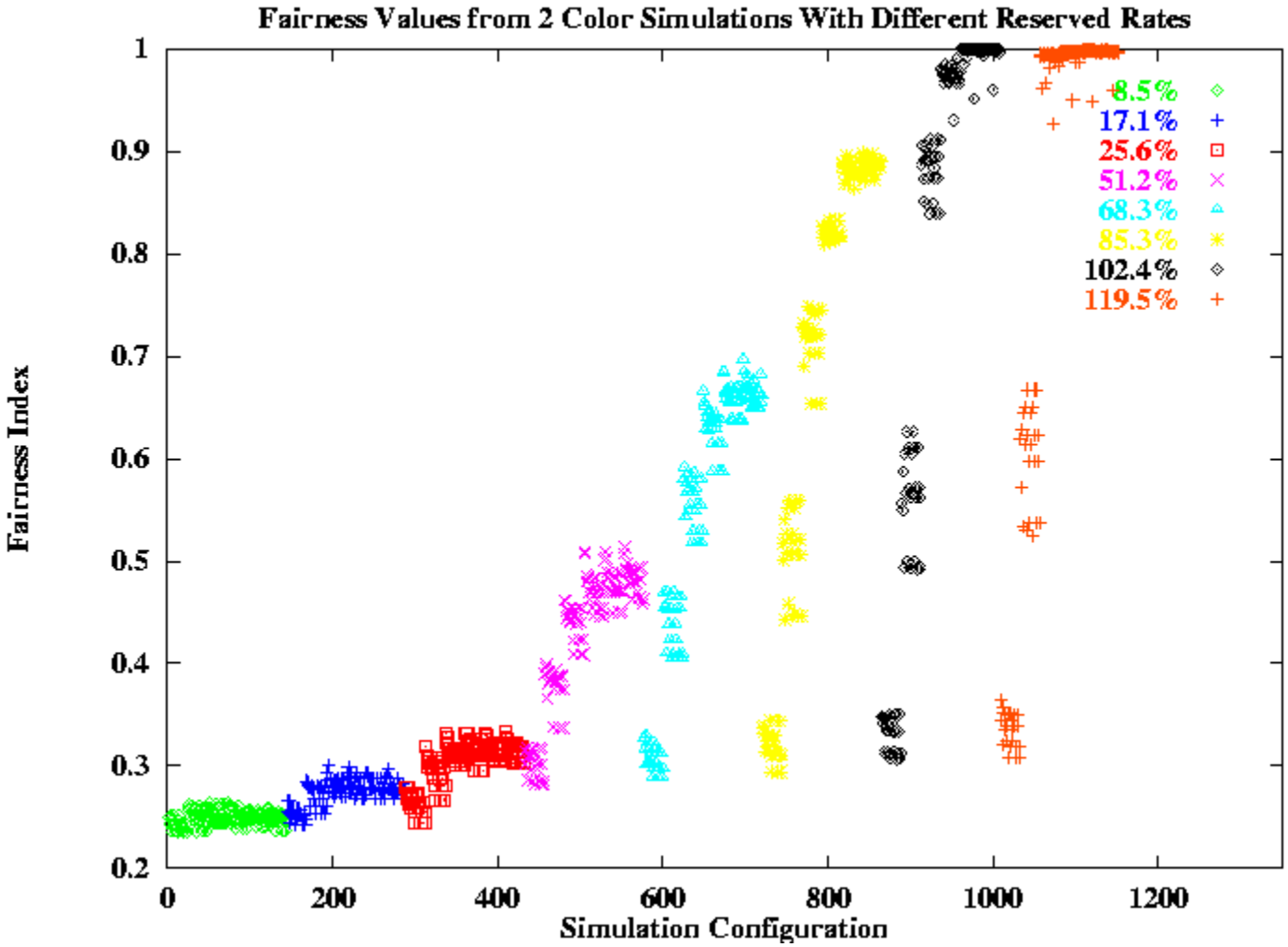
Fairness Index

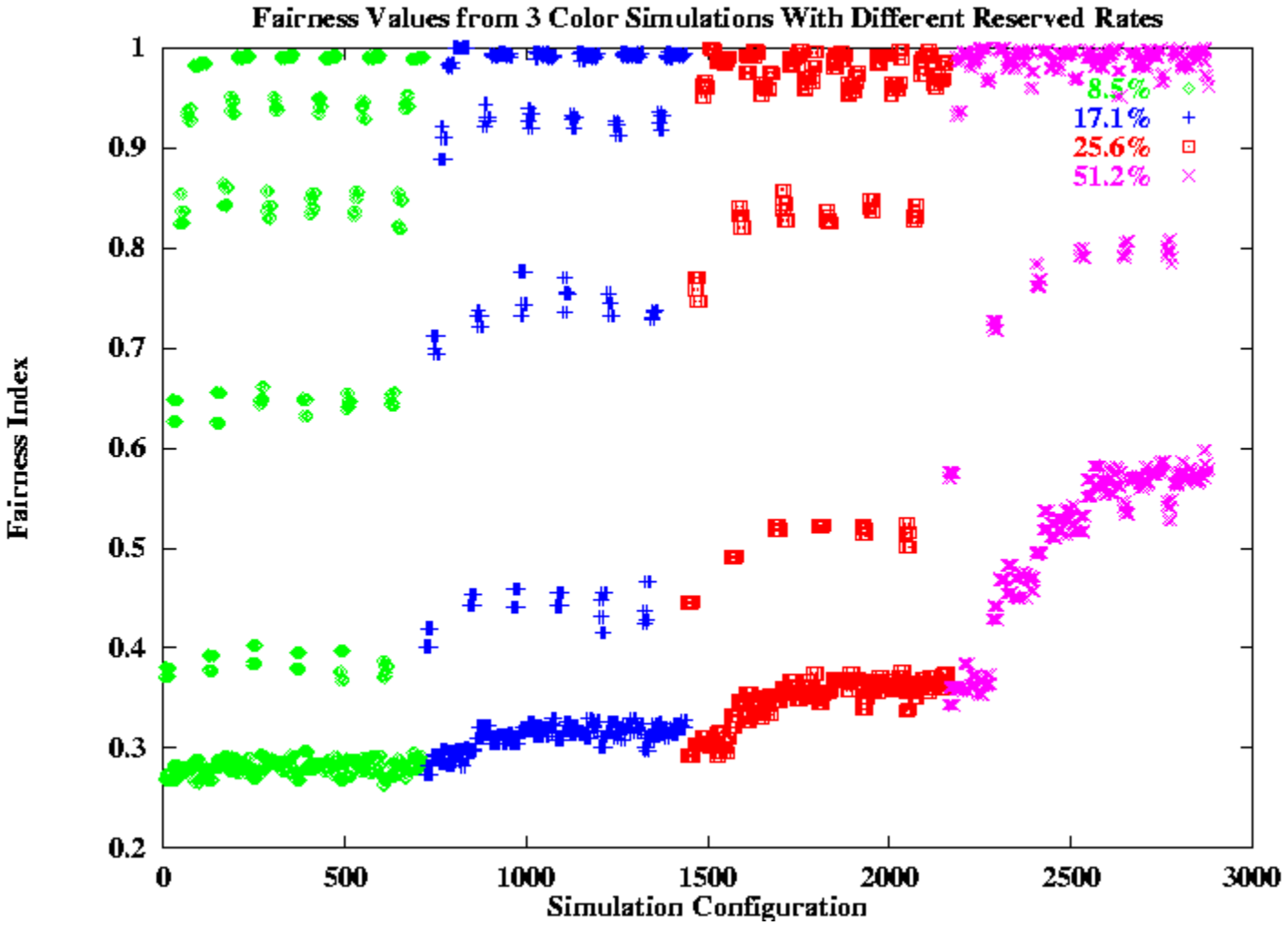
- Measured Throughput: $(T_1, T_2, ..., T_n)$
- Use any criterion (e.g., max-min optimality) to find the Fair Throughput $(O_1, O_2, ..., O_n)$
- Normalized Throughput: $x_i = T_i/O_i$

$$\text{Fairness Index} = \frac{(\Sigma x_i)^2}{n\Sigma x_i^2}$$

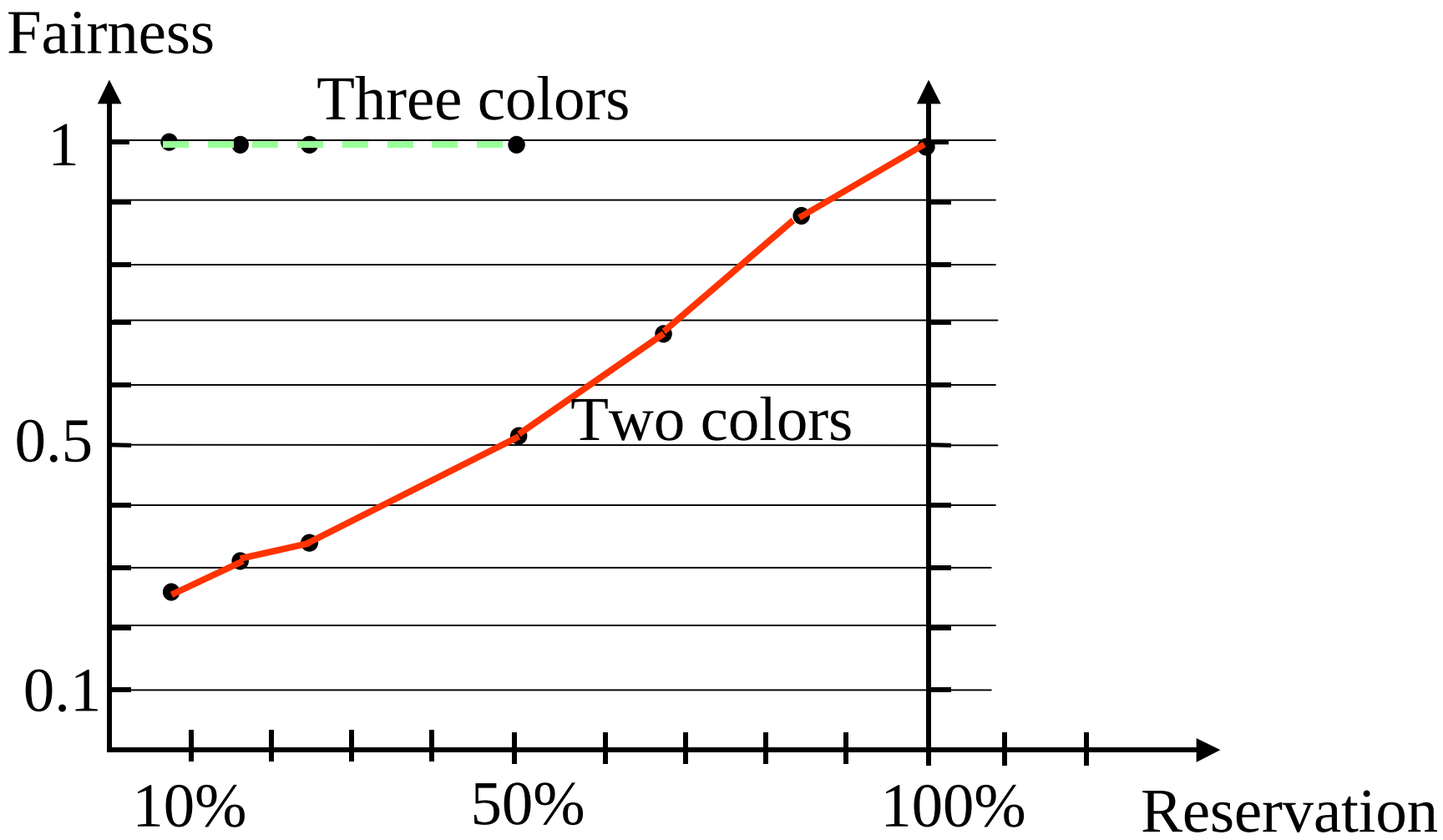
Example: 50/50, 30/10, 50/10 $\Rightarrow$ 1, 3, 5

$$\text{Fairness Index} = \frac{(1+3+5)^2}{3(1^2+3^2+5^2)} = \frac{9^2}{3(1+9+25)} = 0.81$$


Fairness Values from 2 Color Simulations With Different Reserved Rates
Fairness Index
Simulation Configuration
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
200
400
600
800
1000
1200
8.5%
17.1%
25.6%
51.2%
68.3%
85.3%
102.4%
119.5%


Fairness Values from 3 Color Simulations With Different Reserved Rates
Fairness Index
Simulation Configuration
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
500
1000
1500
2000
2500
3000
8.5%
17.1%
25.6%
51.2%

Two vs Three: Best Results

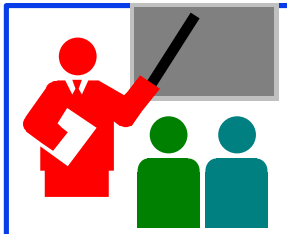


ANOVA For 2 Color Simulations

- Most Important Factors Affecting Fairness:
  - Green Rate (Explains 65.6% of the Variation)
  - Bucket Size (Explains 19.2% of the Variation)
  - Interaction between Green Rate and Bucket Size (Explains 14.8% of the Variation)

ANOVA For 3 Color Simulations

- Most Important Factors Affecting Fairness:
  - Yellow Rate (Explains 74% of the Variation)
  - Yellow Bucket Size (Explains 8.9% of the Variation)
  - Interaction Between Yellow Rate And Yellow Bucket Size (Explains 7.7% of the Variation)
  - Green Rate (Explains 5.6% of the Variation)



Summary

1. The key performance parameter is the level of green (reserved) traffic
2. If reserved traffic level is high or if there is any overbooking, two and three colors give the same throughput and fairness
3. If the reserved traffic is low, three colors give better fairness than two colors
4. Classifiers have to distinguish TCP and UDP: Reserved TCP/UDP $\Rightarrow$ Green, Excess TCP $\Rightarrow$ Yellow, Excess UDP $\Rightarrow$ Red
5. RED parameters and implementations have significant impact.

Thank You!