BBRv3 in the public Internet: a boon or a bane?

Danesh Zeynali, Emilia N. Weyulu, Seifeddine Fathalli

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BBRv1

- Estimates bandwidth, delay
- Probes and drains to avoid filling queues
- Linux kernel version 4.9

2016

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2016

***In 2019, 22% of Alexa's Top 20,000 websites used BBR; Internet traffic volume > 40%**

*Mishra, et al,: The Great Internet TCP Congestion Control Census. ACM Measurement and Analysis of Computing Systems (2019)

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2016

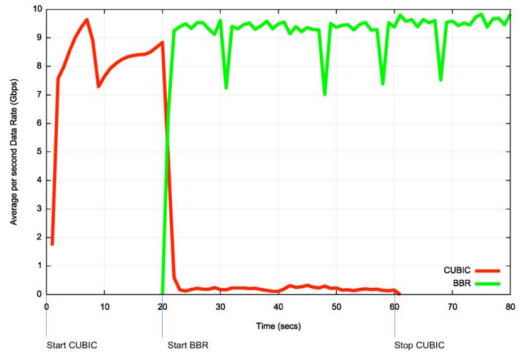
BBR TCP

RIPE Labs

Geoff Huston — 5 May 2017

25 min read

Cubic vs BBR over a 12ms RTT 10G circuit



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BBR TCP

Modeling BBR's Interactions with Loss-Based Congestion Control

Ranysha Ware
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Justine Sherry
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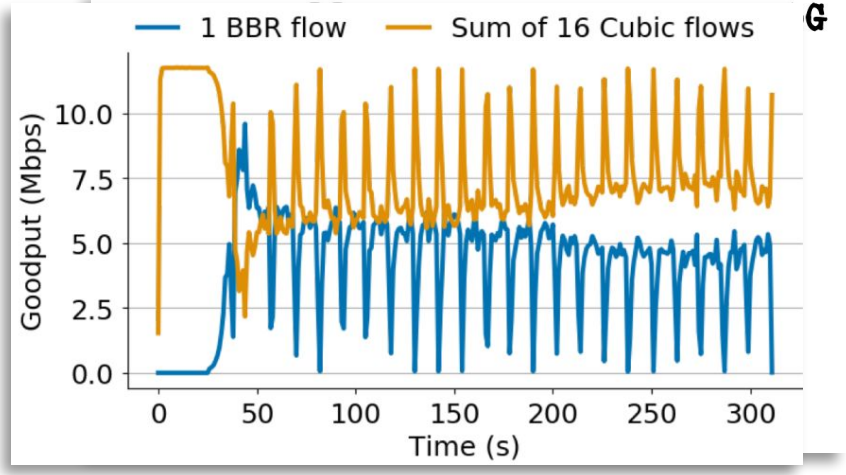
25 min read



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BBRv2

- Reacts to loss and ECN
- Adjusted parameters to ensure fairness to loss-based CCAs

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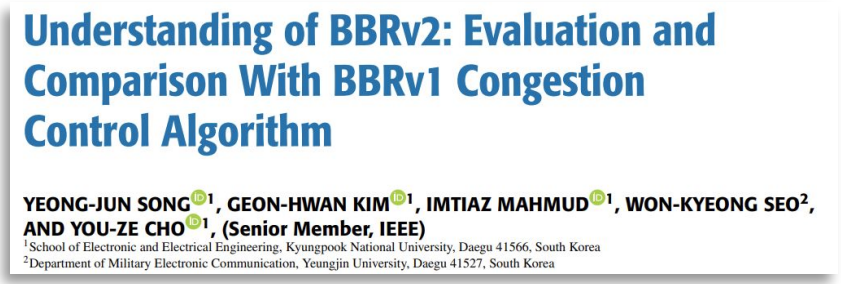

Understanding of BBRv2: Evaluation and Comparison With BBRv1 Congestion Control Algorithm

YEONG-JUN SONG[1], GEON-HWAN KIM[1], IMTIAZ MAHMUD[1], WON-KYEONG SEO[2], AND YOU-ZE CHO[1], (Senior Member, IEEE)
[1]School of Electronic and Electrical Engineering, Kyungpook National University, Daegu 41566, South Korea
[2]Department of Military Electronic Communication, Yeungjin University, Daegu 41527, South Korea

2016

2019

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BBRv1

- Estimates bandwidth, delay
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BBRv1 vs BBRv2: Examining Performance Differences through Experimental Evaluation

Aarti Nandagiri*, Mohit P. Tahiliani*, Vishal Misra†, K. K. Ramakrishnan‡
*National Institute of Technology Karnataka, Surathkal, Mangalore, India
†Columbia University, New York, NY, USA
‡University of California, Riverside, Riverside, CA, USA
*aarti.nandagiri@gmail.com, *tahiliani@nitk.edu.in, †vishal.misra@columbia.edu, ‡kk@cs.ucr.edu

2016

2019

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BBRv1

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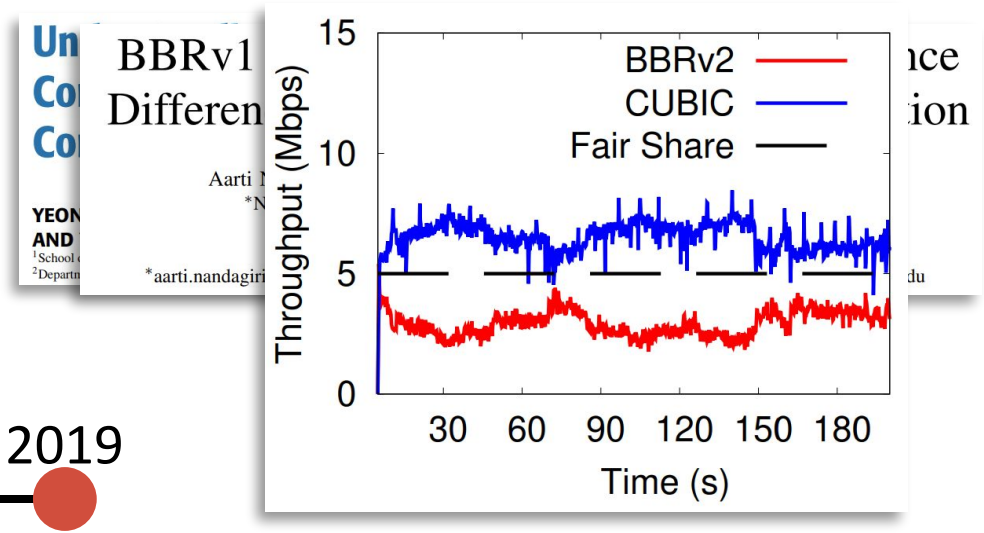
2019



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BBRv3

…

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2019

2023

BBRv2

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BBRv3: The new kid on the block

Minor evolution of BBRv2

- Fix BW convergence with/without loss and/or ECN marks
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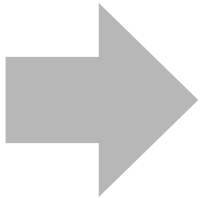
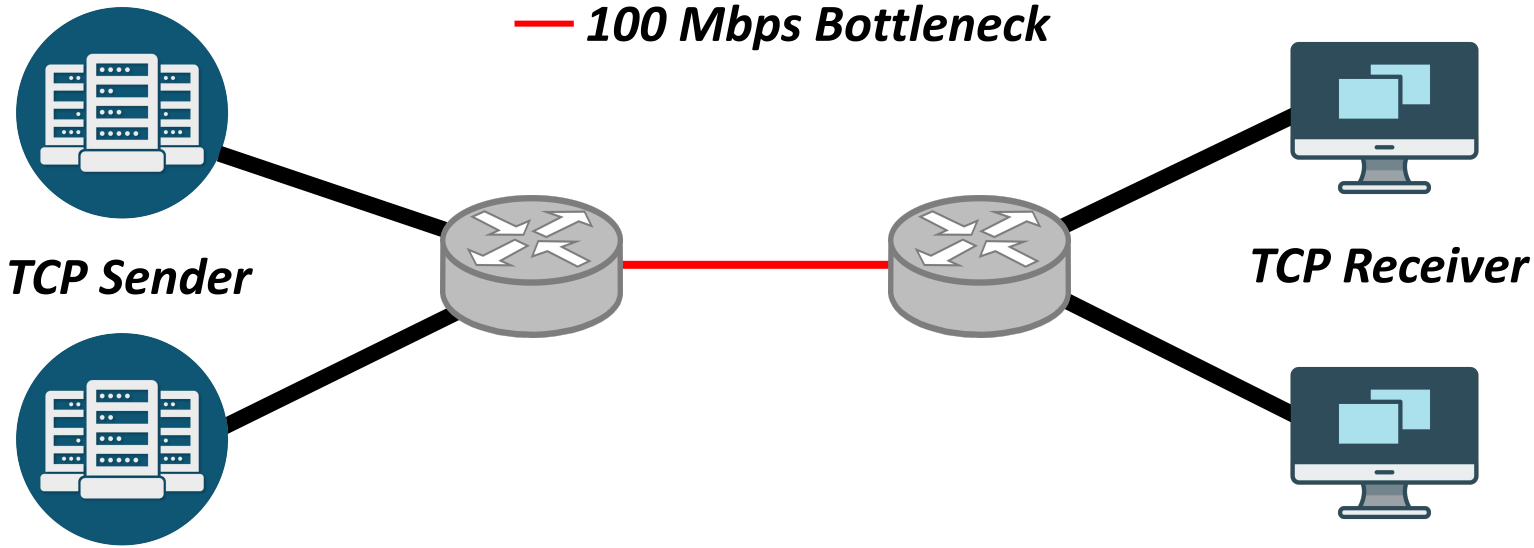


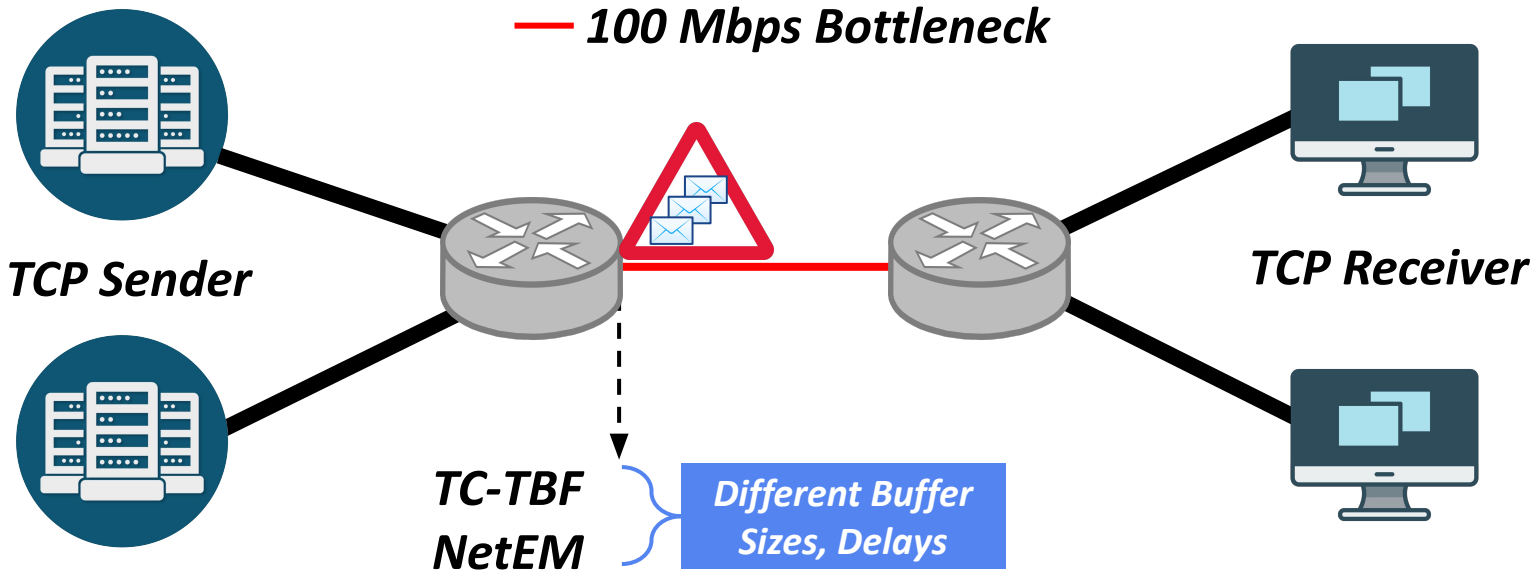
Promises

- Better coexistence with CUBIC/Reno
- Lower retransmit rate
- Reduced latency for different buffer configurations

Evaluation: Testbed setup



Evaluation: Testbed setup

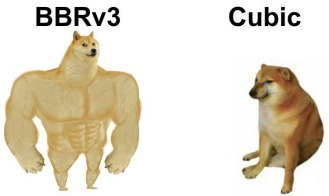


Evaluation scenarios

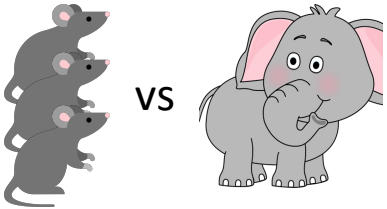
Intra-CCA fairness

RTT fairness

Coexistence with loss-based CCAs



Real-world network traffic



Evaluation scenarios

- Intra-CCA fairness
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Promises and Potential of BBRv3

Danesh Zeynali[1], Emilia N. Weyulu[1], Seifeddine Fathalli[1], Balakrishnan Chandrasekaran[2], and Anja Feldmann[1]

[1] Max-Planck-Institut für Informatik
{dzeynali,eweyulu,fathalli,anja}@mpi-inf.mpg.de
[2] Vrije Universiteit Amsterdam b.chandrasekaran@vu.nl

Passive and Active Measurement (PAM) 2024

Evaluation scenarios

Intra-CCA fairness

RTT fairness

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Real-world network traffic

Promises and Potential of BBRv3

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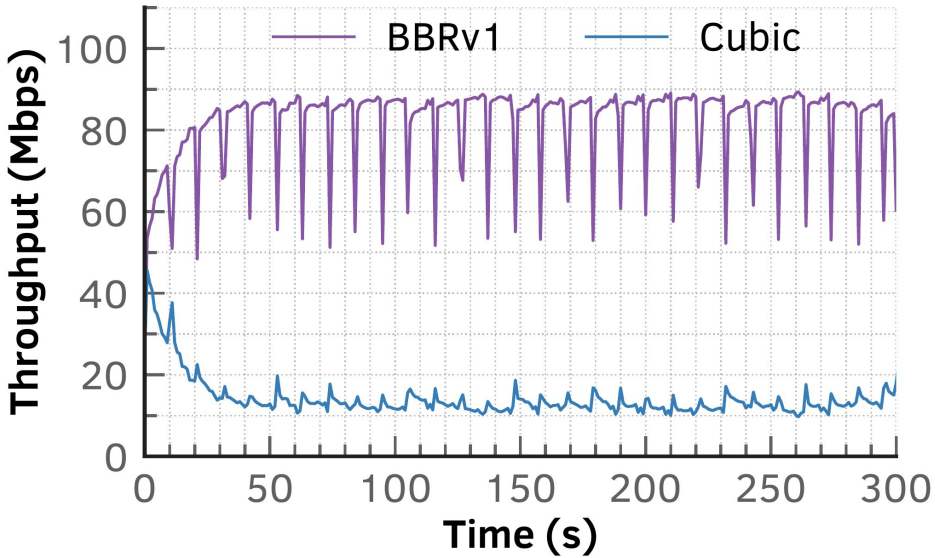
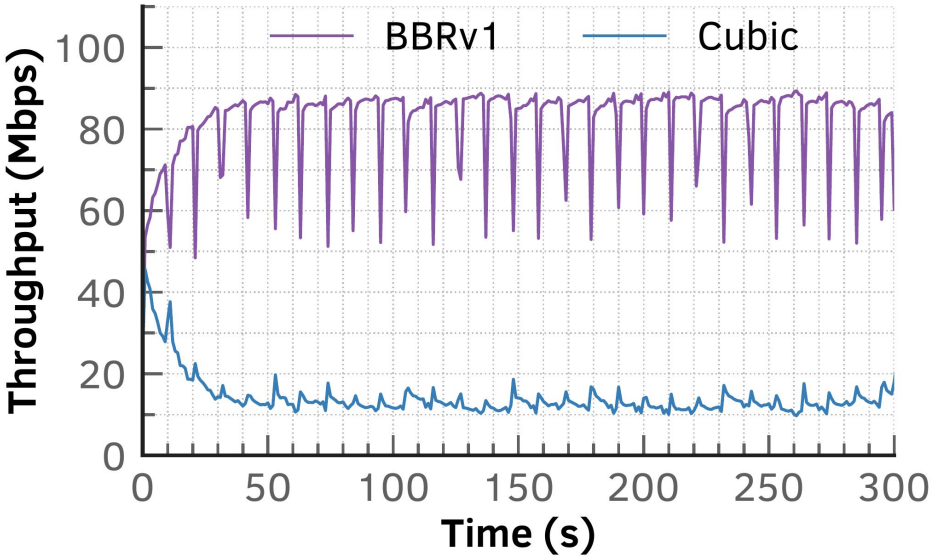
Passive and Active Measurement (PAM) 2024

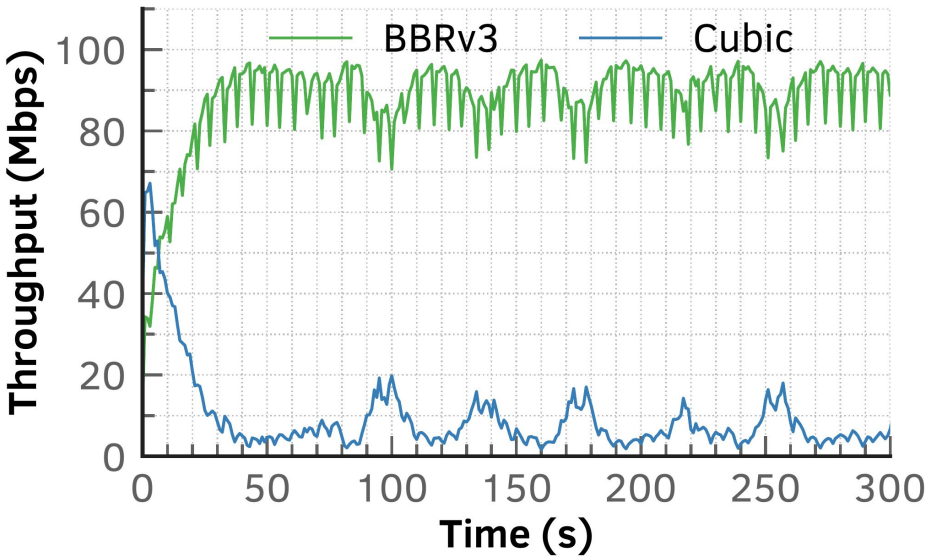
Does BBRv3 coexist well with Cubic?

Coexistence with Cubic: 1xBDP buffer

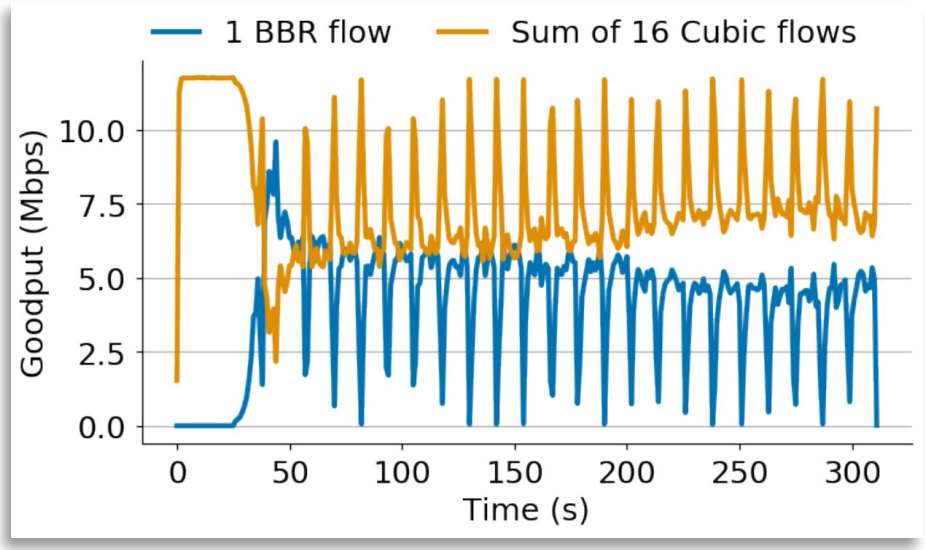


Coexistence with Cubic: 1xBDP buffer



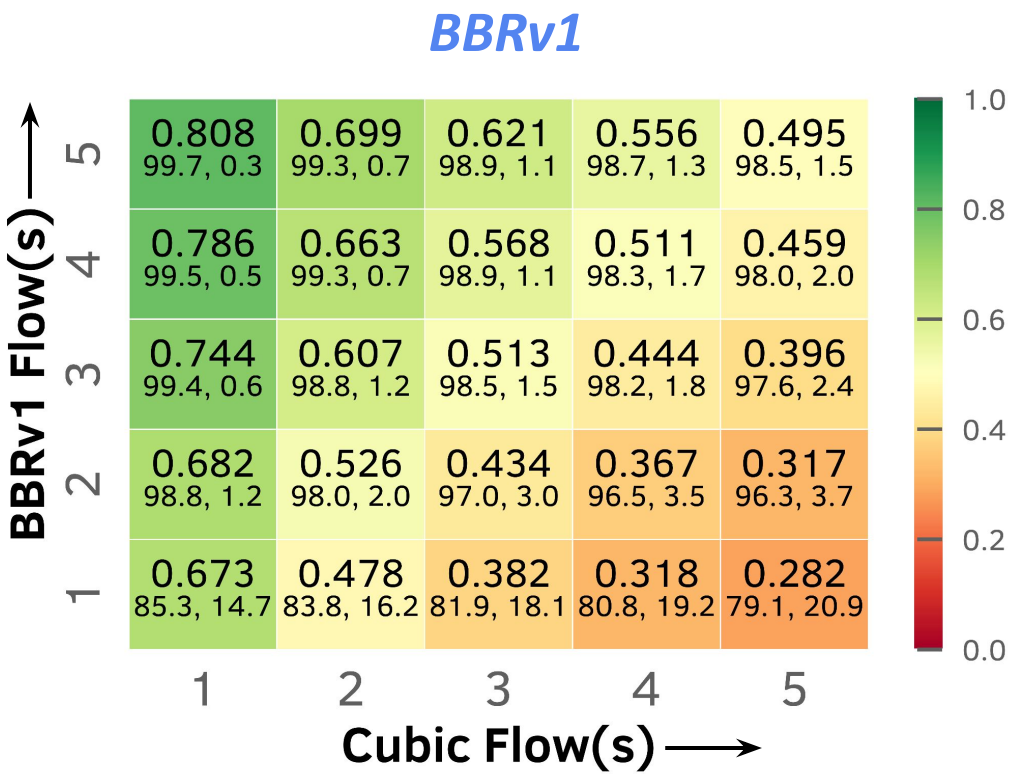


Single BBR flow competing with multiple Cubic flows



Ware, R.,et. al, : Modeling BBR's Interactions with Loss-Based Congestion Control. ACM IMC '19

Inter-CCA fairness



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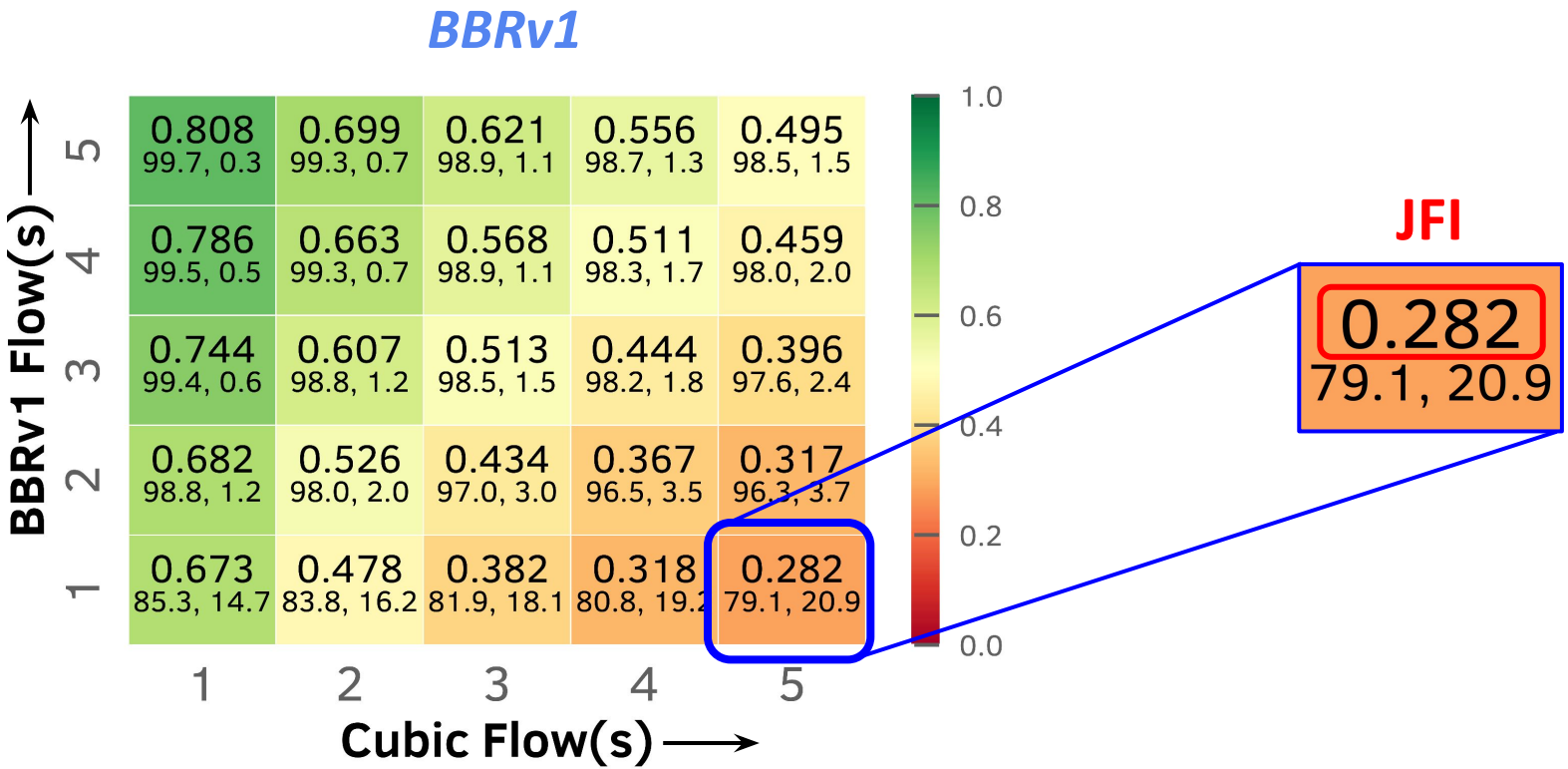

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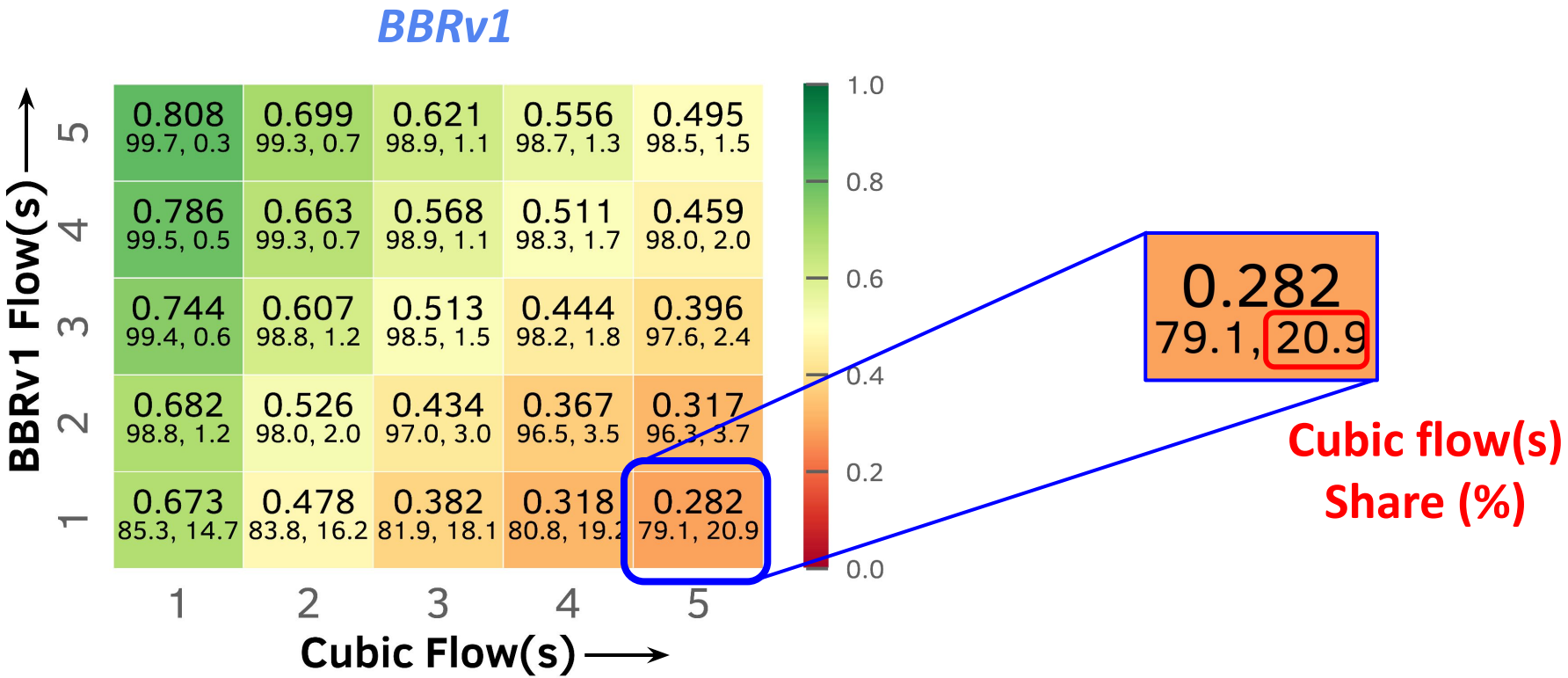

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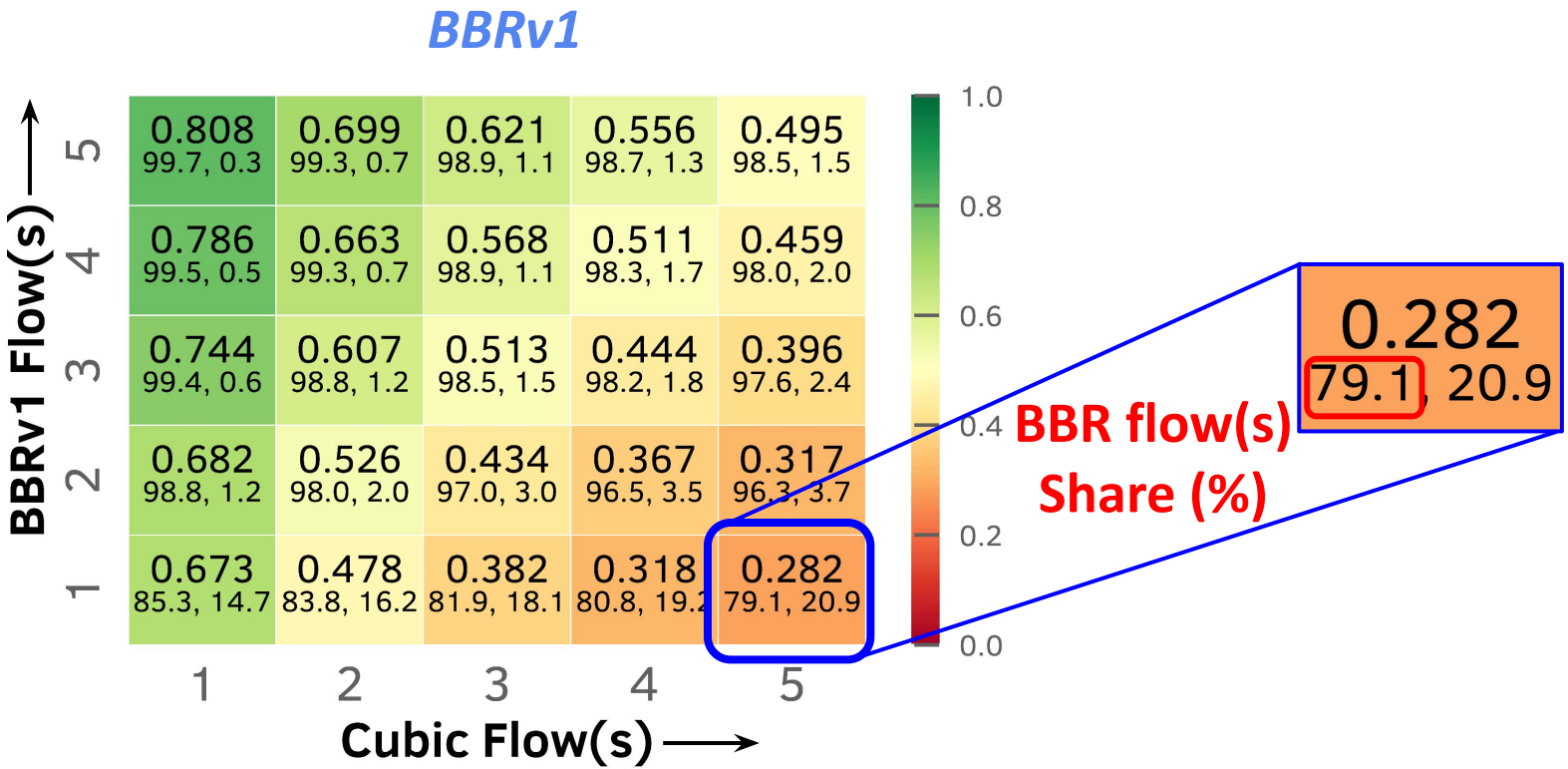
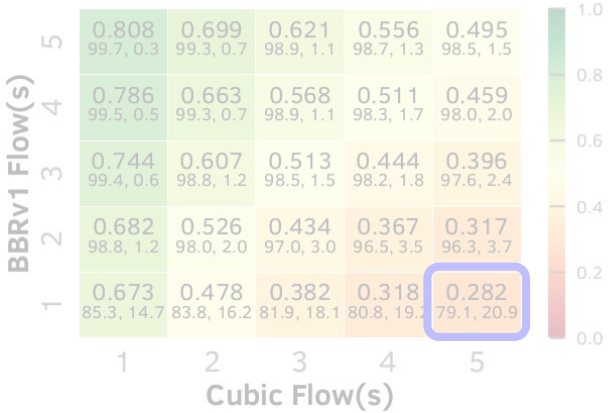


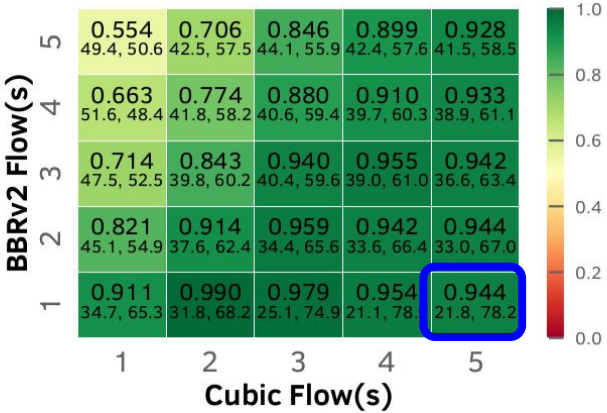
Inter-CCA fairness

BBRv1



0.282
79.1, 20.9

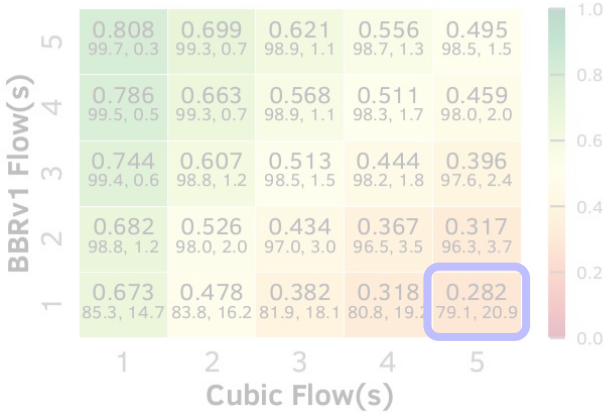
BBRv2



0.944
21.8, 78.2

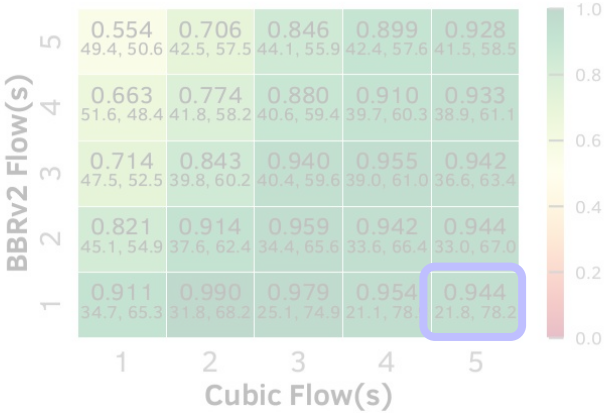
Inter-CCA fairness

BBRv1



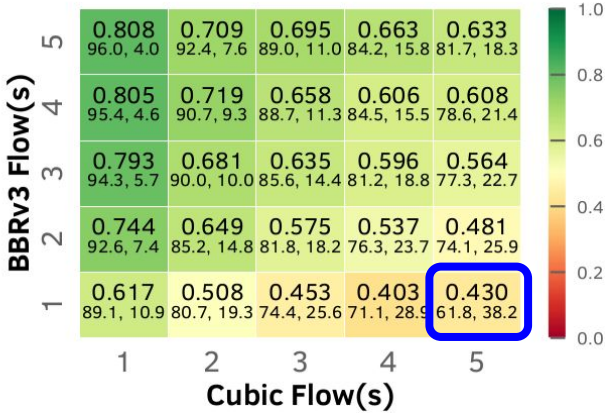
0.282
79.1, 20.9

BBRv2



0.944
21.8, 78.2

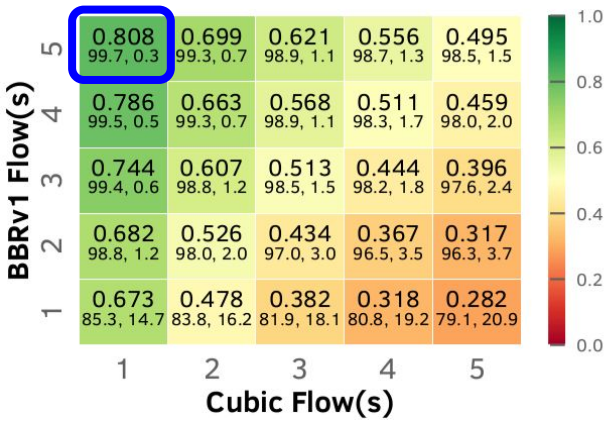
BBRv3



0.430
61.8, 38.2

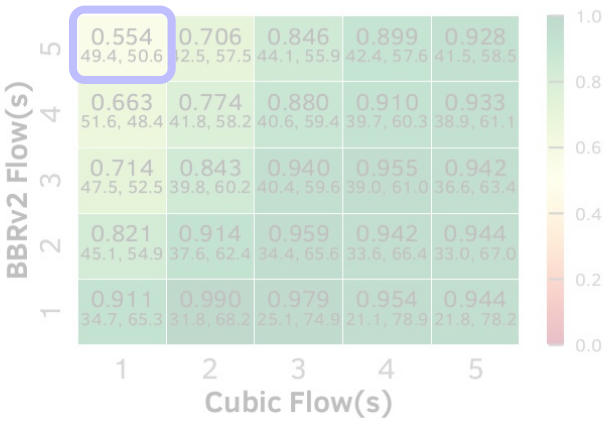
Inter-CCA fairness

BBRv1



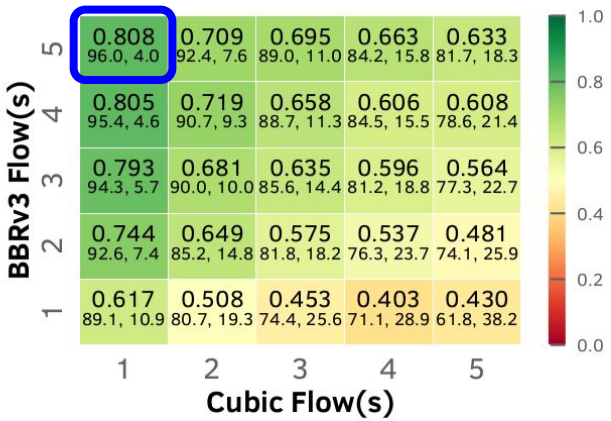
0.808
99.7, 0.3

BBRv2



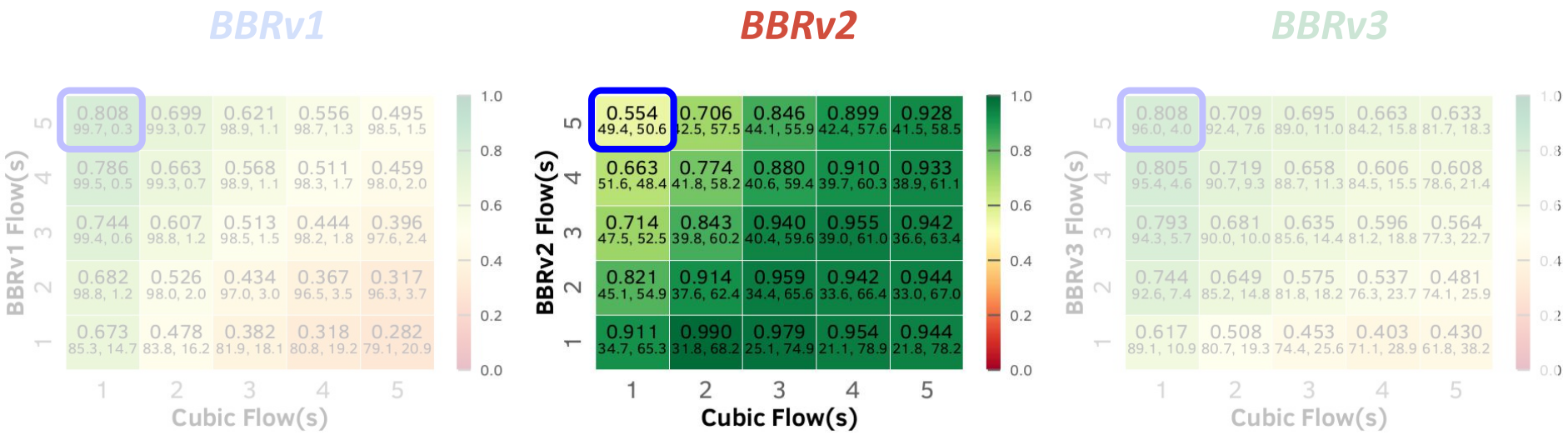
0.554
49.4, 50.6

BBRv3



0.808
96.0, 4.0

Inter-CCA fairness



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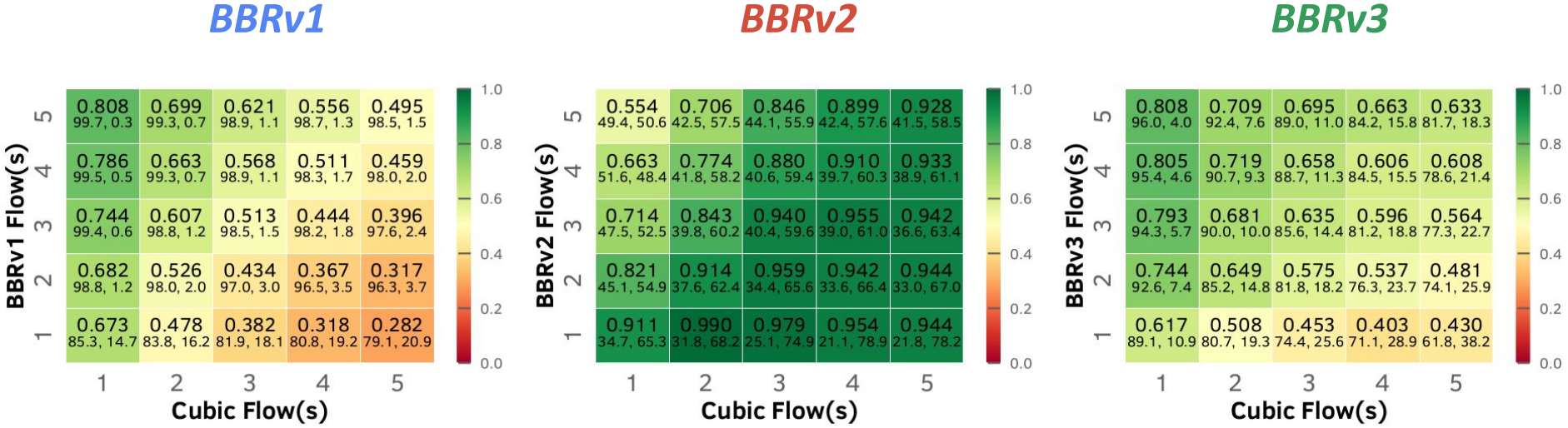

BBRv3 shows unfairness towards multiple Cubic flows as seen with BBRv1

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BBRv3

- Fix BW convergence with/without loss and/or ECN marks
- Performance tuning

2016 — 2019 — 2023

BBRv2

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Explicit Congestion Notification (ECN)

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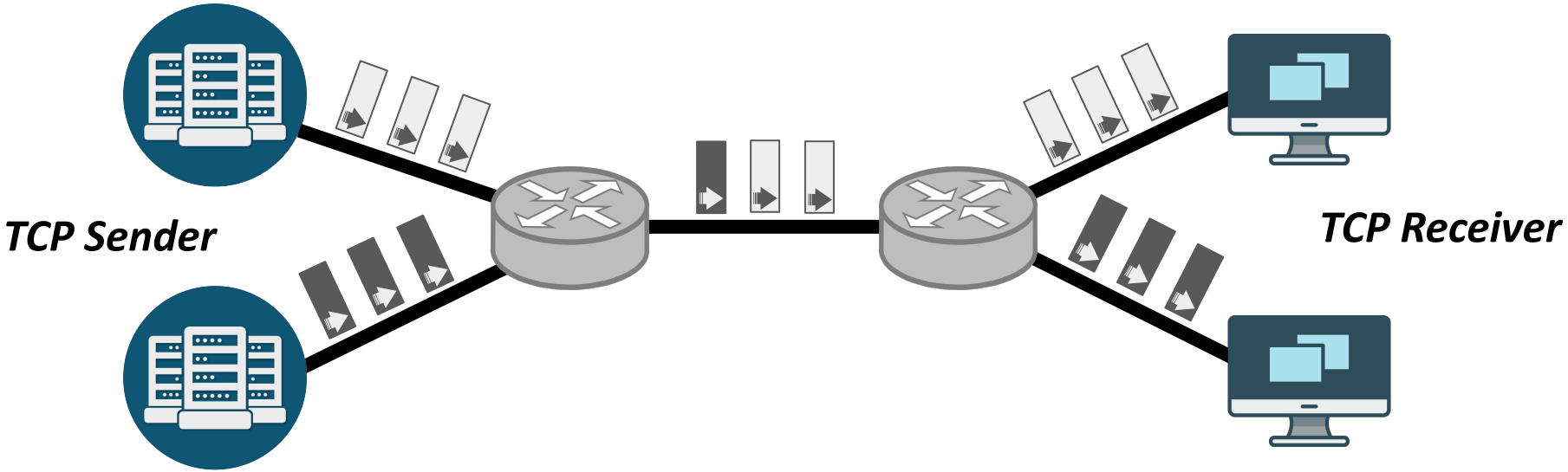

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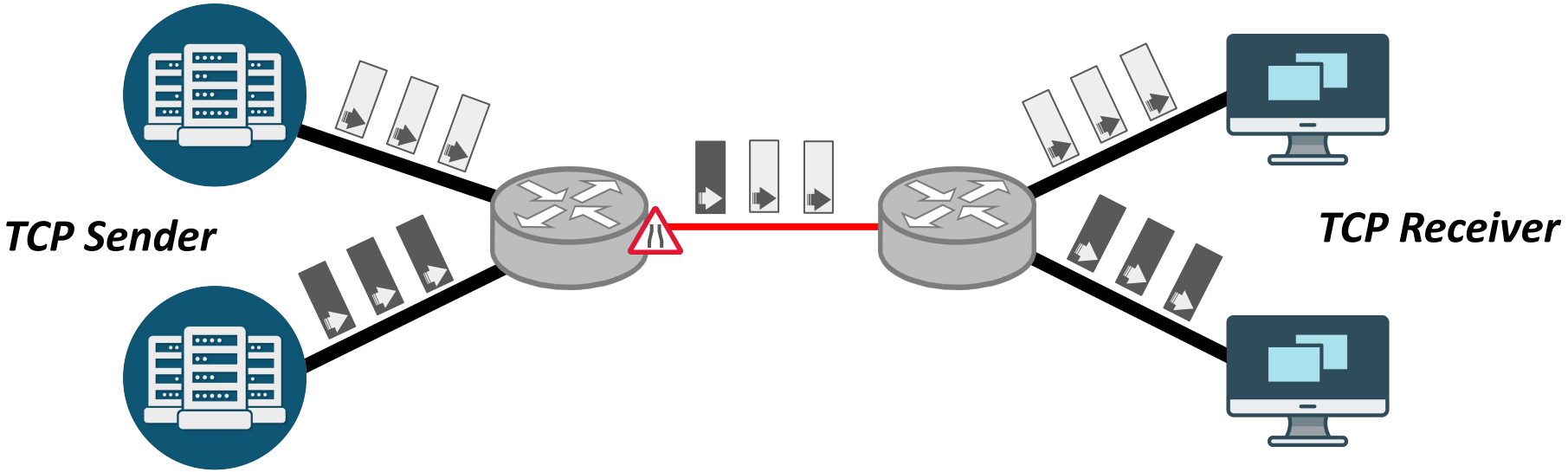

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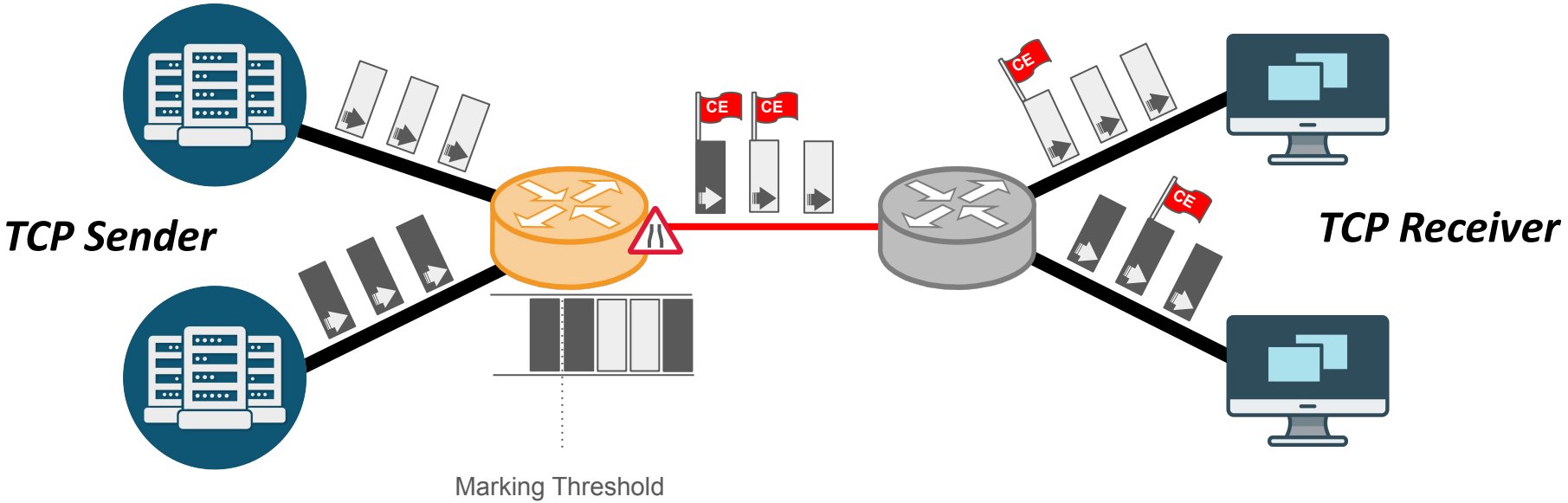
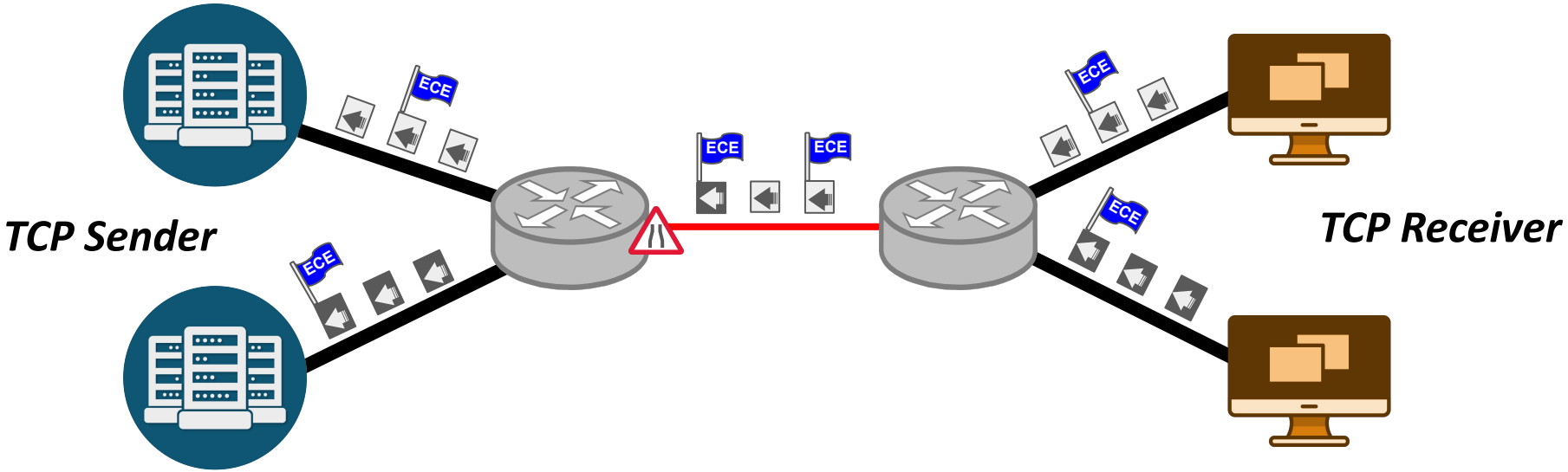


Explicit Congestion Notification (ECN)



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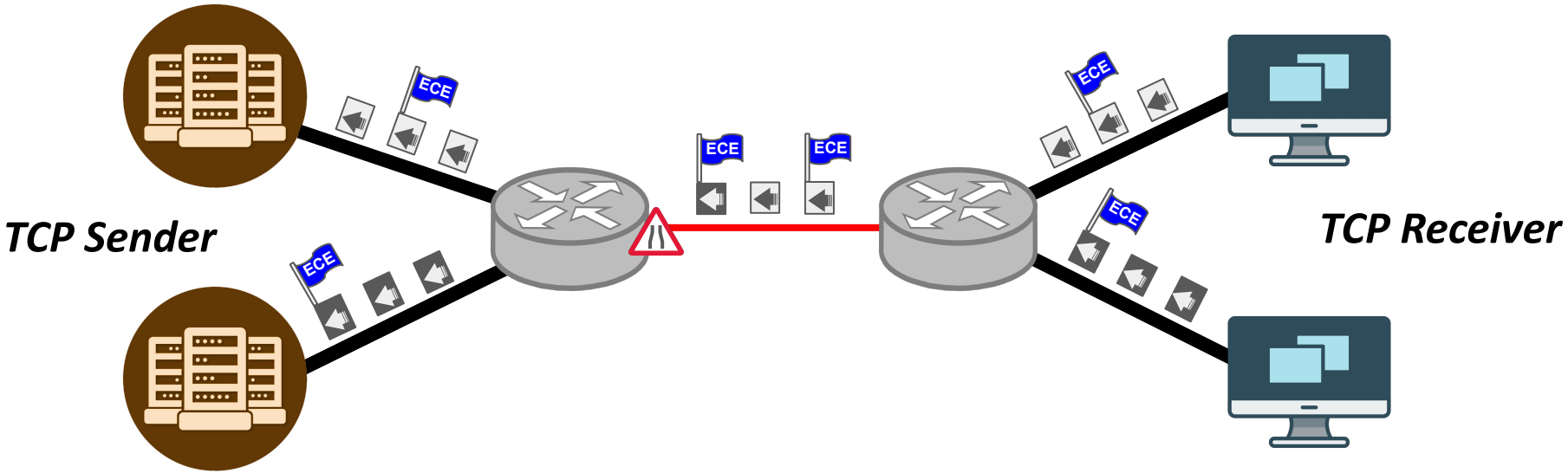


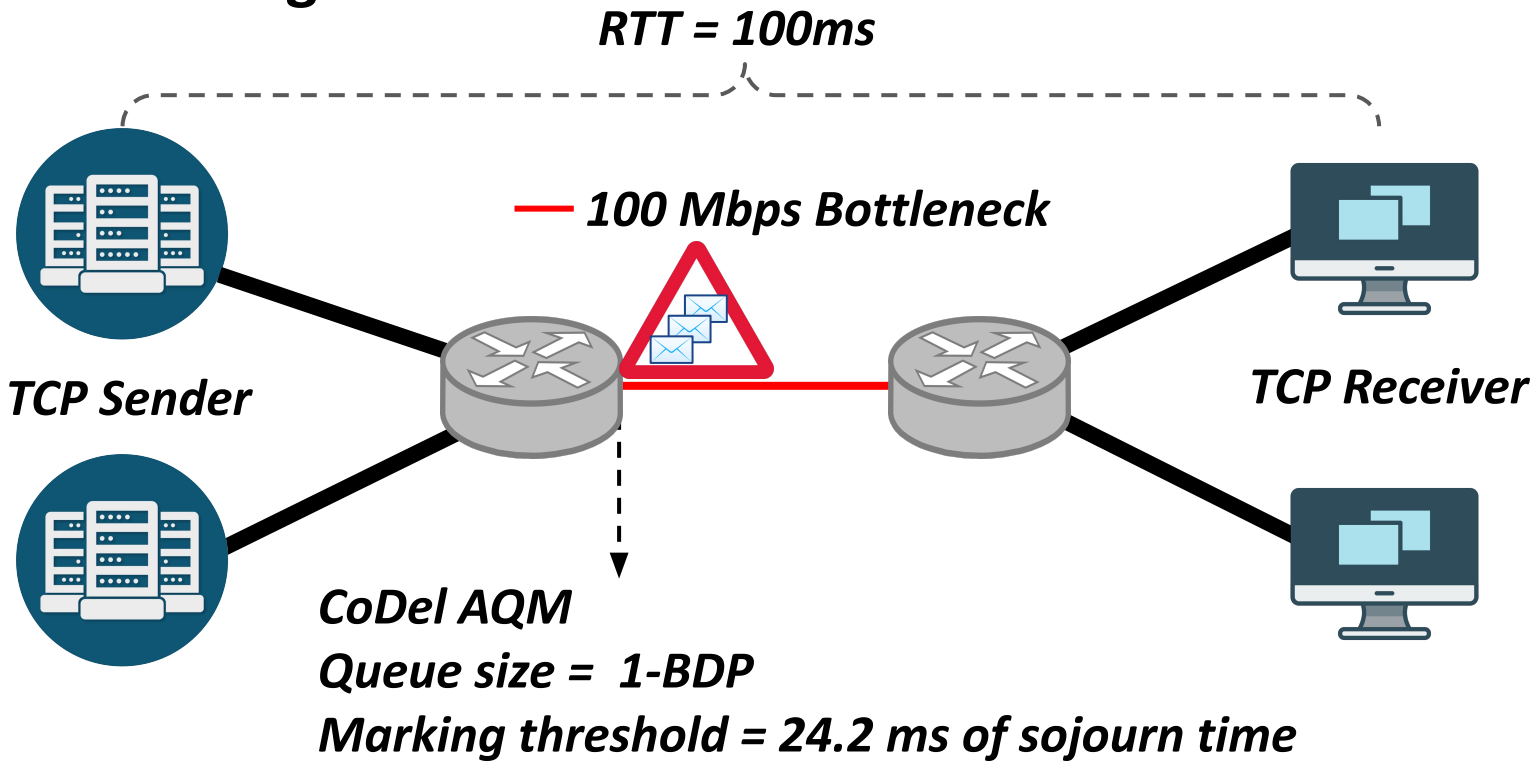
Testbed Configuration

What's new in BBR v2: a summary

	CUBIC	BBR v1	BBR v2
Model parameters to the state machine	N/A	Throughput, RTT	Throughput, RTT, max aggregation, max inflight
Loss	Reduce cwnd by 30% on window with any loss	N/A	Explicit loss rate target
ECN	RFC3168 (Classic ECN)	N/A	DCTCP-inspired ECN
Startup	Slow-start until RTT rises (Hystart) or any loss	Slow-start until tput plateaus	Slow-start until tput plateaus or ECN/loss rate > target

* Neal Cardwell, Yuchung Cheng, Soheil Hassas Yeganeh, Ian Swett,, Victor Vasiliev, Matt Mathis Bin Wu, Priyaranjan Jha, Yousuk Seung, and Van Jacobson. 2019. BBR v2: A Model-based Congestion Control IETF 105 Update. Technical Report. [IETF 105; ICCRG].

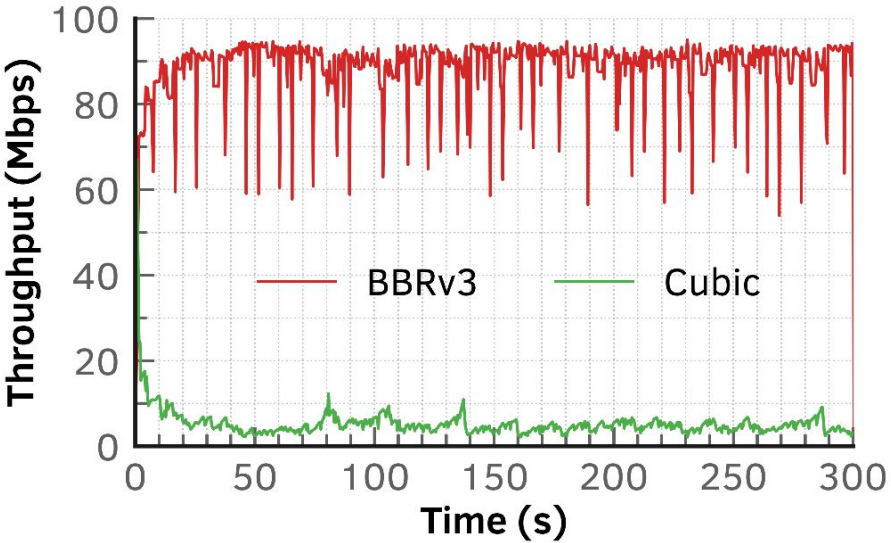
Testbed Configuration



* Neal Cardwell, Yuchung Cheng, Soheil Hassas Yeganeh, Ian Swett,, Victor Vasiliev, Matt Mathis Bin Wu, Priyaranjan Jha, Yousuk Seung, and Van Jacobson. 2019. BBR v2: A Model-based Congestion Control IETF 105 Update. Technical Report. [IETF 105; ICCRG].

Does BBRv3 coexist well with Cubic With ECN marking?

Coexistence with Cubic: 1xBDP buffer



ECN disabled

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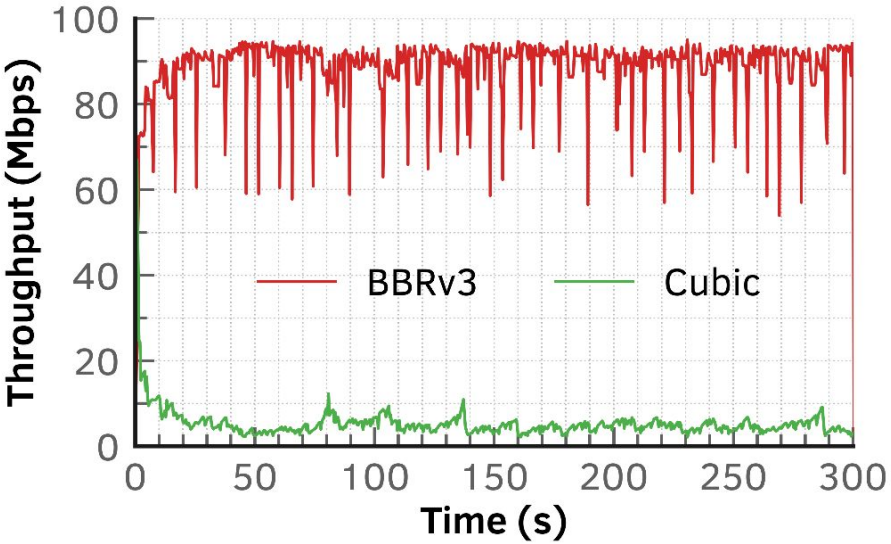

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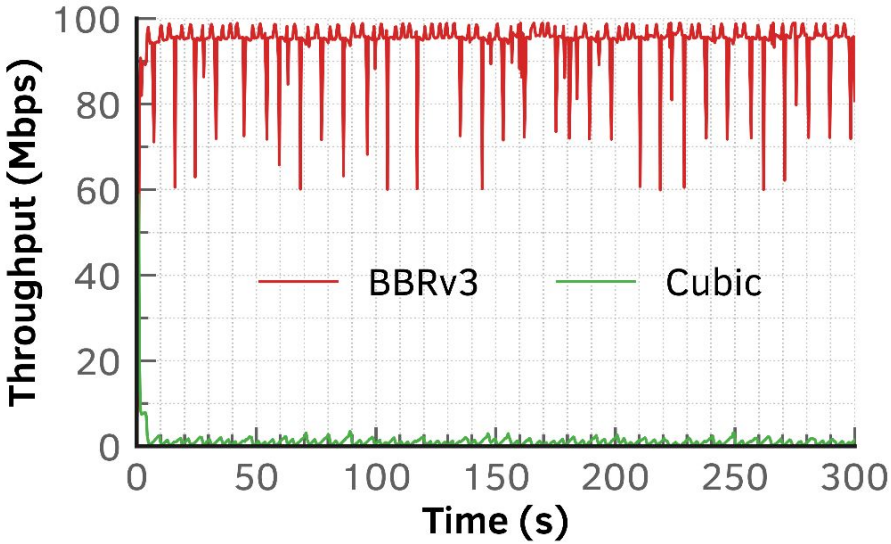
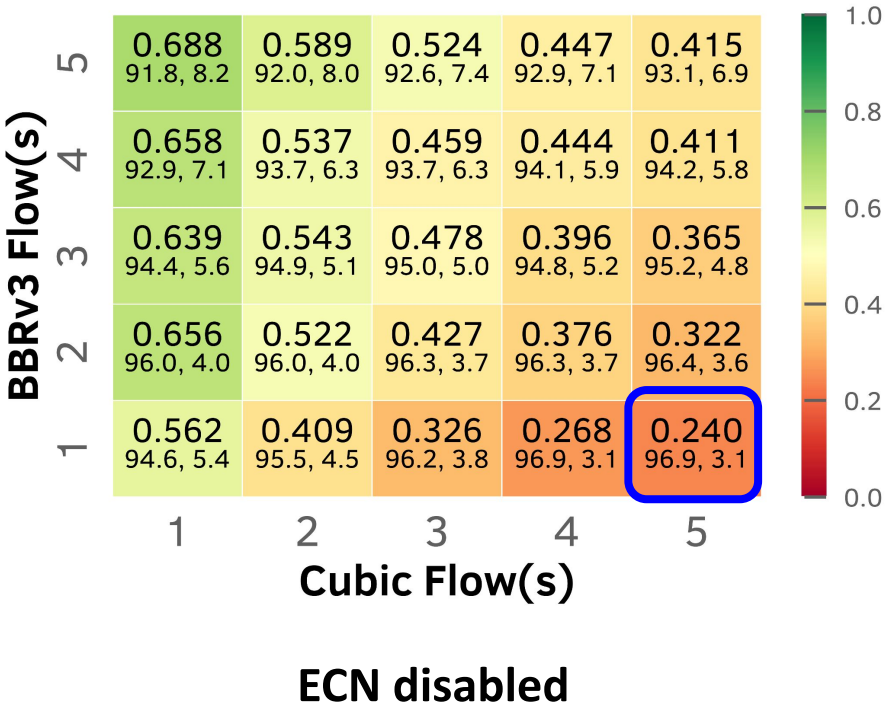


ECN enabled

Coexistence with Cubic: 1xBDP buffer



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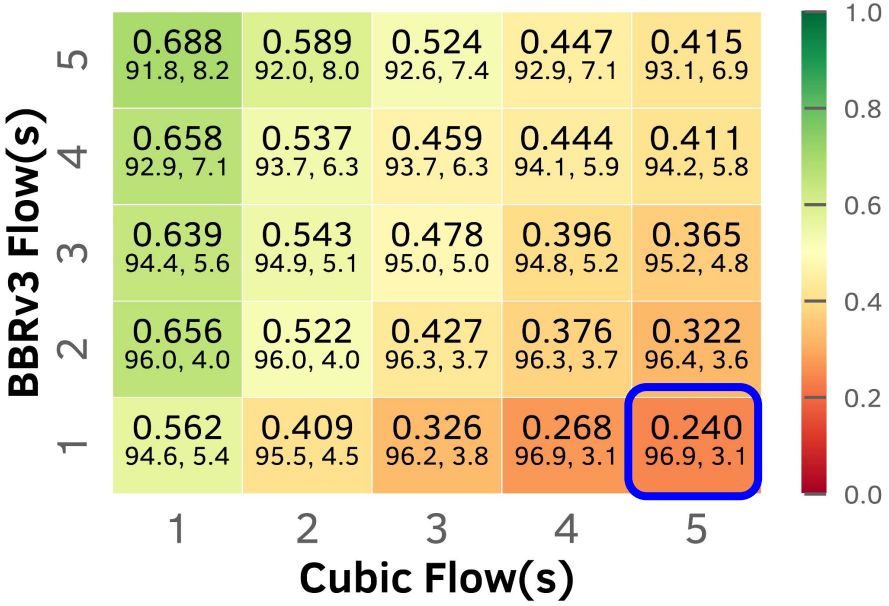
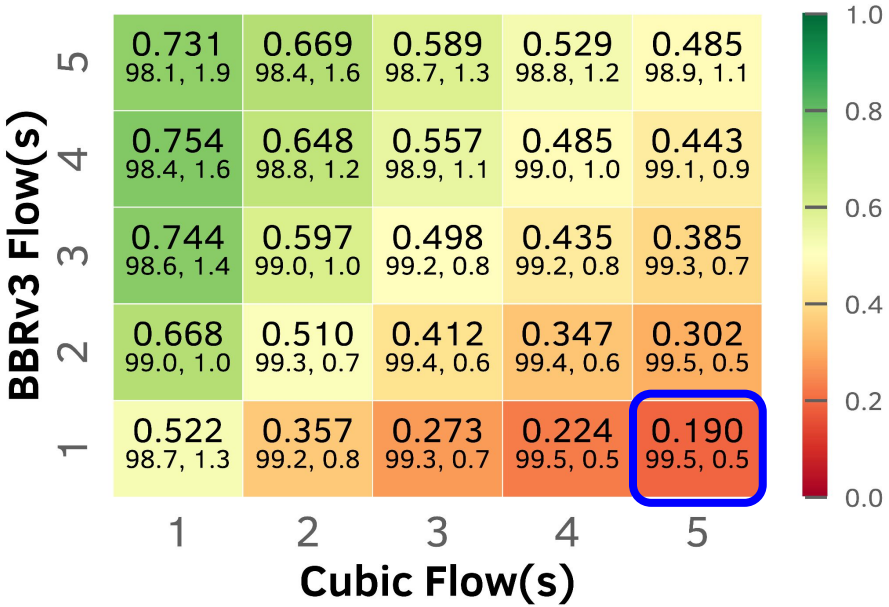
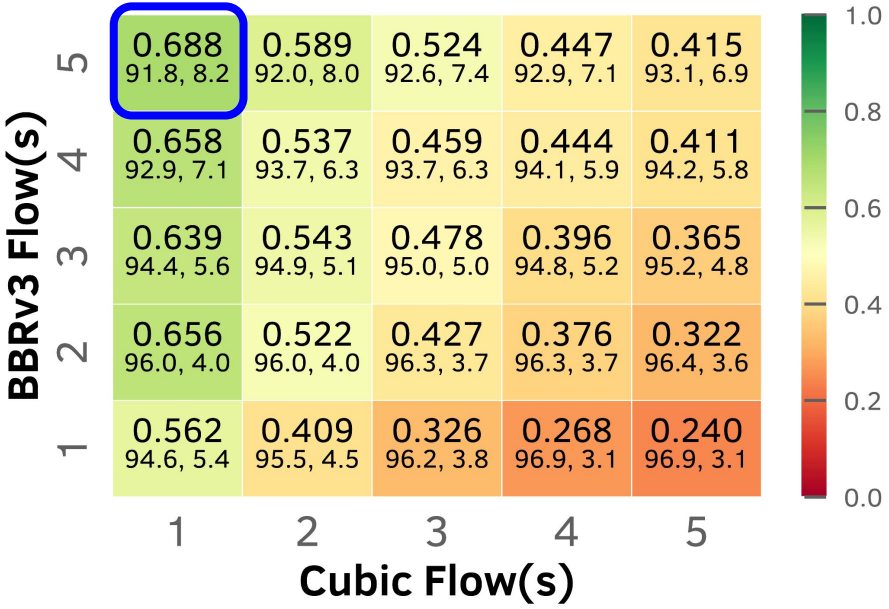


ECN disabled



ECN enabled

Coexistence with Cubic: 1xBDP buffer



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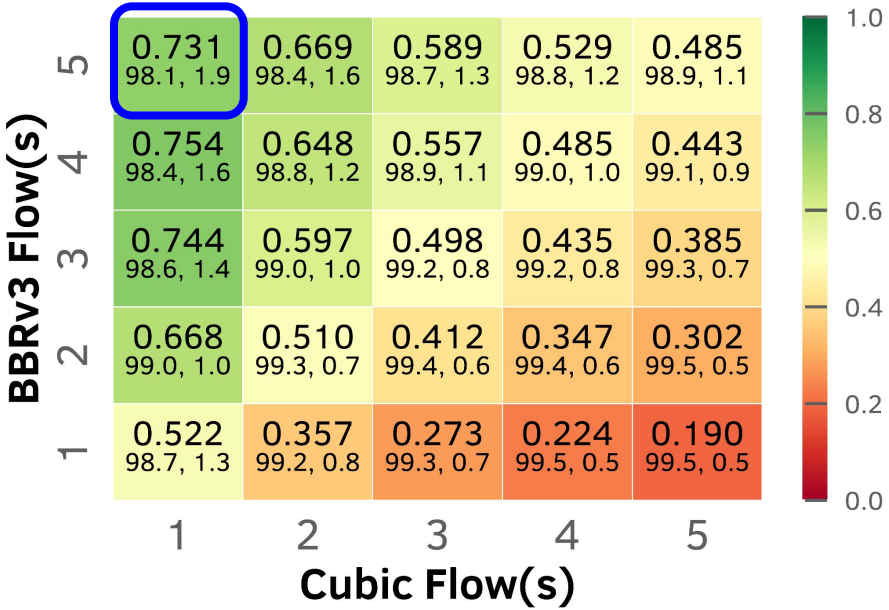

ECN enabled

Conclusion

Does BBRv3 coexist well with Cubic?

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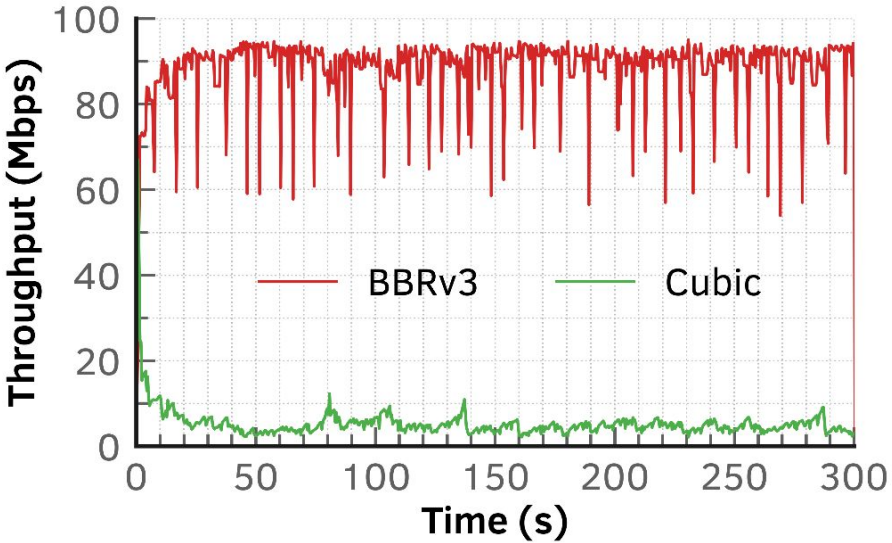

Conclusion

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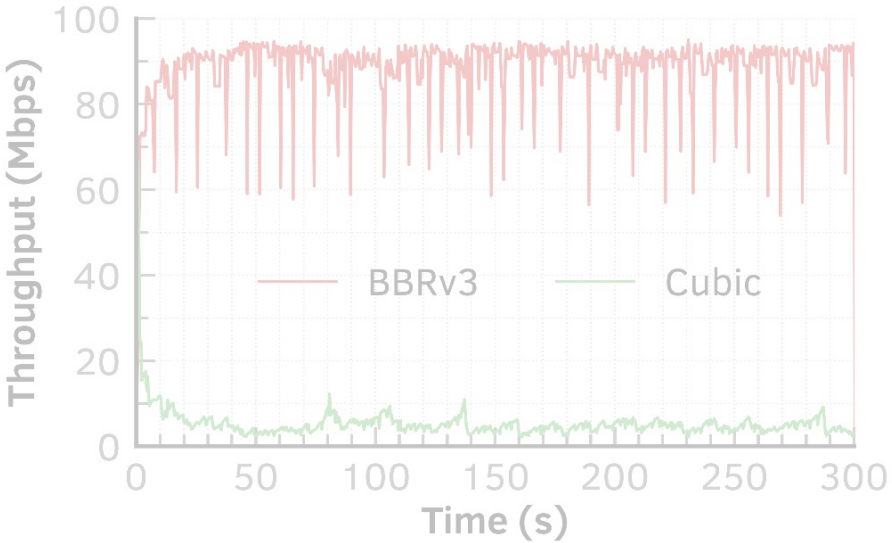

Does ECN improve the fairness?

Conclusion

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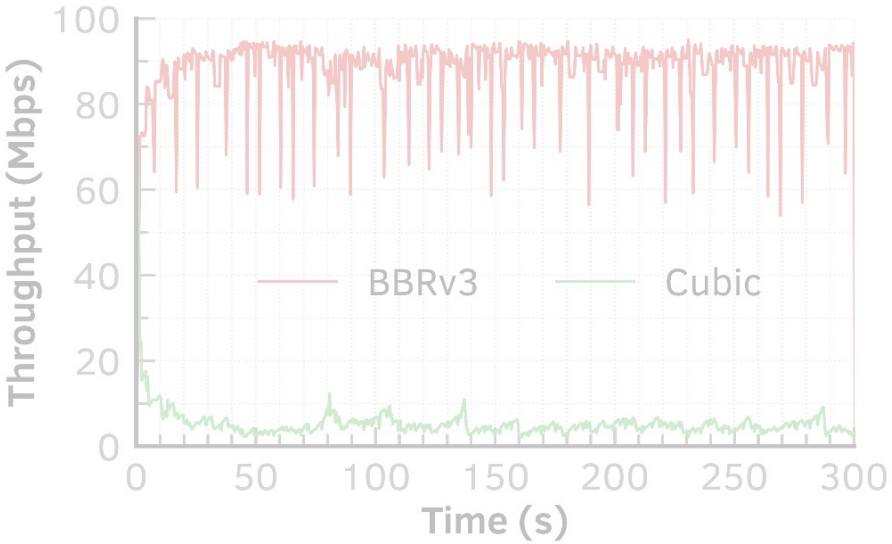
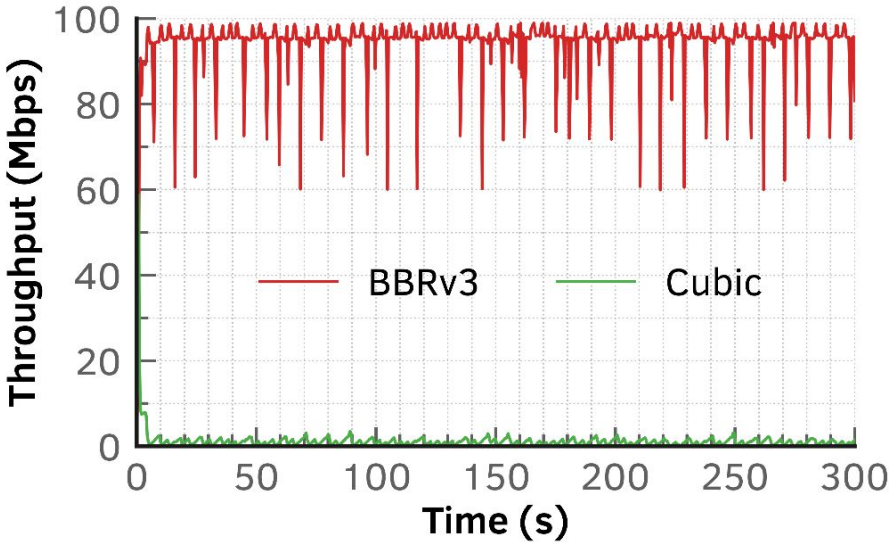


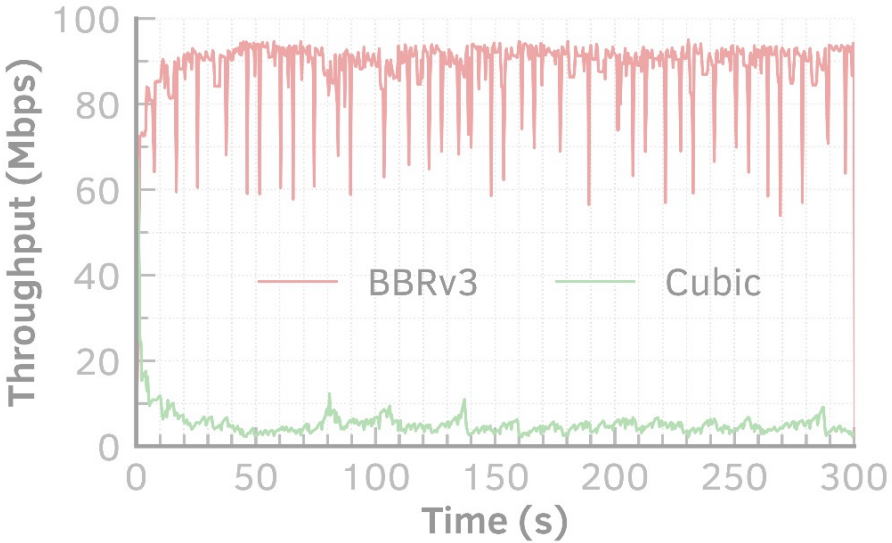
Does ECN improve the fairness?



Conclusion

inet-bbrv3eval.mpi-inf.mpg.de
tinyurl.com/bbrv3eval

Does BBRv3 coexist well with Cubic?



Does ECN improve the fairness?