An experimental study of the learnability of congestion control

Anirudh Sivaraman, Keith Winstein, Pratiksha Thaker, Hari Balakrishnan

MIT CSAIL

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Designing congestion-control protocols today

- Formulate a mental model of the target network and application workload
- Decide on the protocol's goal
- Design a protocol to achieve this goal on the target network
- Model and goal can either be implicit or explicit

But, the model is always wrong ...

- Bufferbloat when queues are incorrectly sized
- Diminished fairness and unpredictability in small-packet regimes
- Incast in datacenters
- Lost throughput under stochastic loss

Our work

- Can we formalize this design process?
- Quantify consequences of model mismatch

Approach

- Specify a *training scenario* for training.
  - Topology
  - Locations of senders and receiver
  - Application workload
  - Buffer size and queuing discipline
- Specify an *objective function*
- Synthesize a protocol using an automated protocol-synthesis tool, Remy [**?**]
- Evaluate on a *testing scenario* inside ns-2
- Difference between training and testing scenario represents model imperfection

Automated protocol synthesis

- Find best protocol for an imperfect network model.
- Problem is NEXP-complete.
- Rely on Remy to produce Tractable Attempts at Optimal (TAO) congestion-control protocols.

Tractable Attempts at Optimal

- Just how suboptimal are these TAO protocols?
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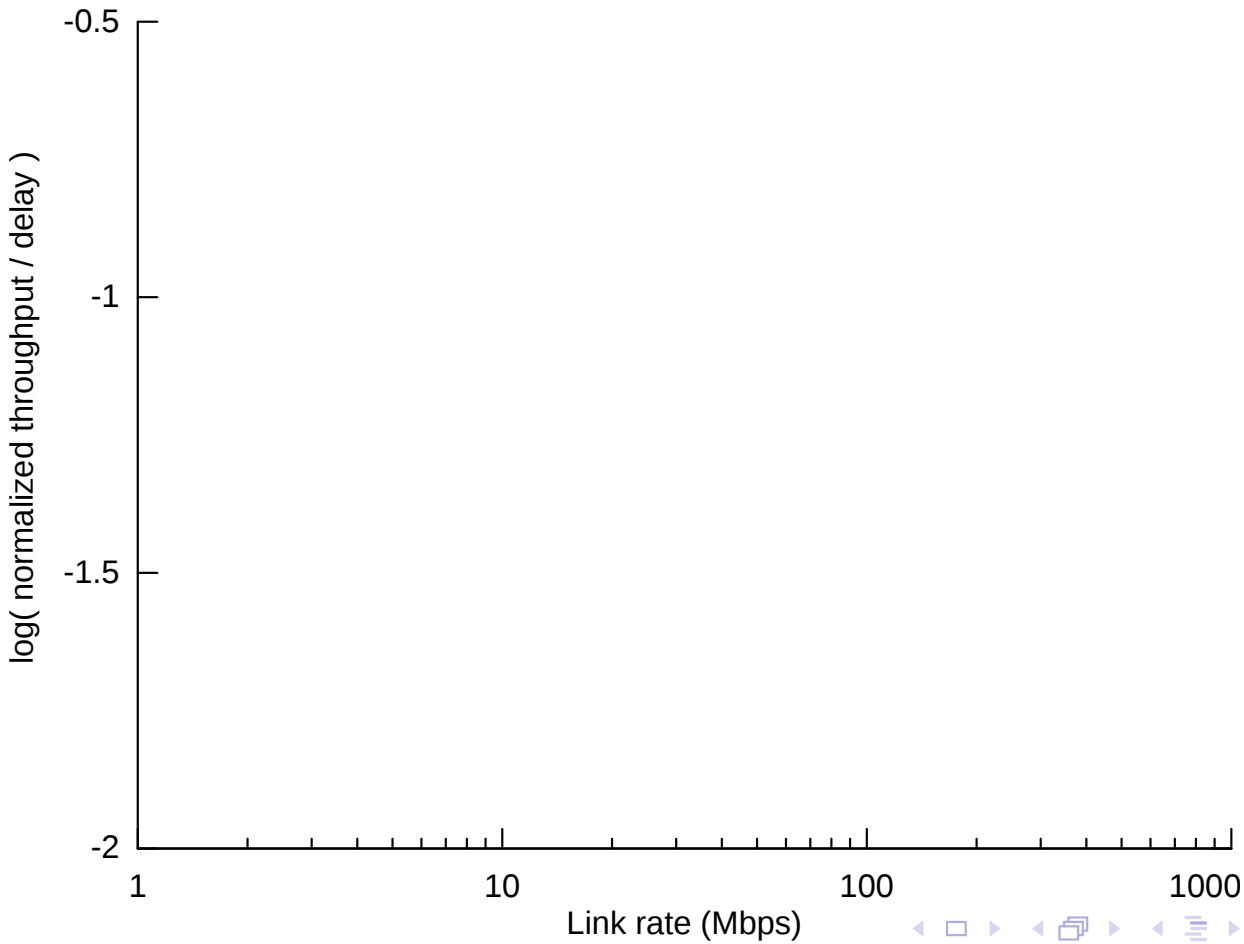
The cost of generality, or forwards-compatibility



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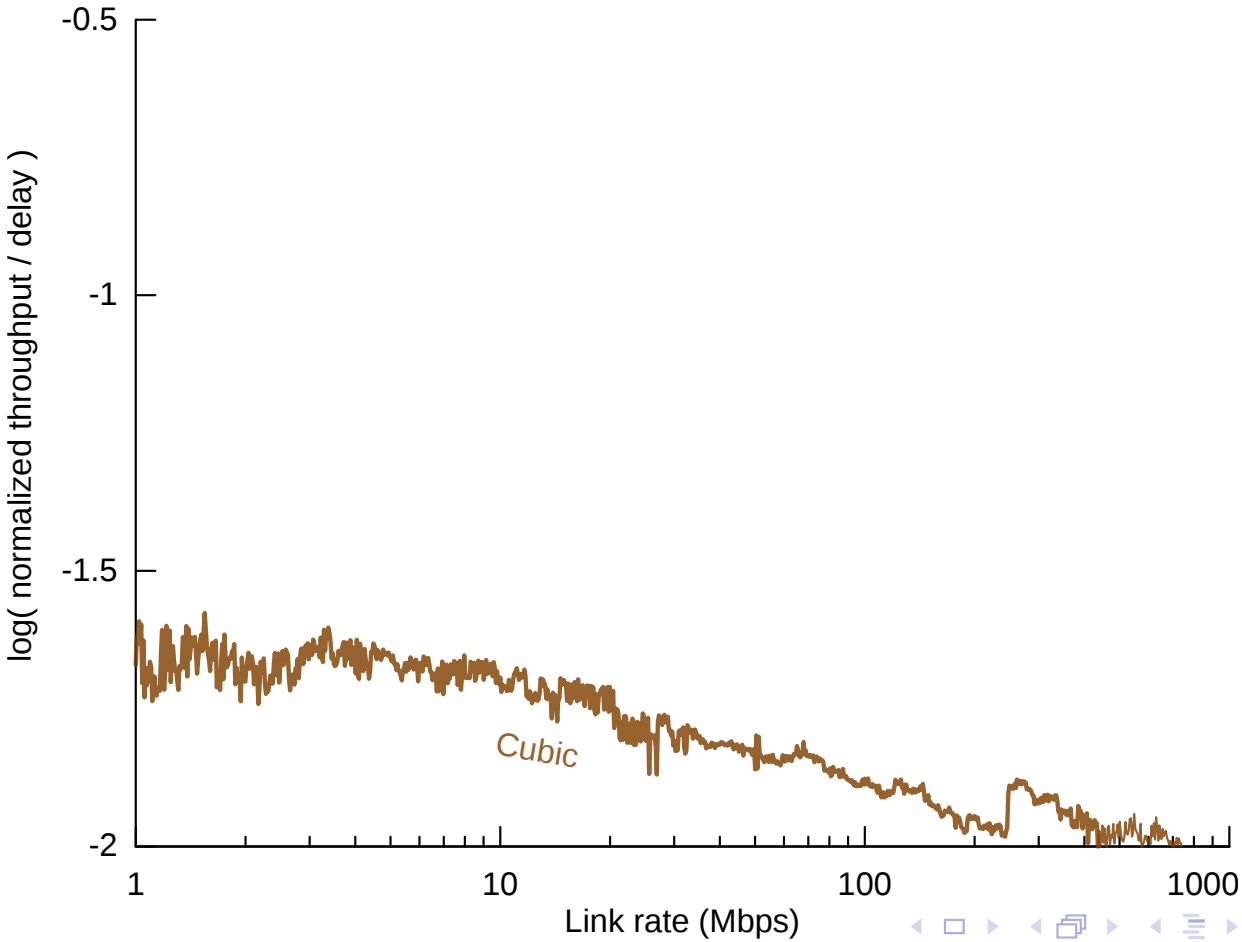

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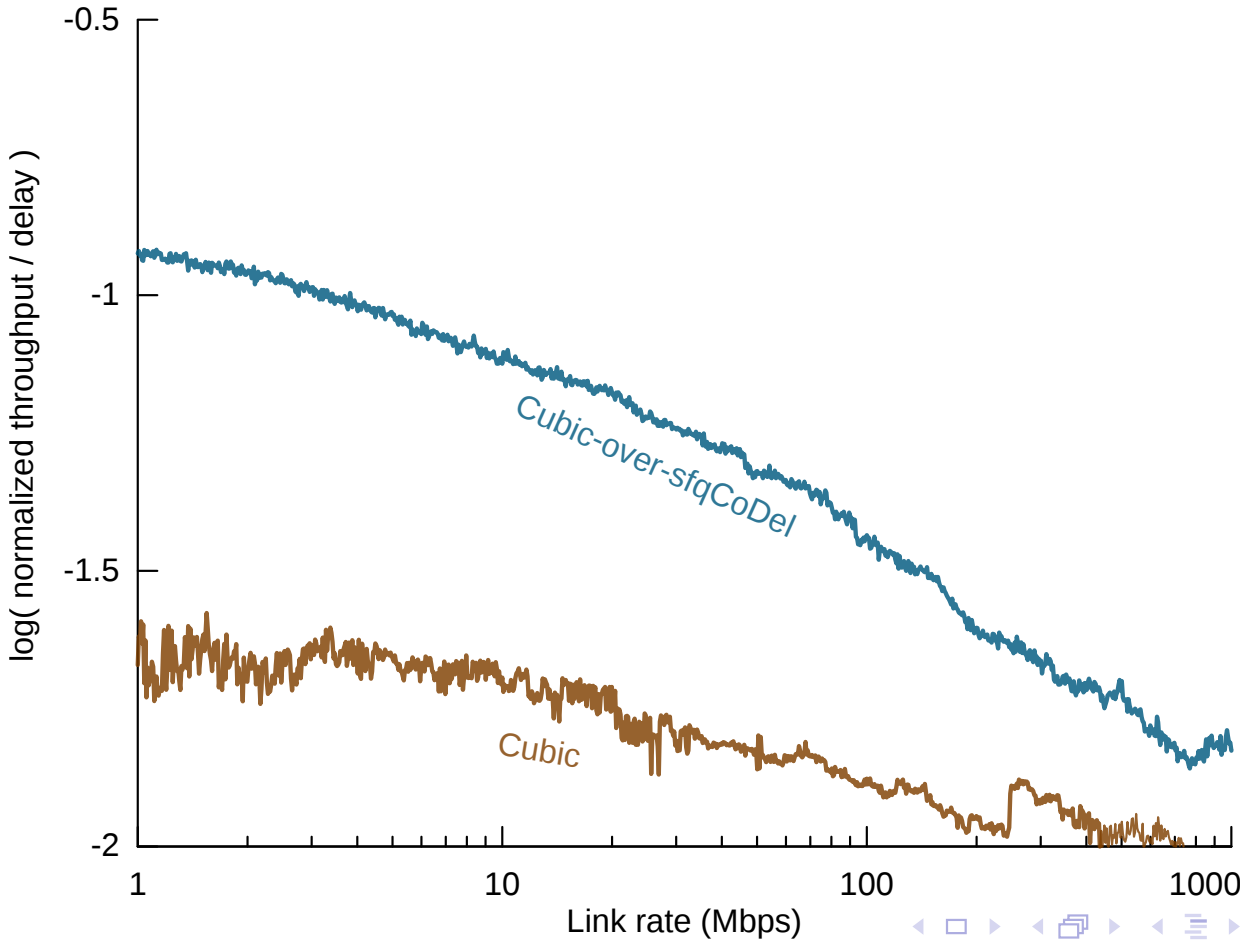

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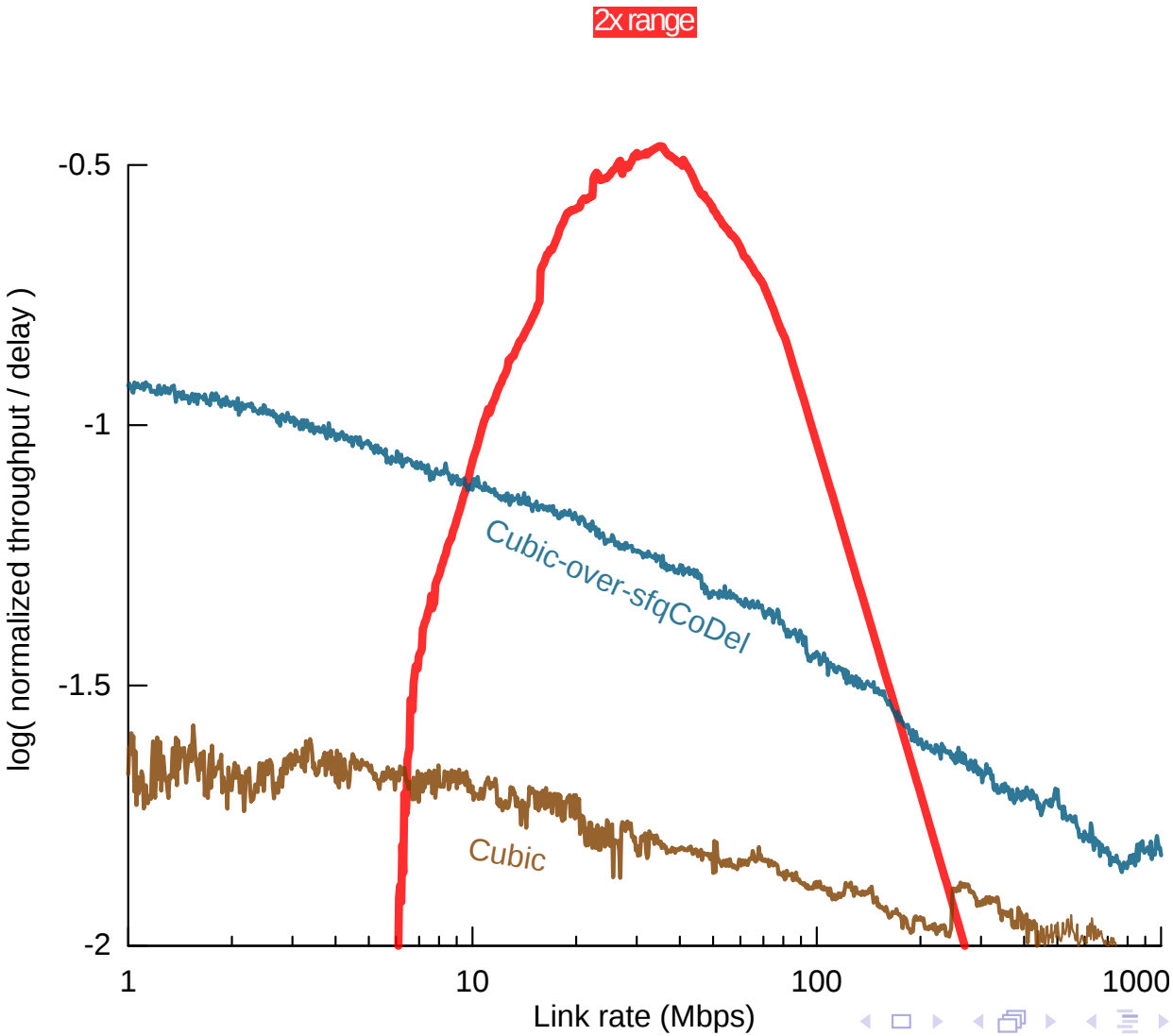

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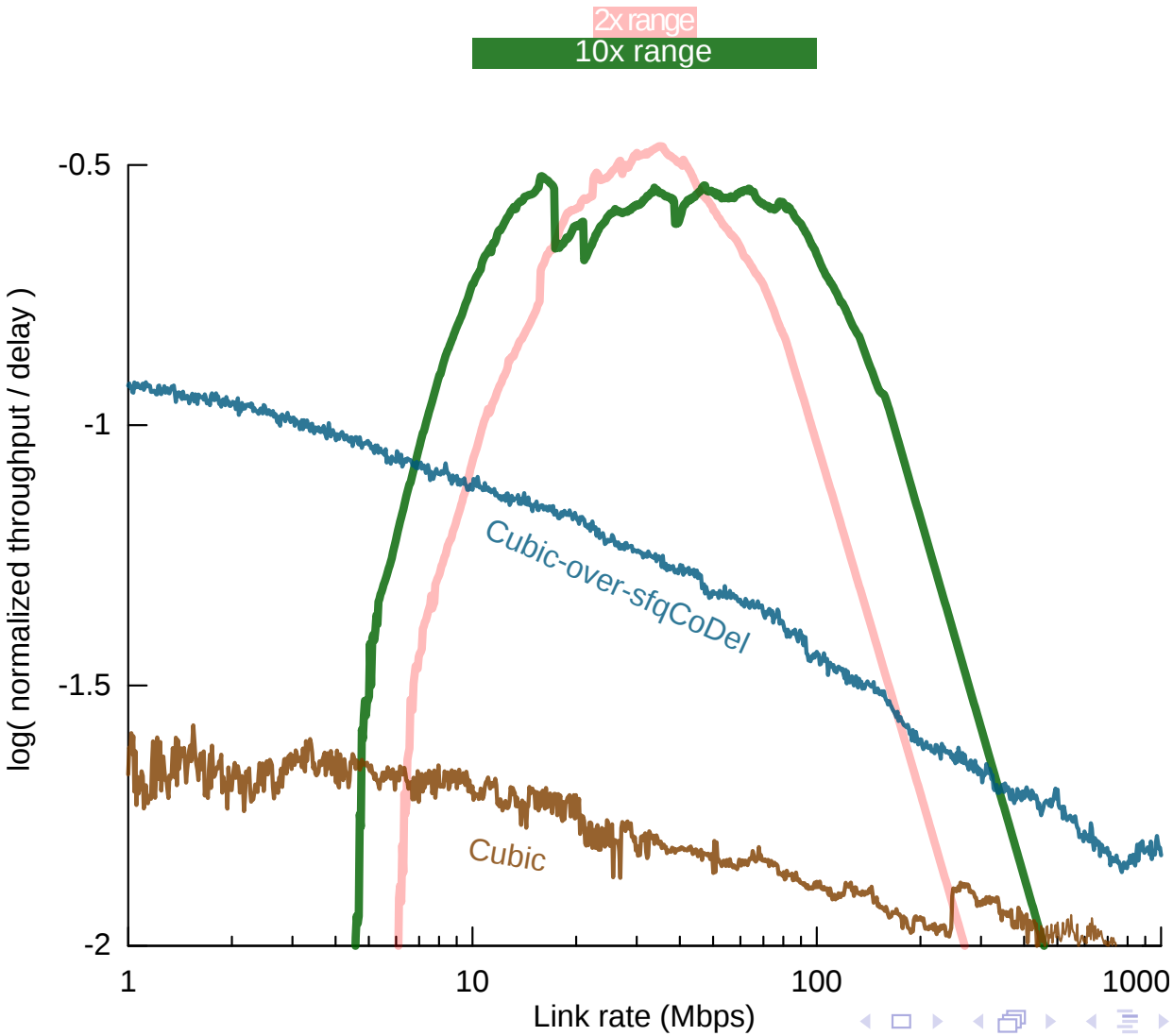

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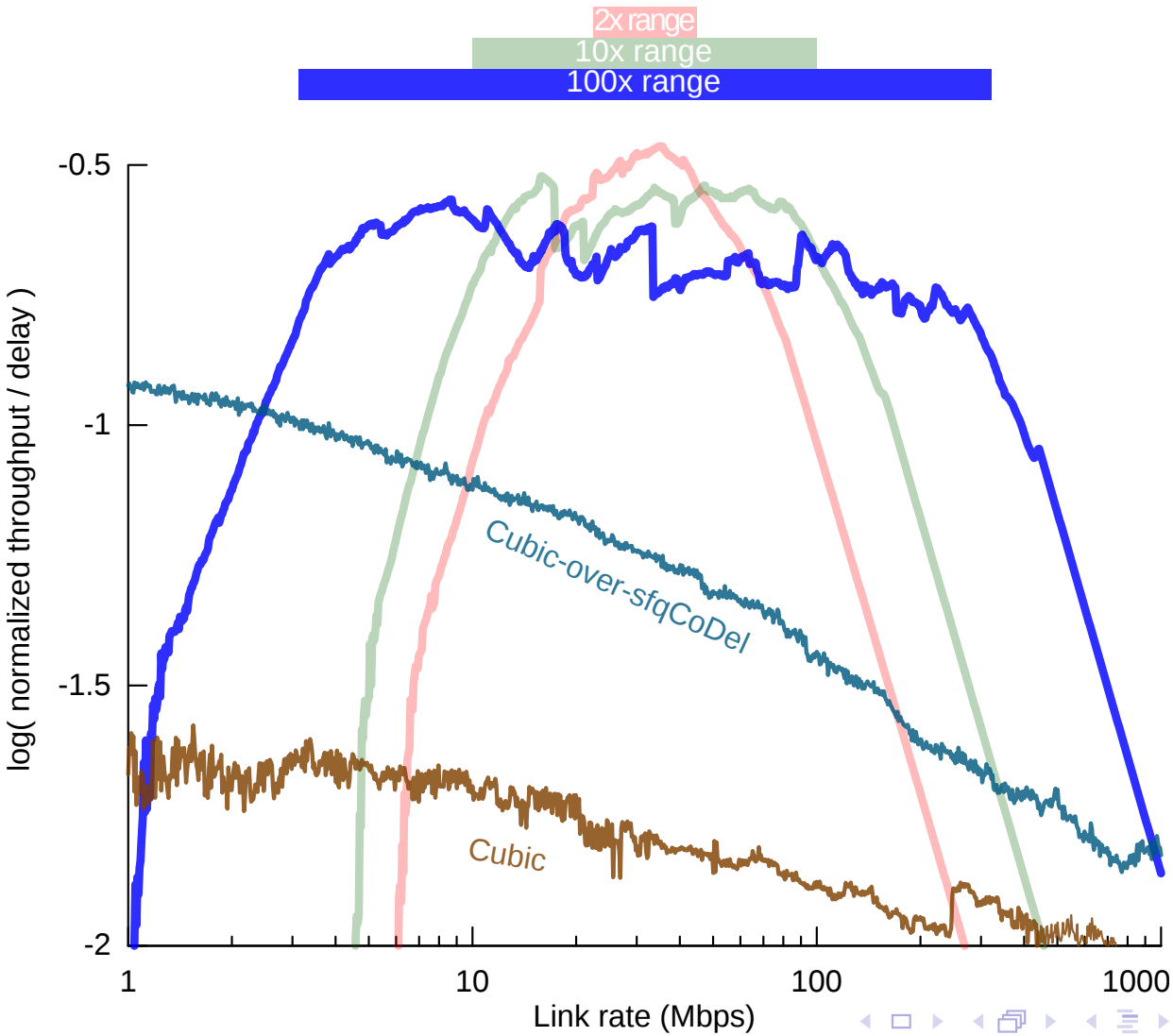

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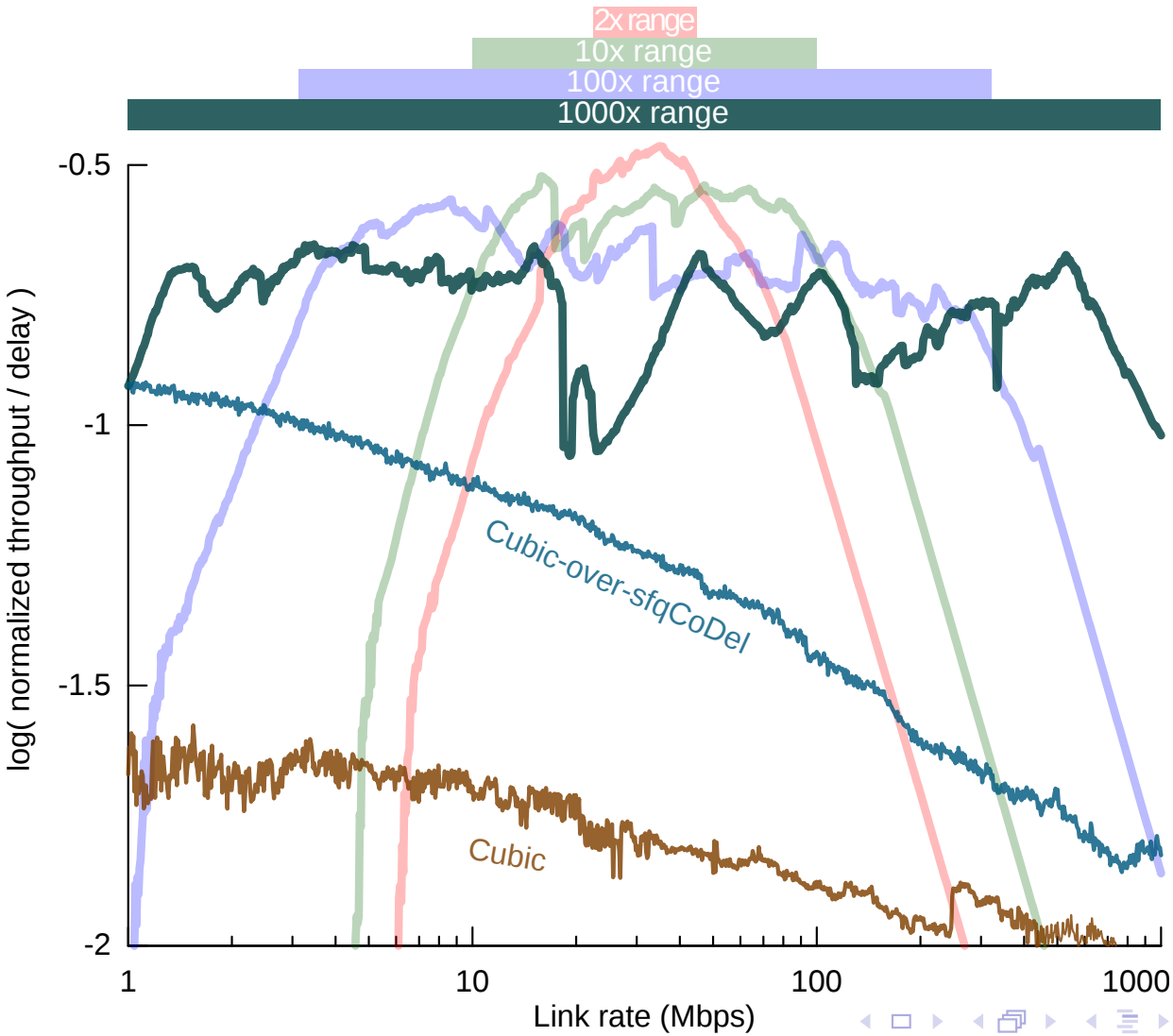
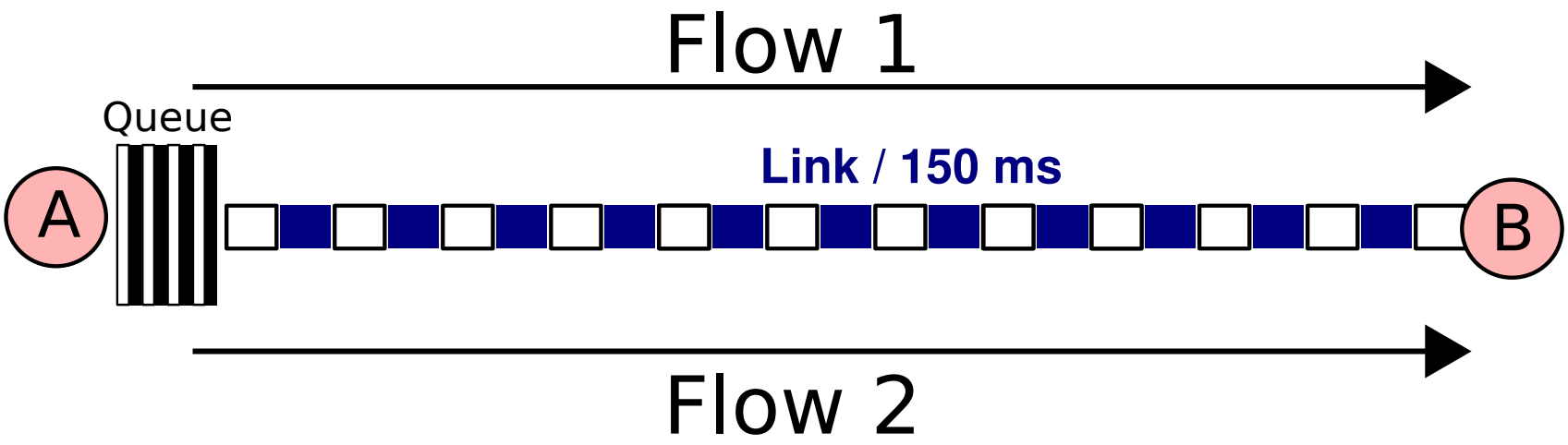


Workload imperfections

RTT imperfections

When the model is wrong about the topology

One bottleneck



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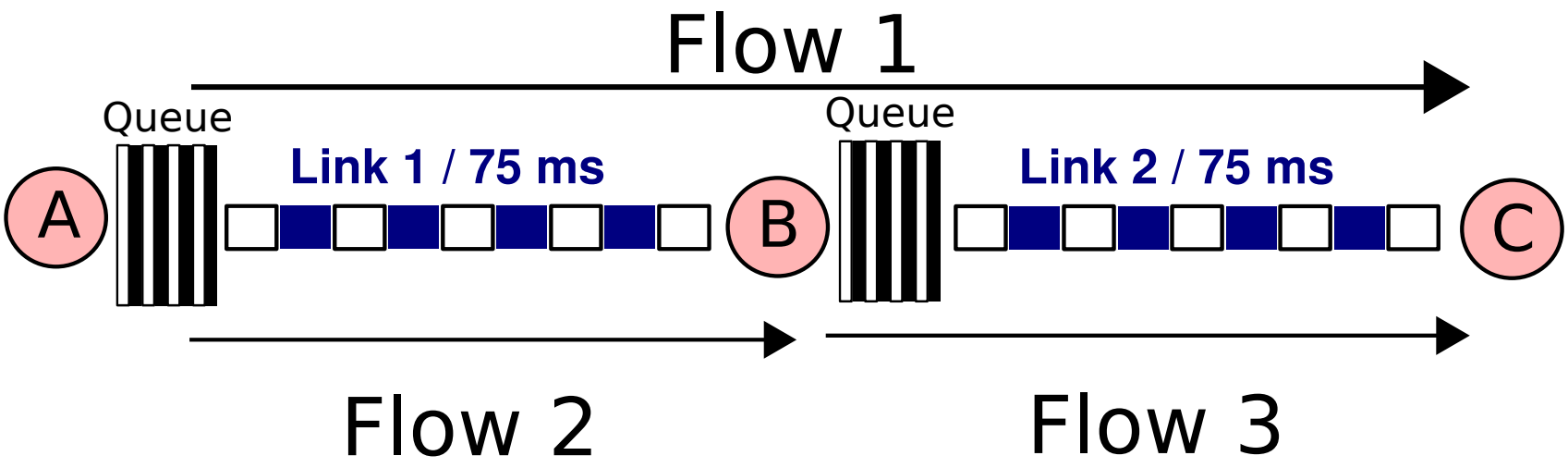
Two bottlenecks



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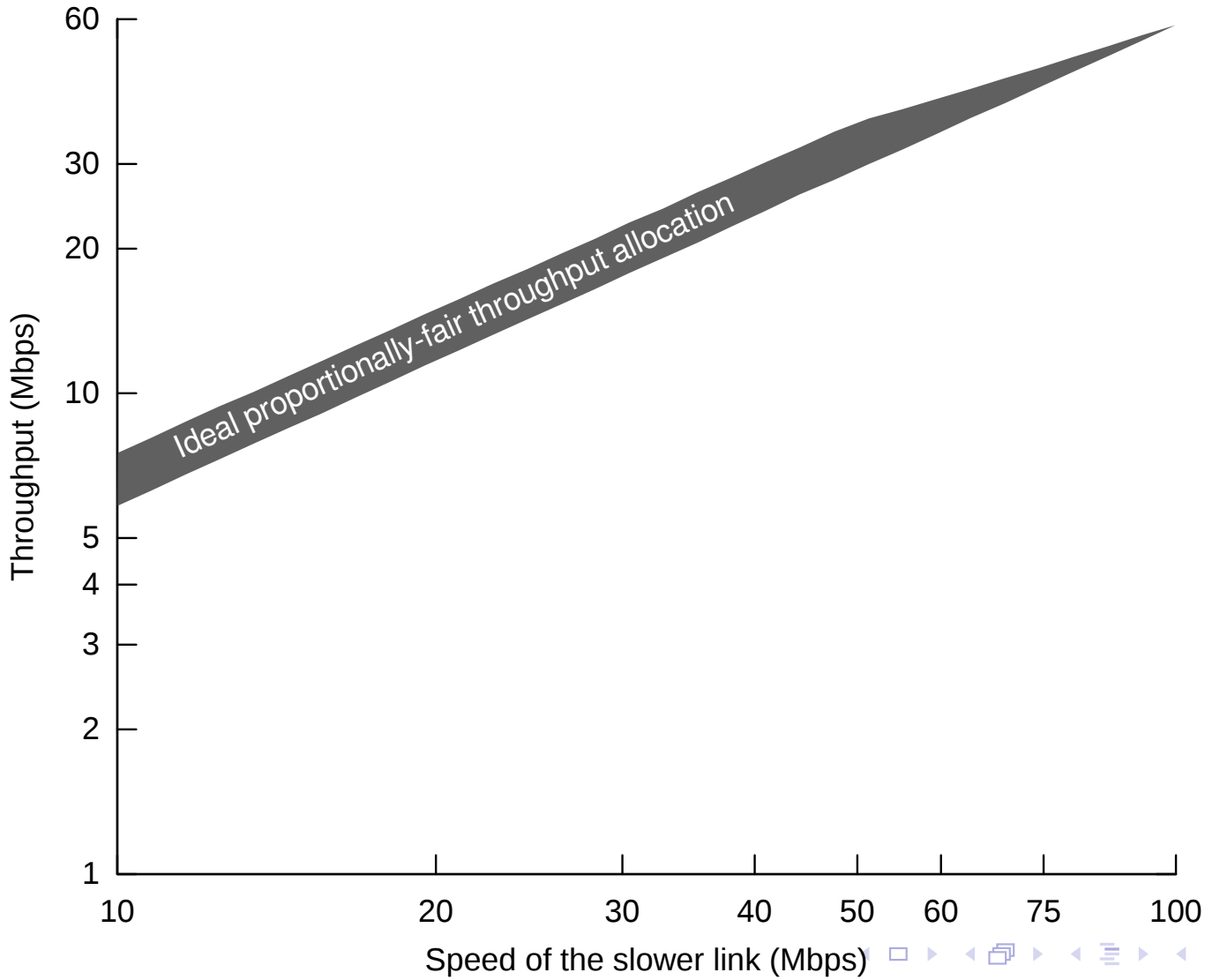

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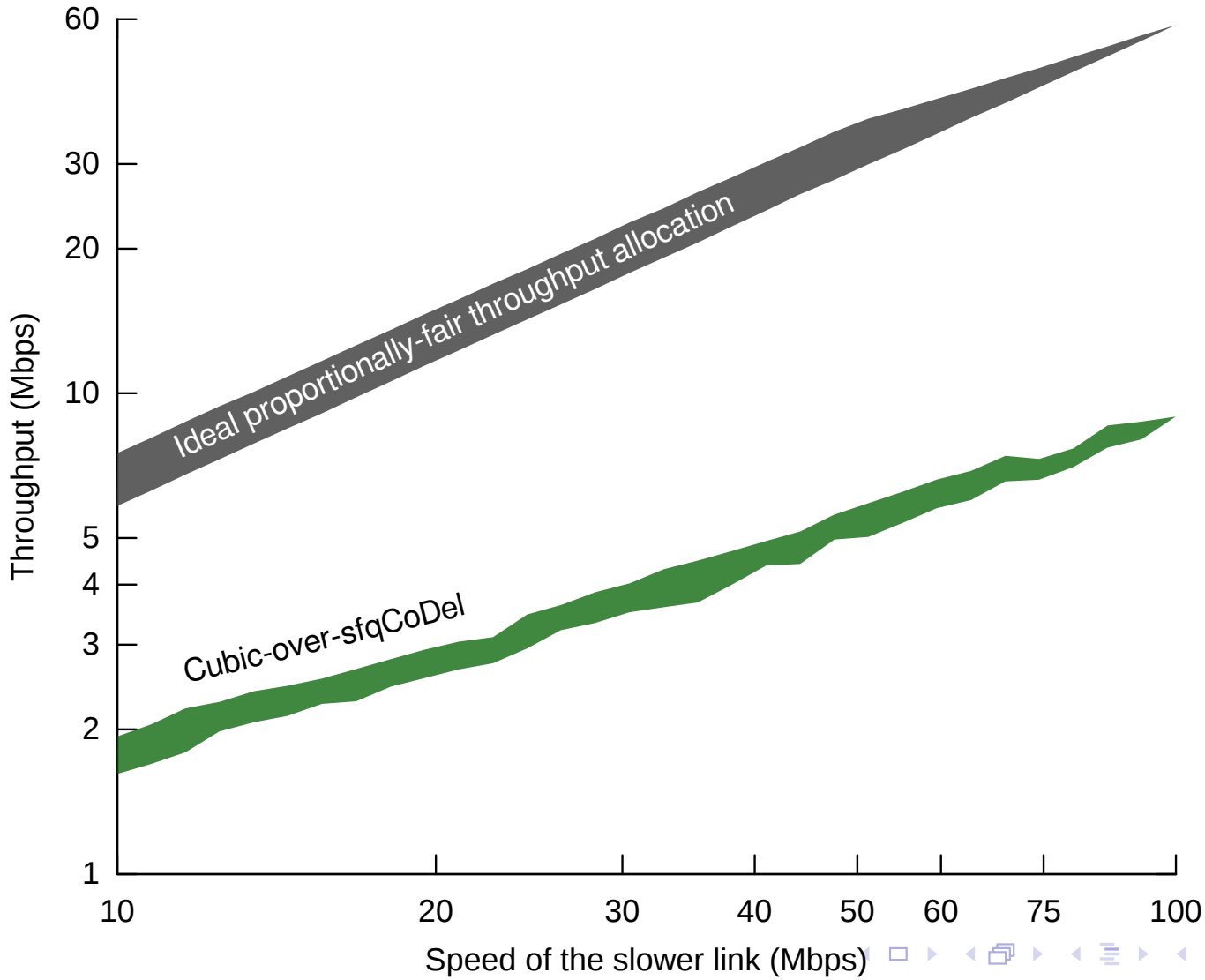

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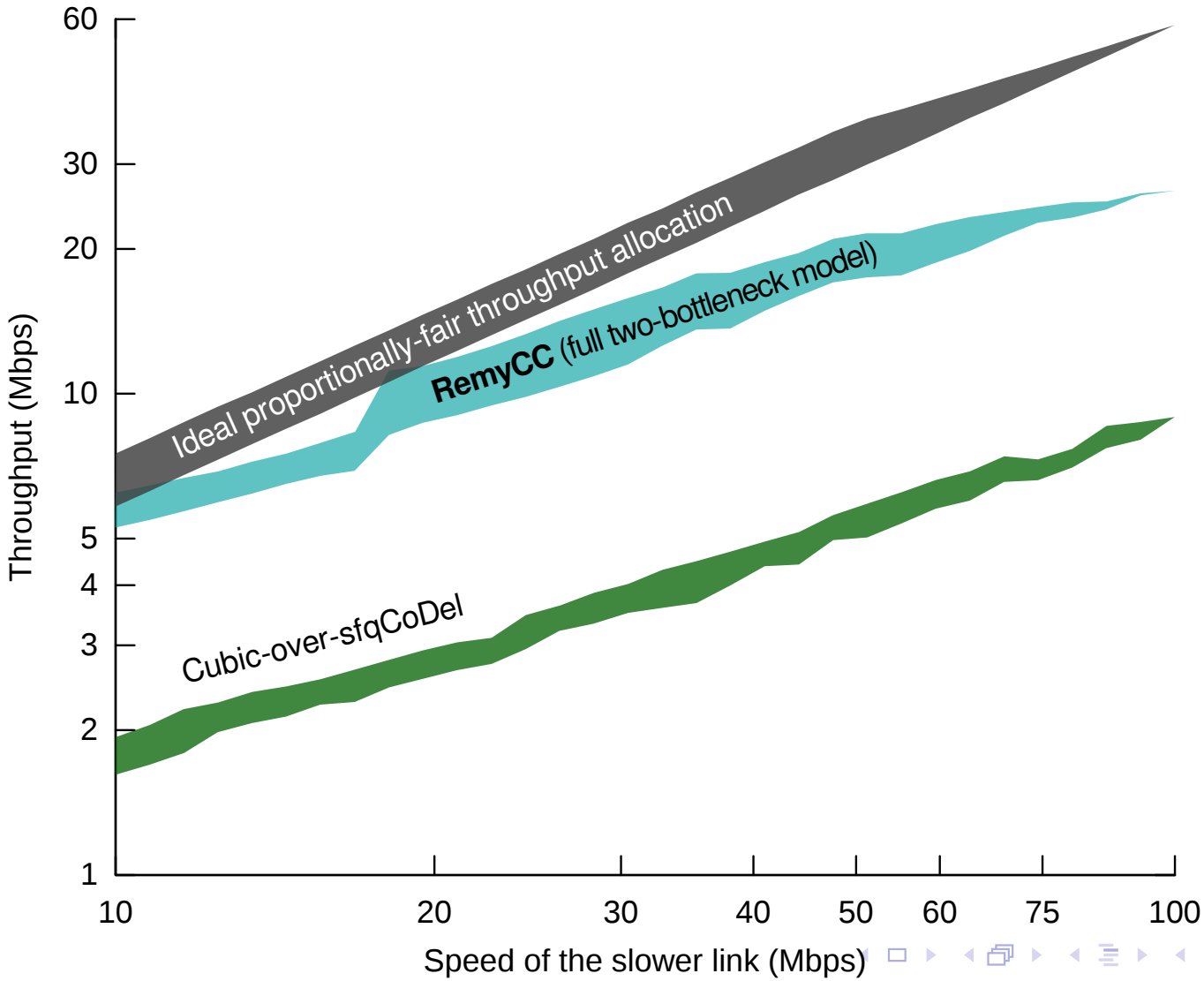

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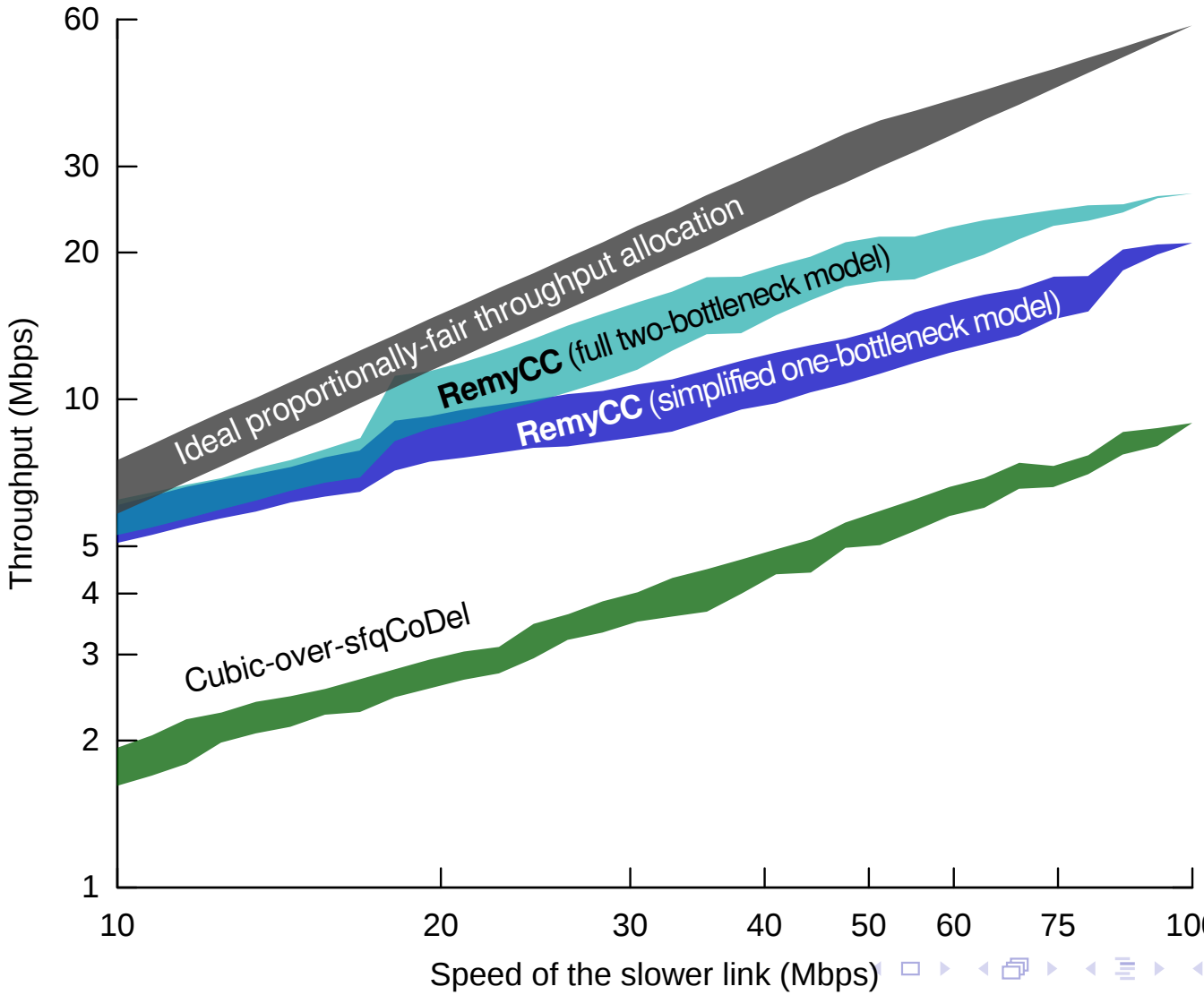
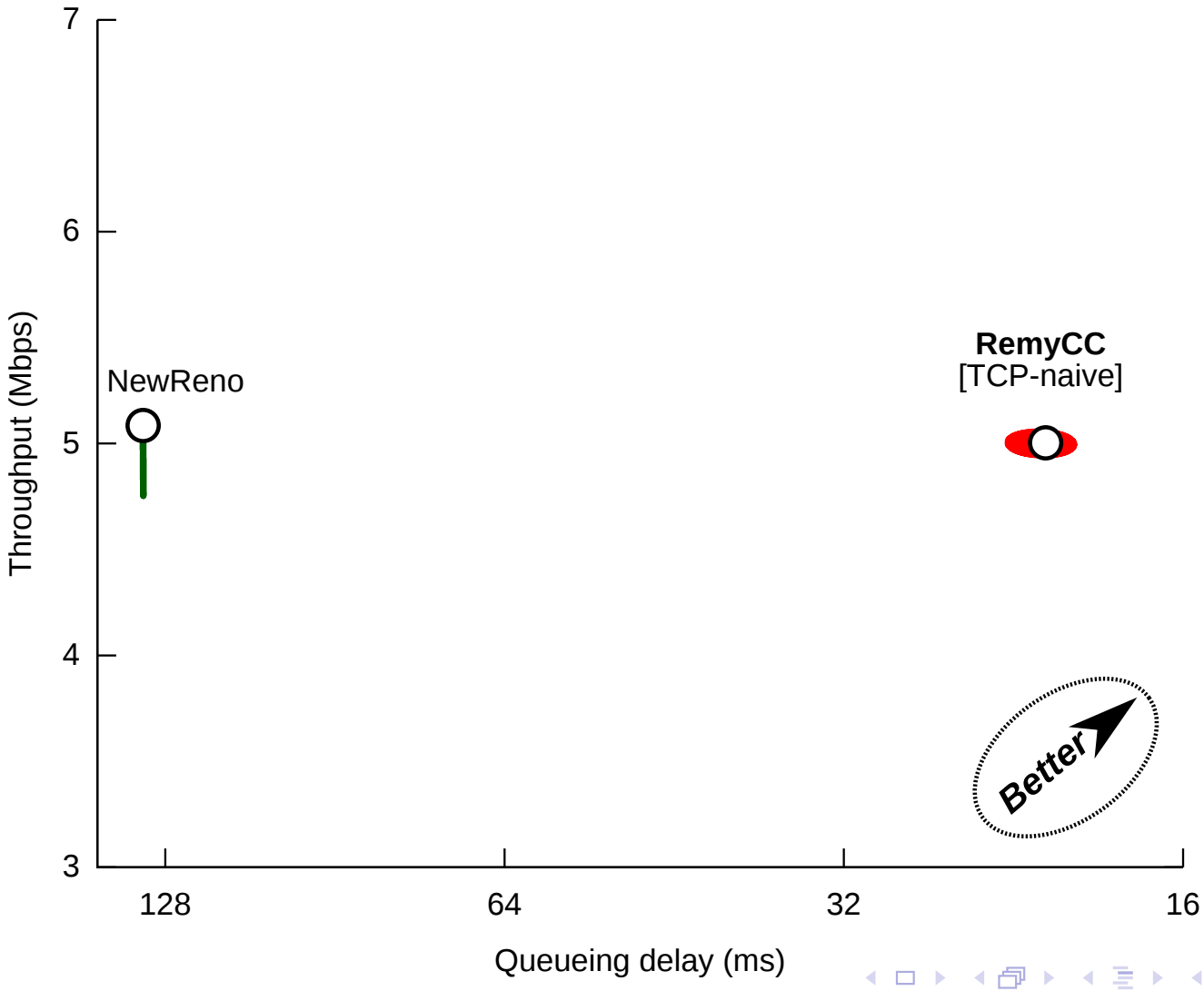


RemyCC competing against itself



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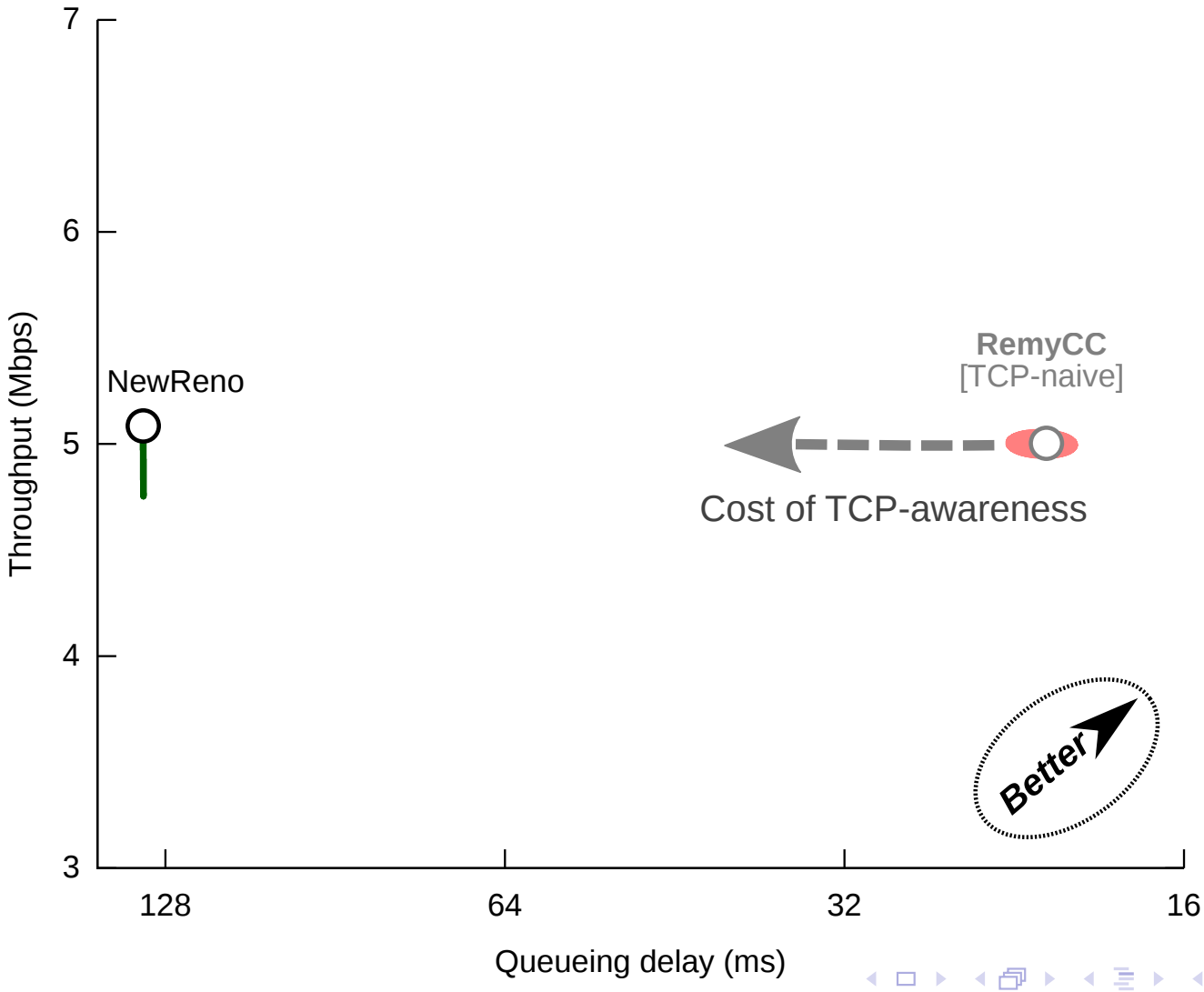

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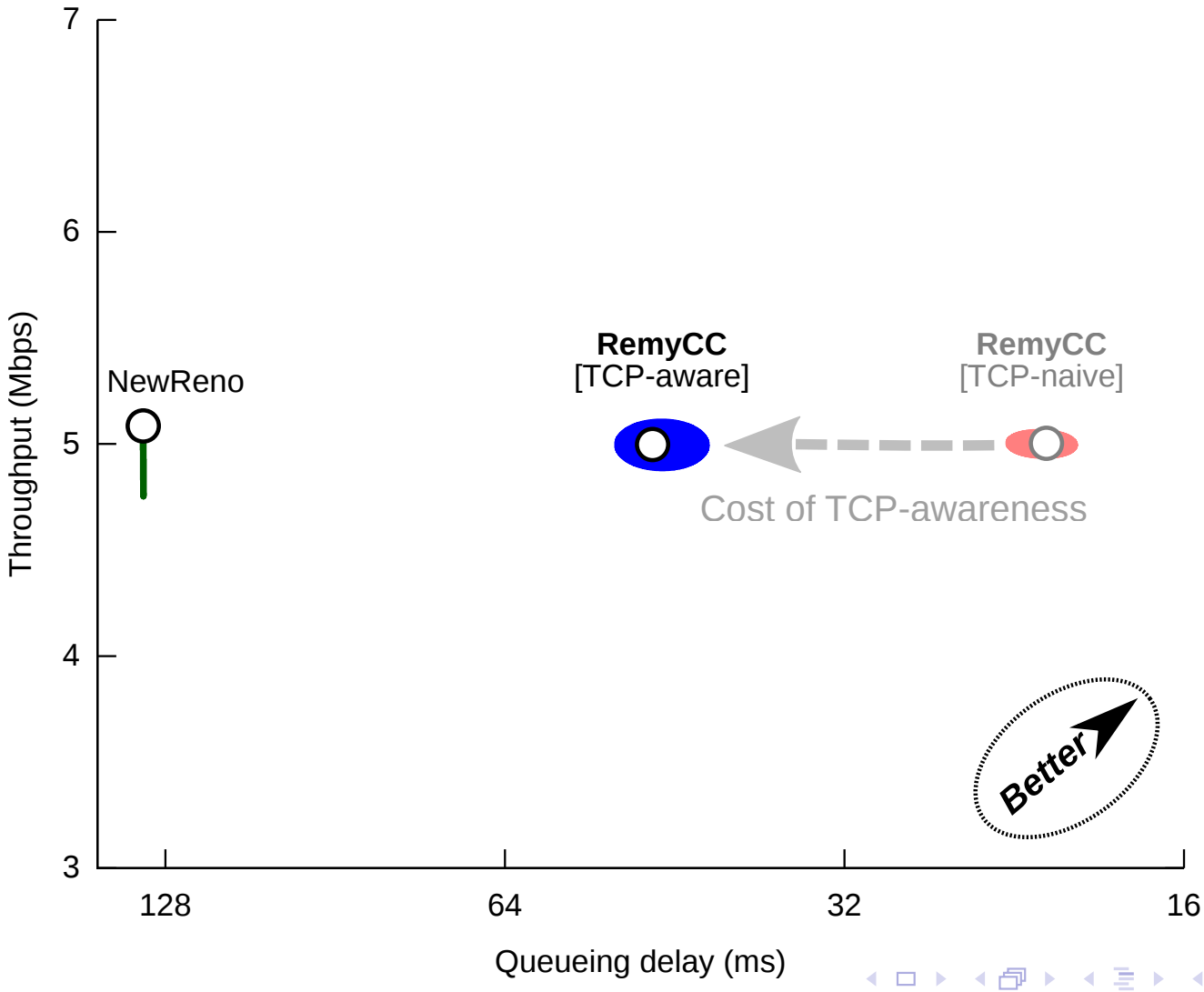
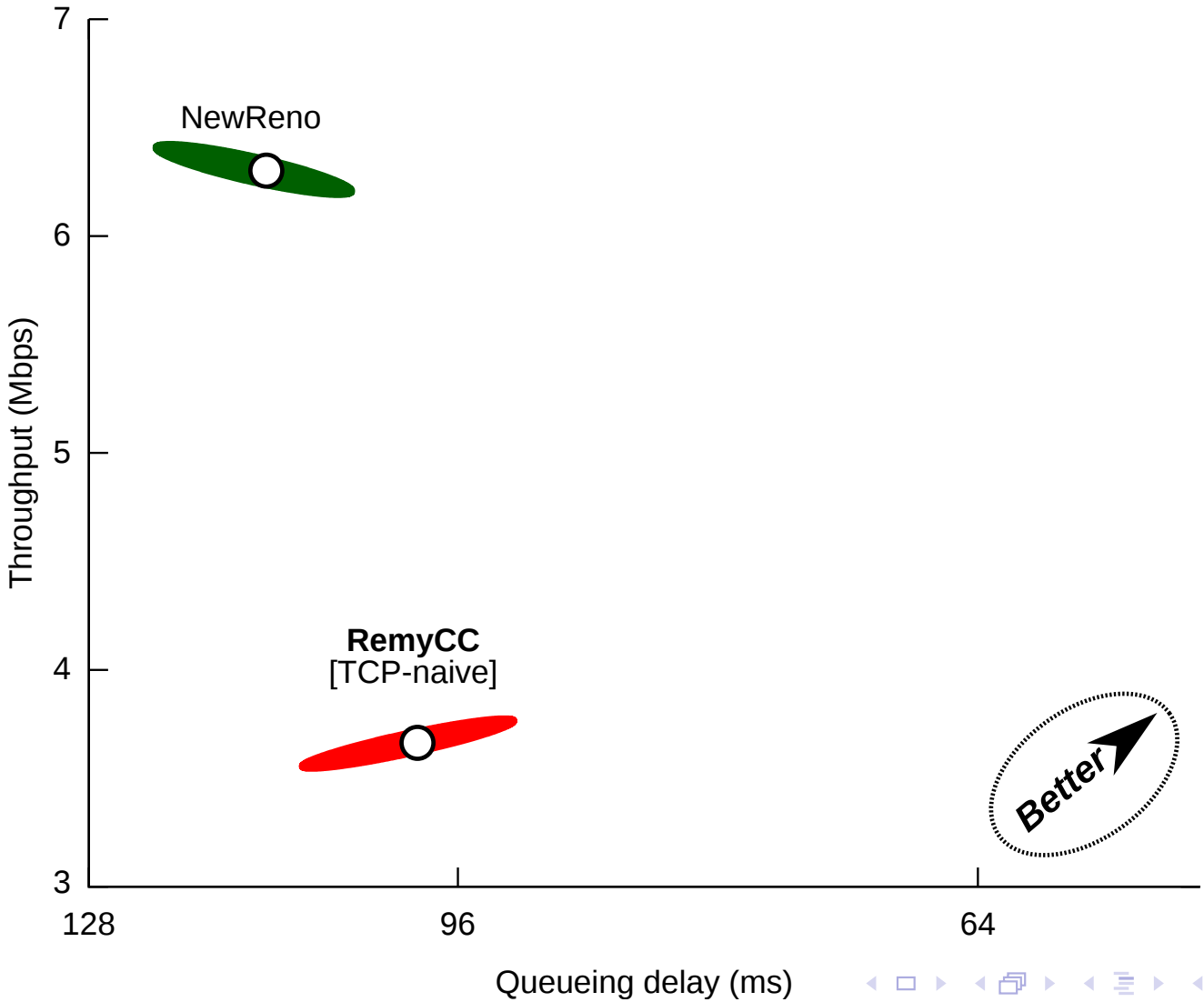


RemyCC competing against TCP NewReno



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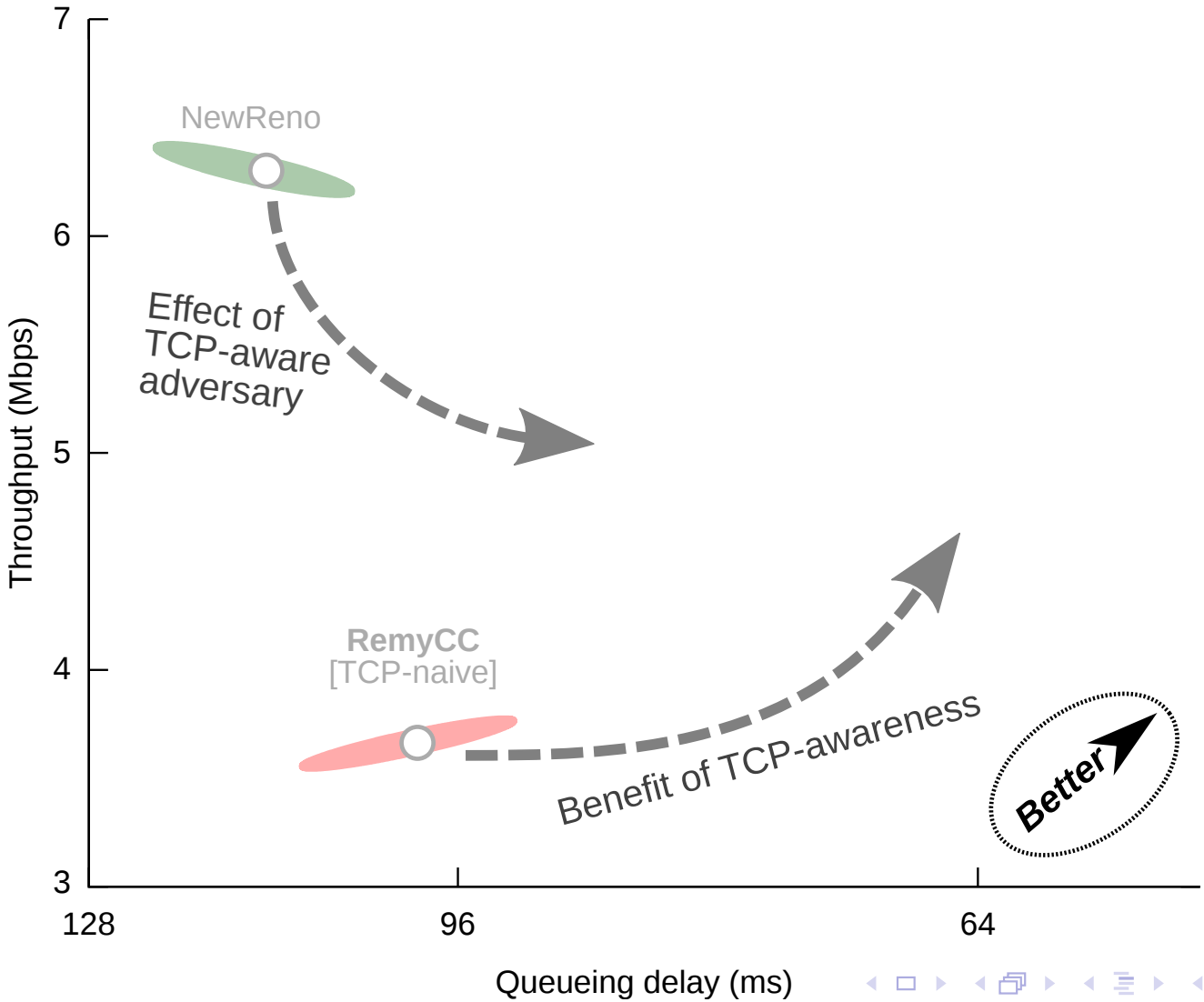

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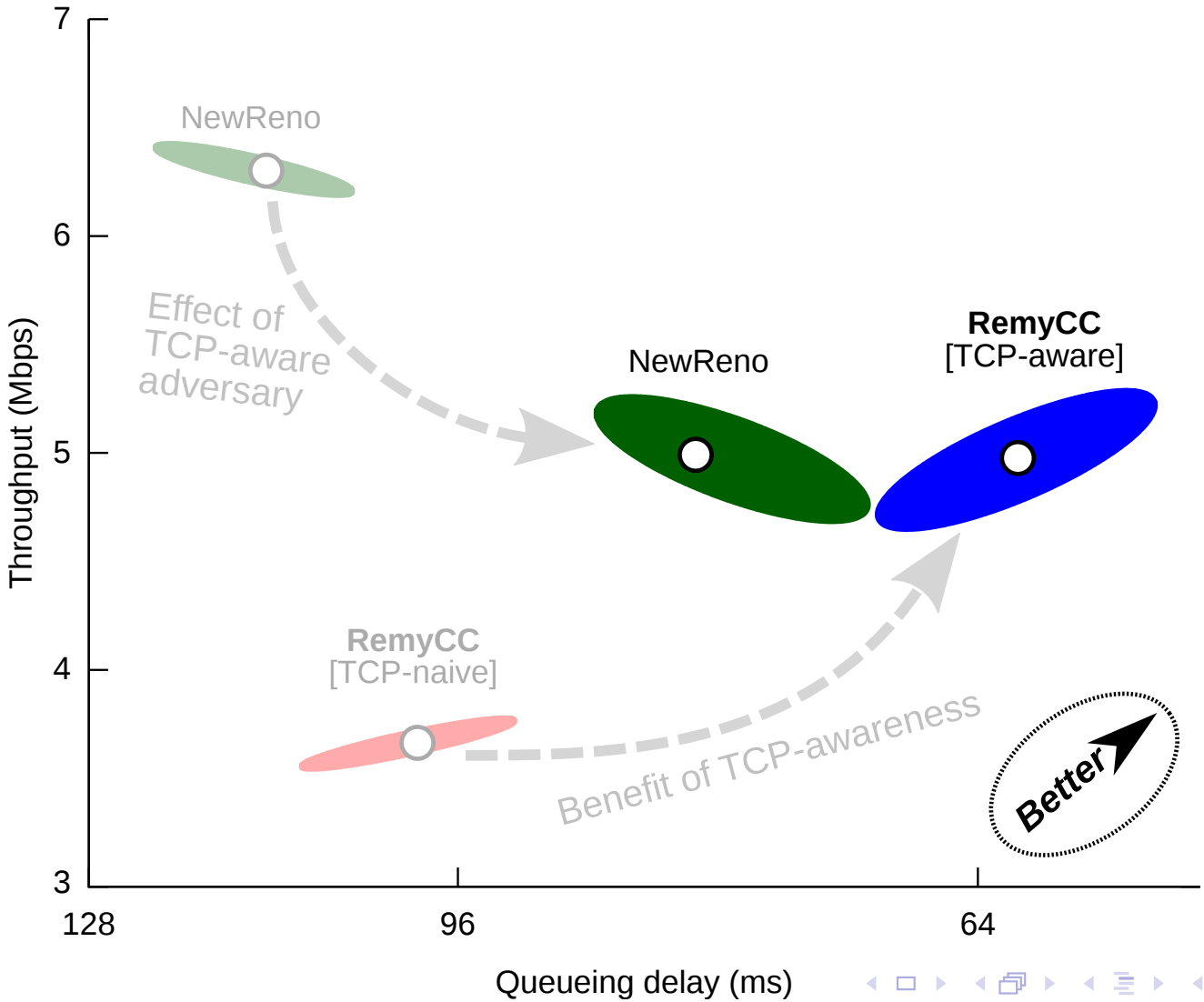

Coping with diverse application requirements

Related Work

- PAC
- Transfer learning

Limitations and future work

- Better characterization of optimal protocols
- Extending protocol-generation to in-network algorithms as well.
- Characterize model imperfections between simulation and the real world.
- Why are the results the way they are?