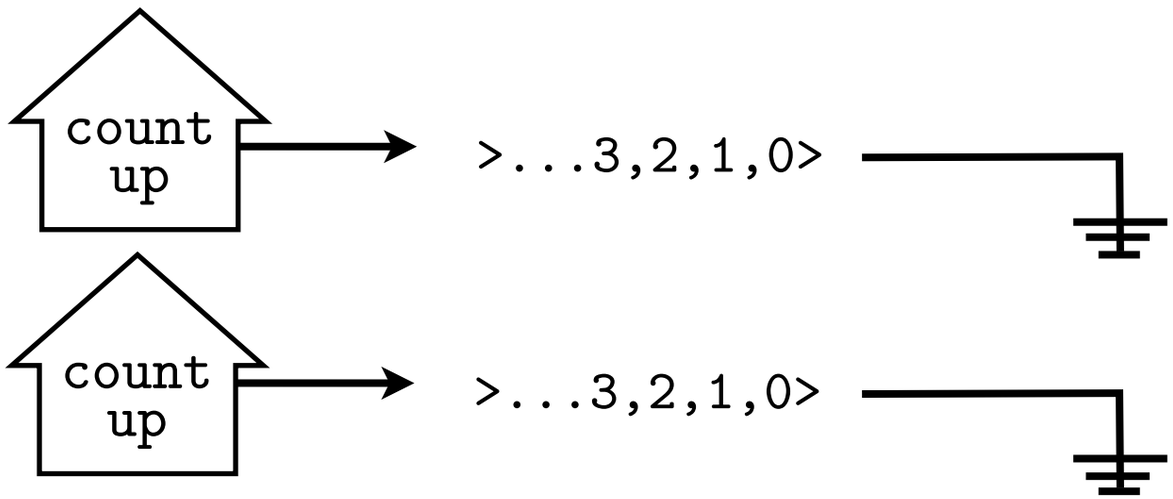
CS294 - Hardware Languages - Week 3

- I have two [multi-stage] slides [after this one]
- Two problems that I spend a lot of time thinking about
  - Both have to do with *bounded buffering*
- Trends
  - Software design is a programming task. Hardware design is becoming more of a programming task.
  - Hardware is concurrent and parallel. Software is becoming more concurrent and parallel.
  - As the two disciplines grow towards each other, I speculate that *bounded buffering* is the fundamental division between them that will remain after the dust settles.

A Transactor Network



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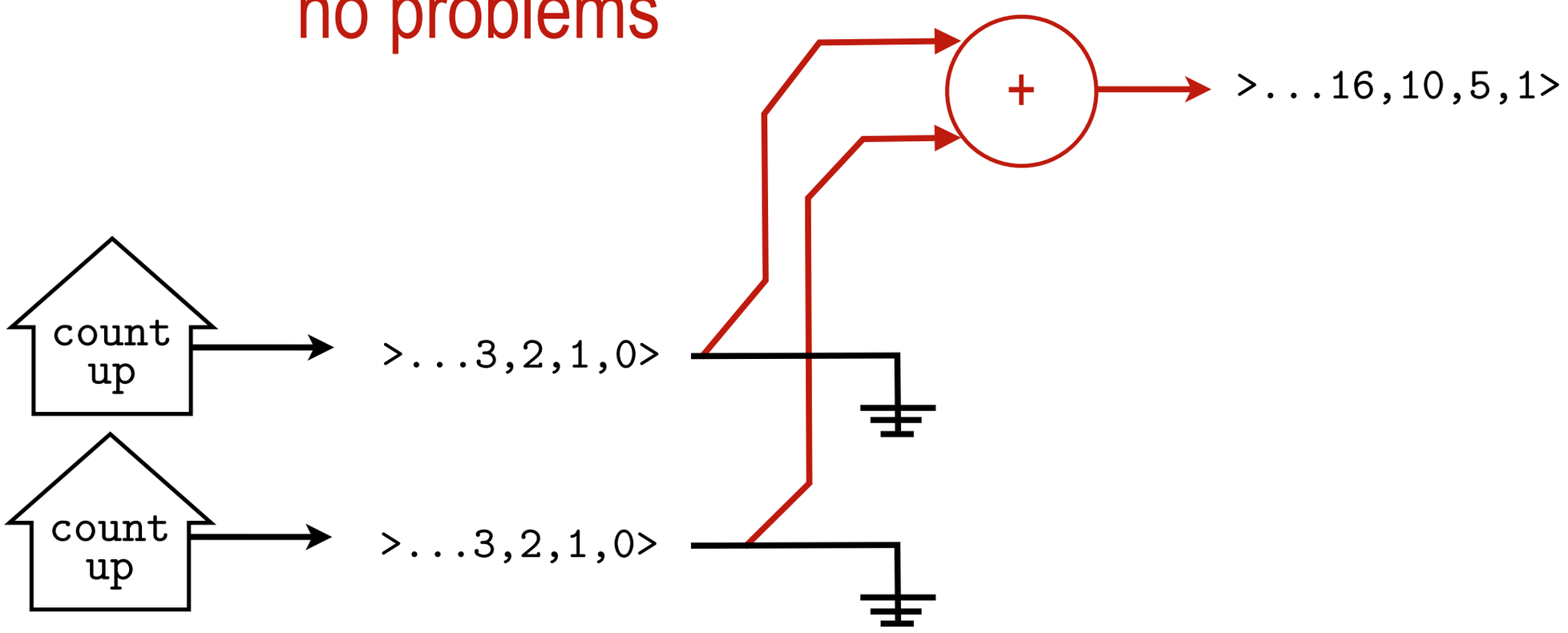
This addition causes no problems



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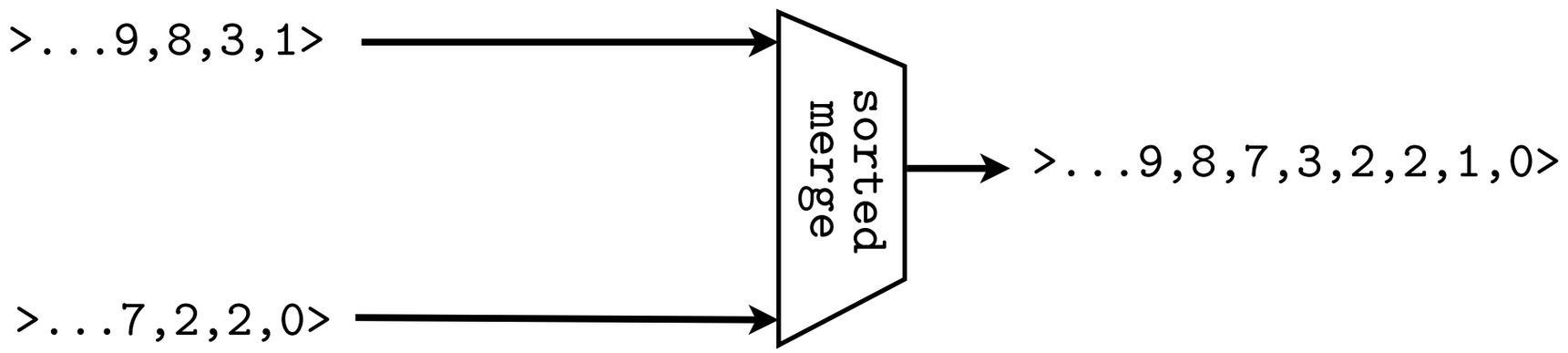

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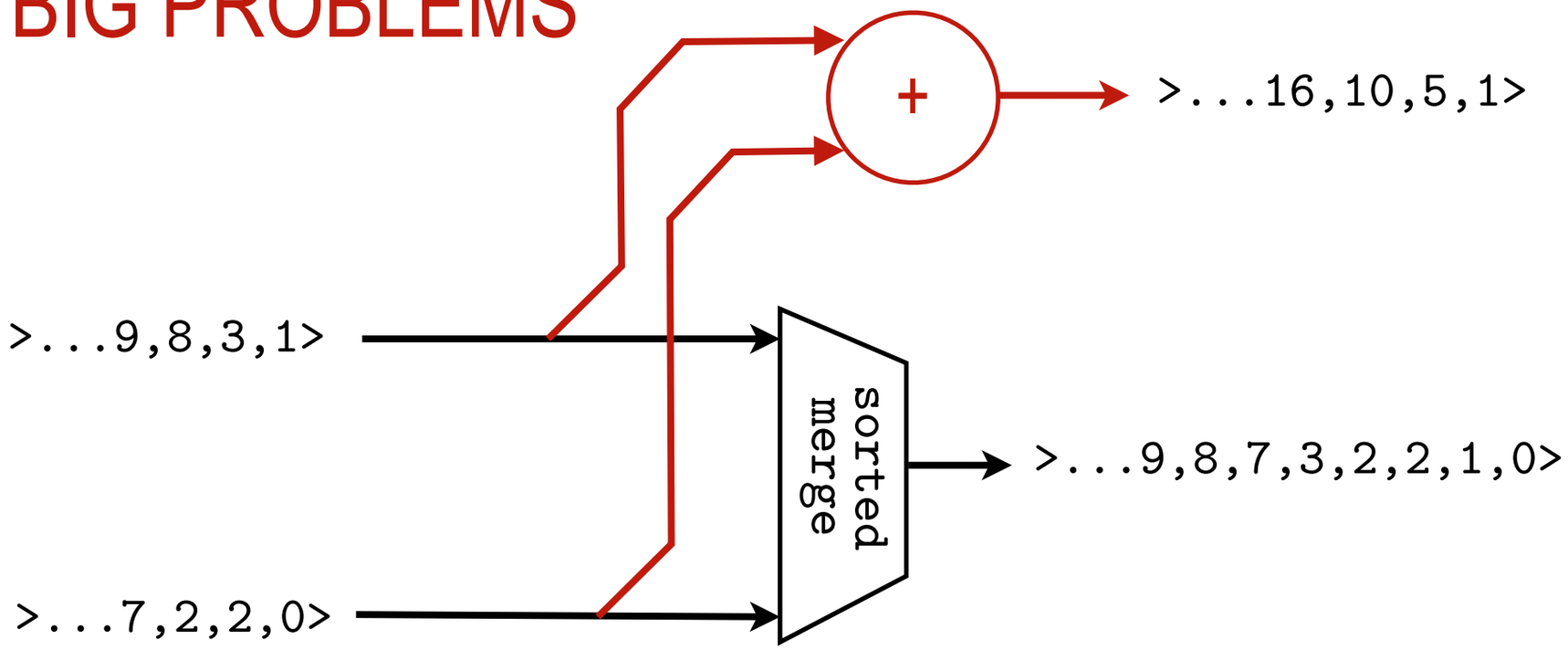

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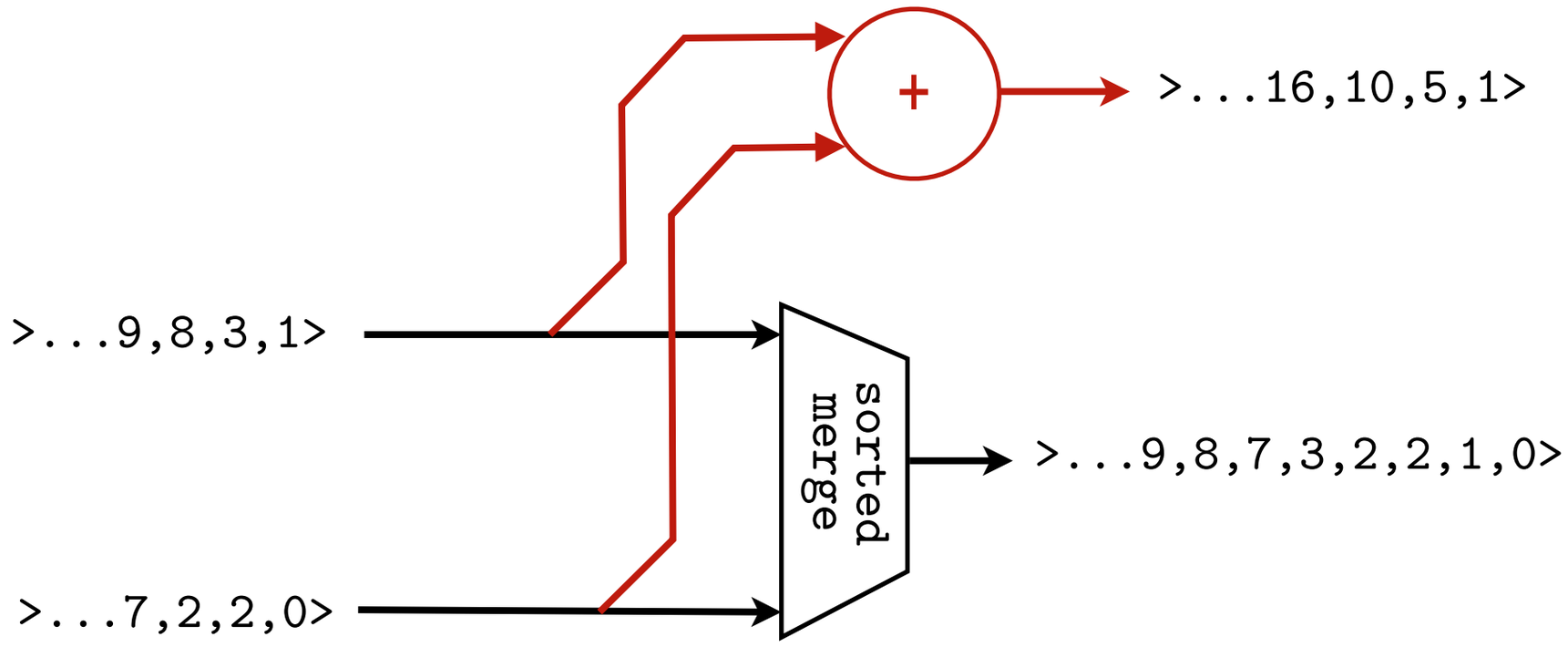

No finite amount of buffering on the input channels is sufficient. ∃loise can always beat ∀belard.

Clogging Networks

- A network at *transactor granularity* cannot afford:
  - Retransmit buffers at every sender
  - Reordering buffers at every reciever
  - Sequence numbers and timers
  - Bufferlock recovery (RAW/Tilera/Parks)

- Therefore, the network cannot simply imitate the Internet
  - Cannot drop packets in response to congestion
  - Must offer reliable delivery (and wrap unreliable links)
  - *But this raises serious clogging issues*!

Clogging Networks

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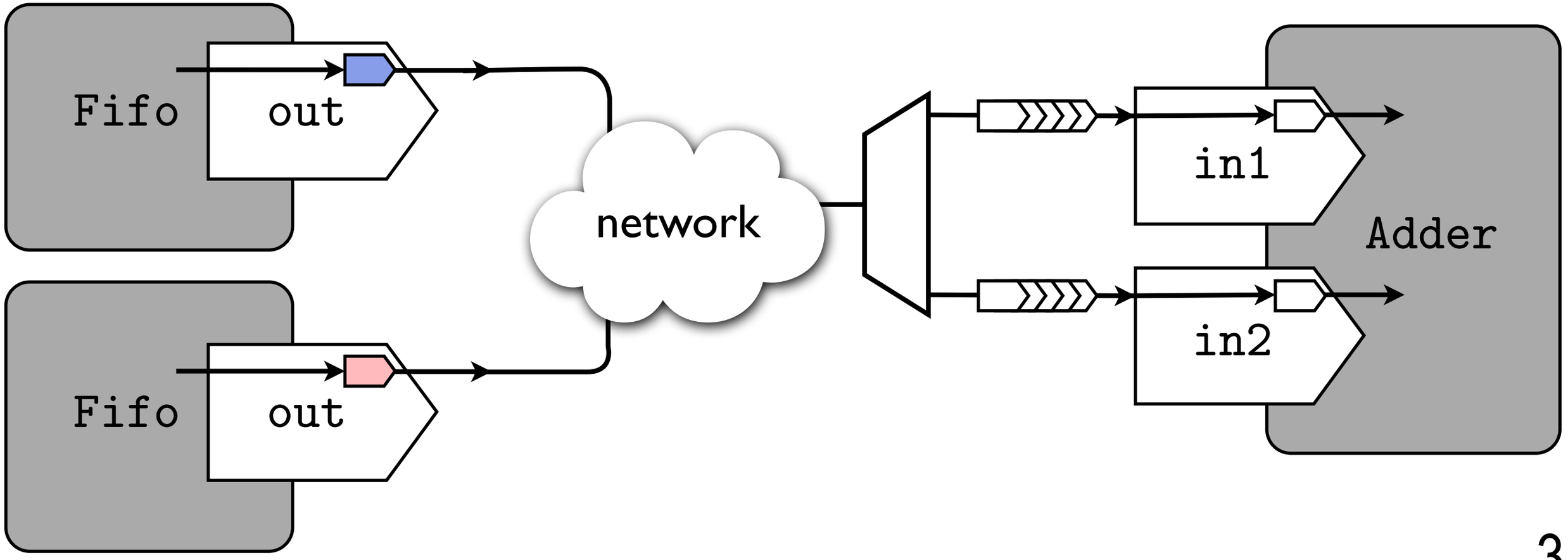
  - If items sent from the two outputs are interleaved properly, this will work.



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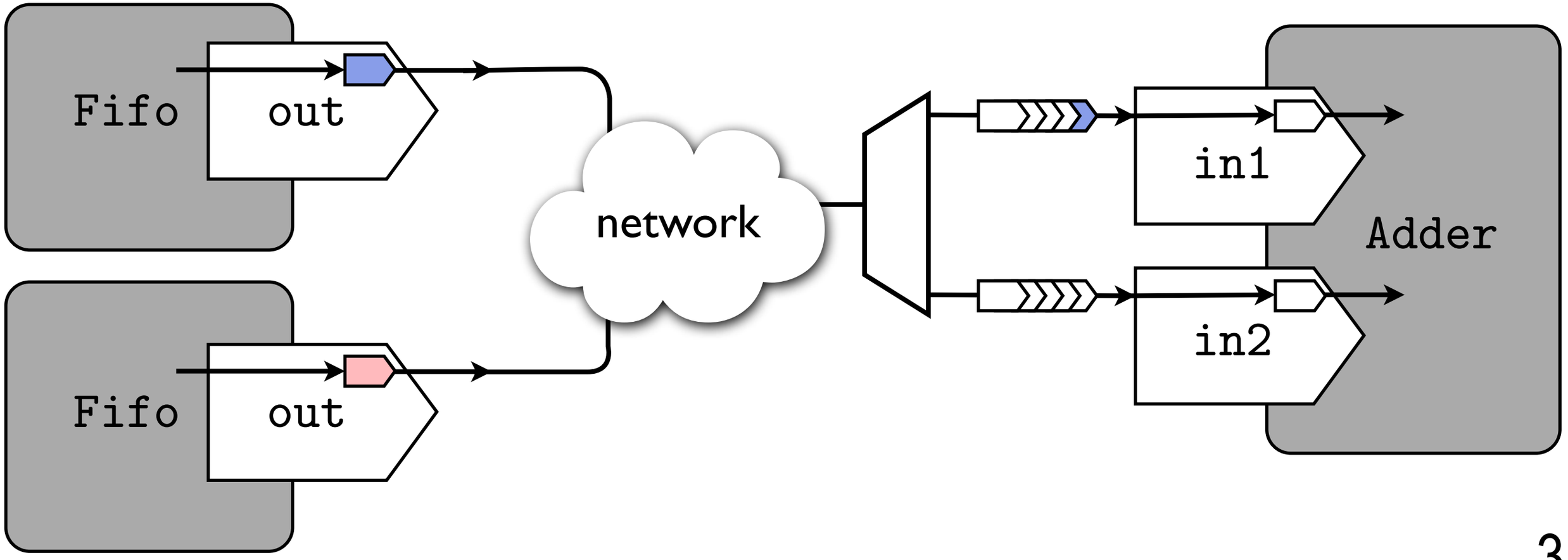

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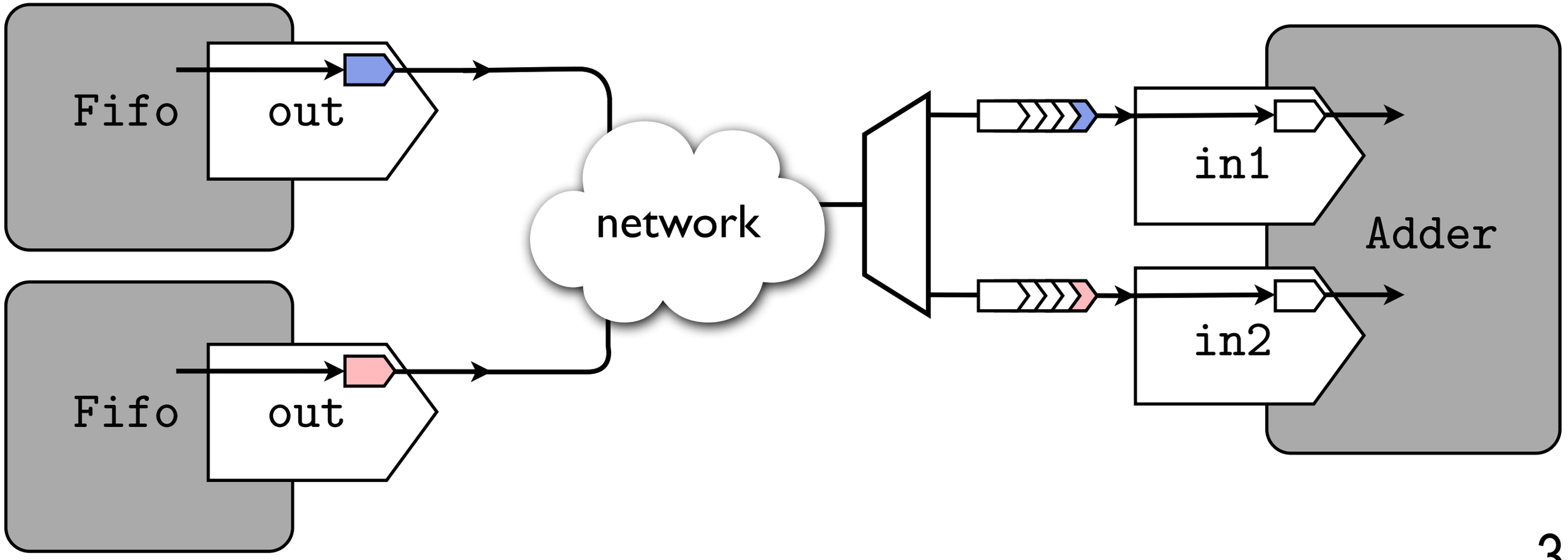

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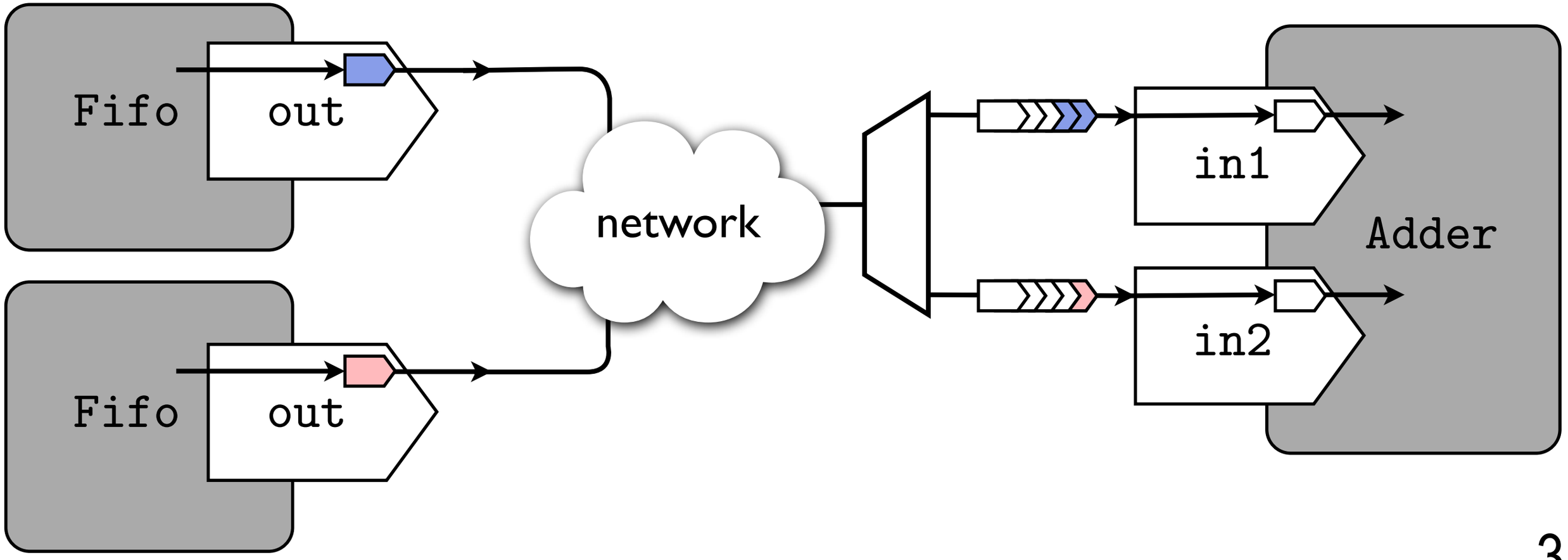

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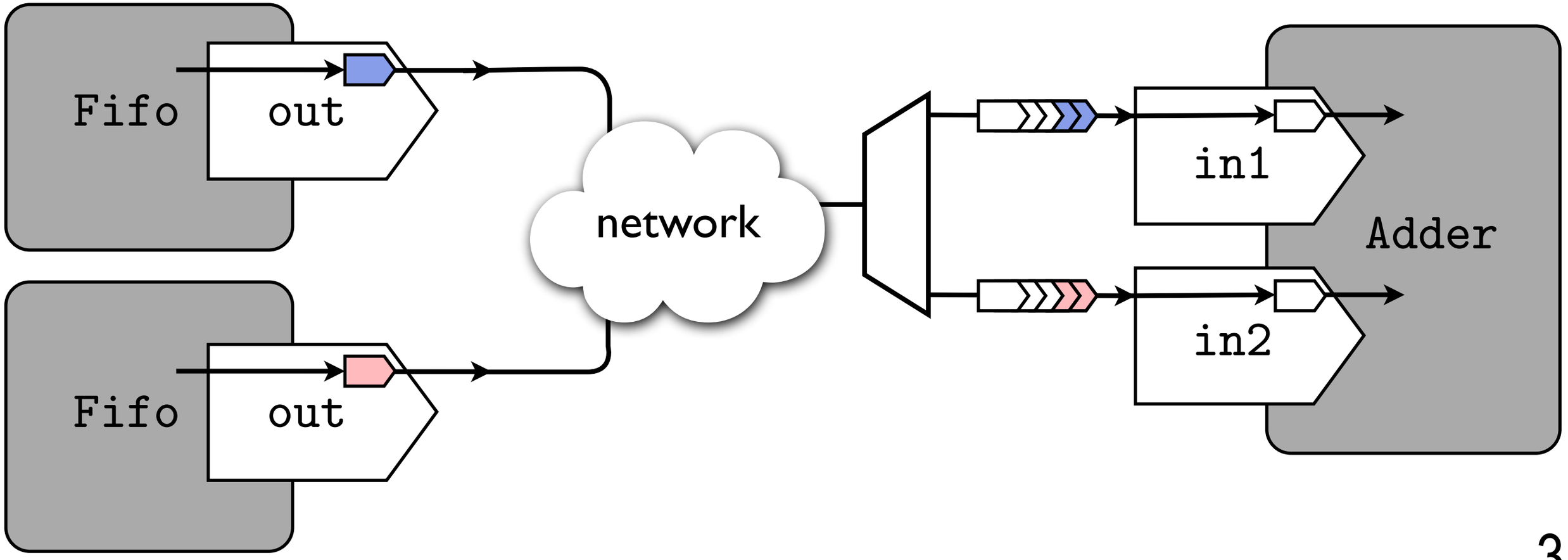

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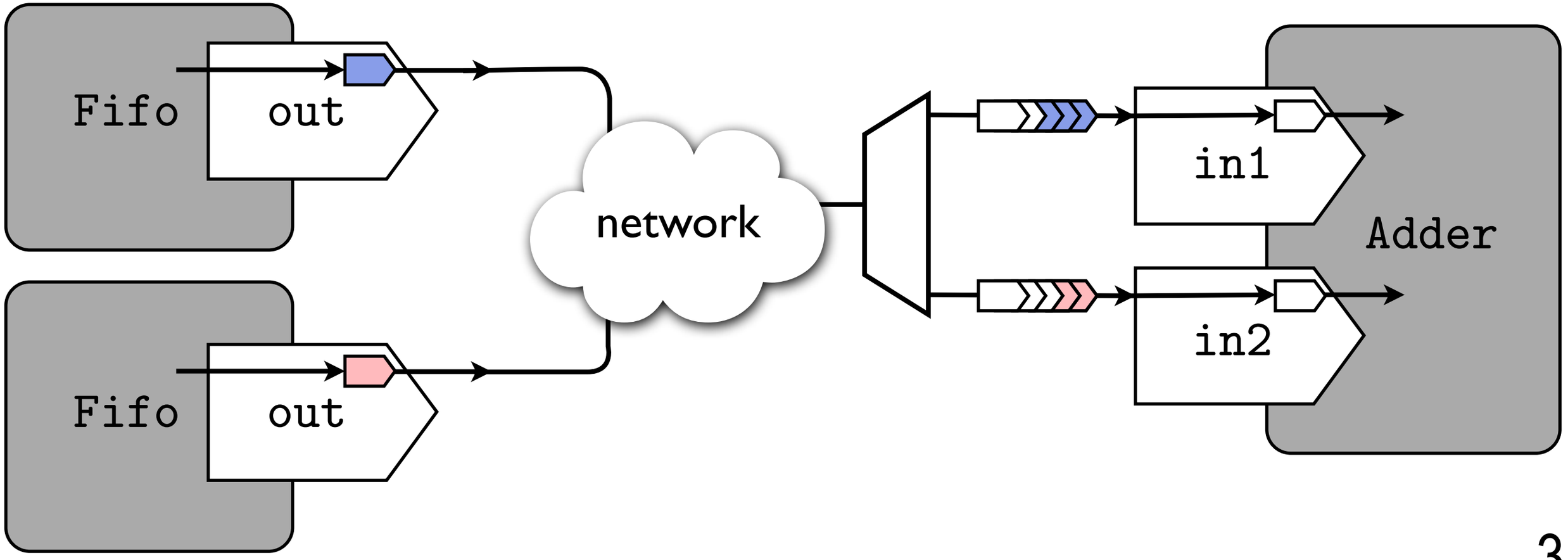

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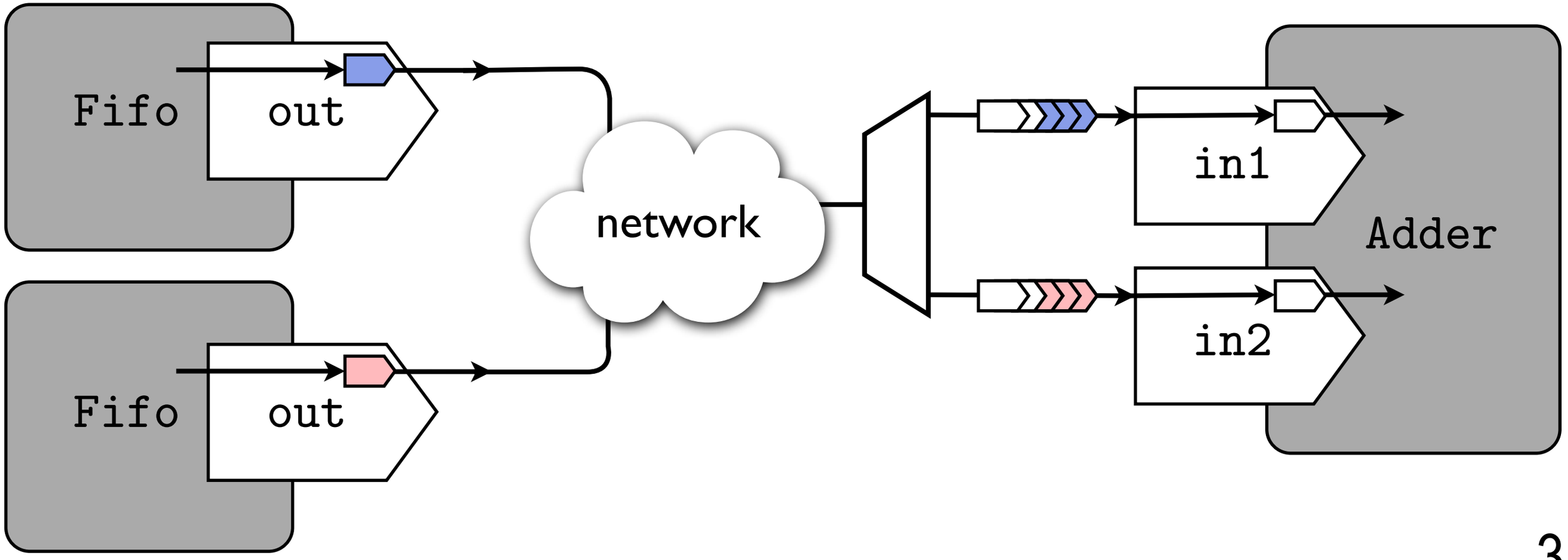

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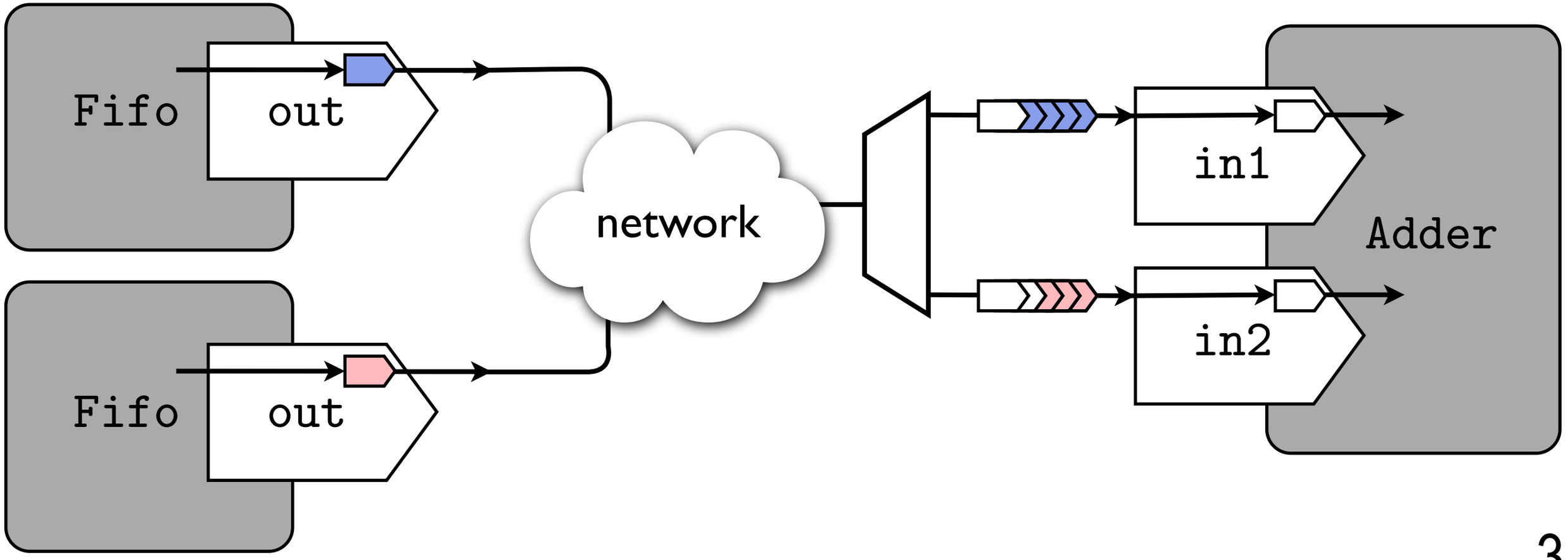

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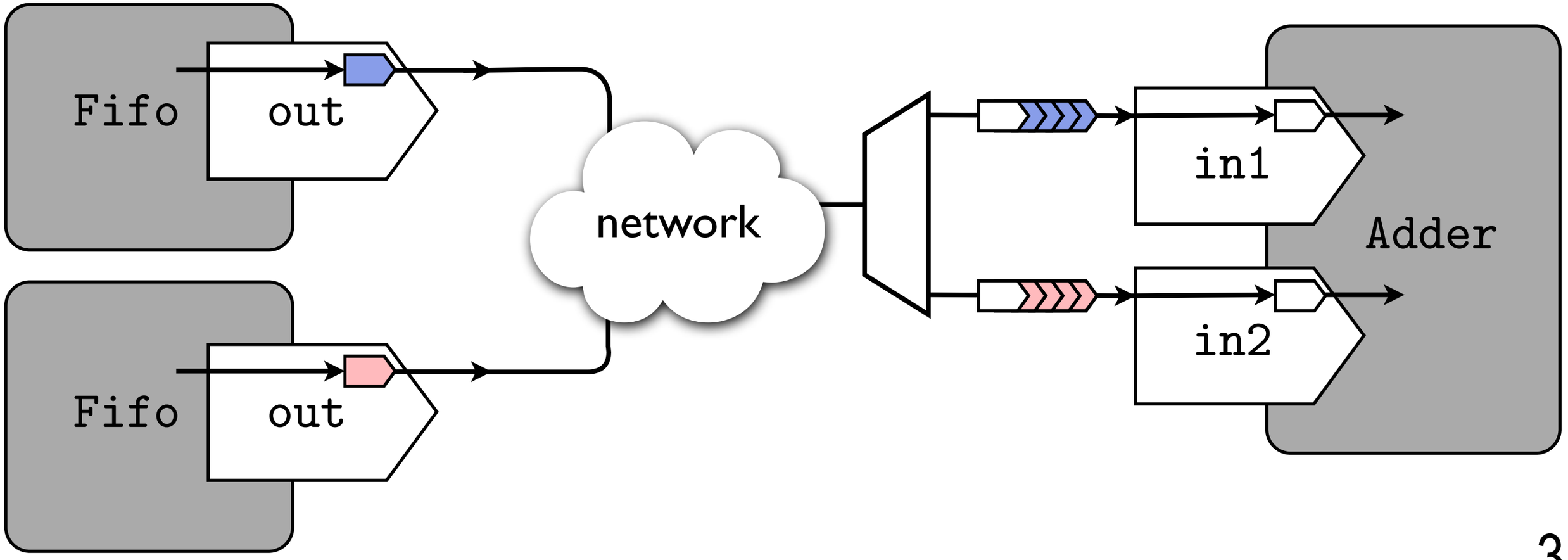

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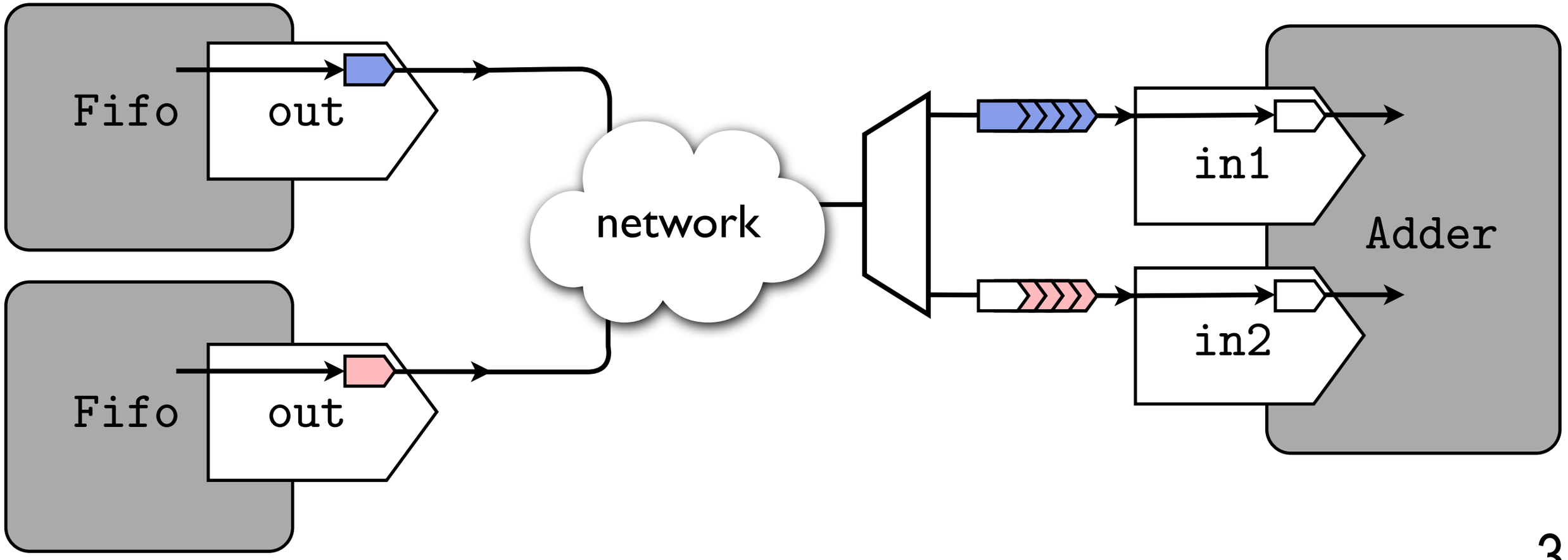

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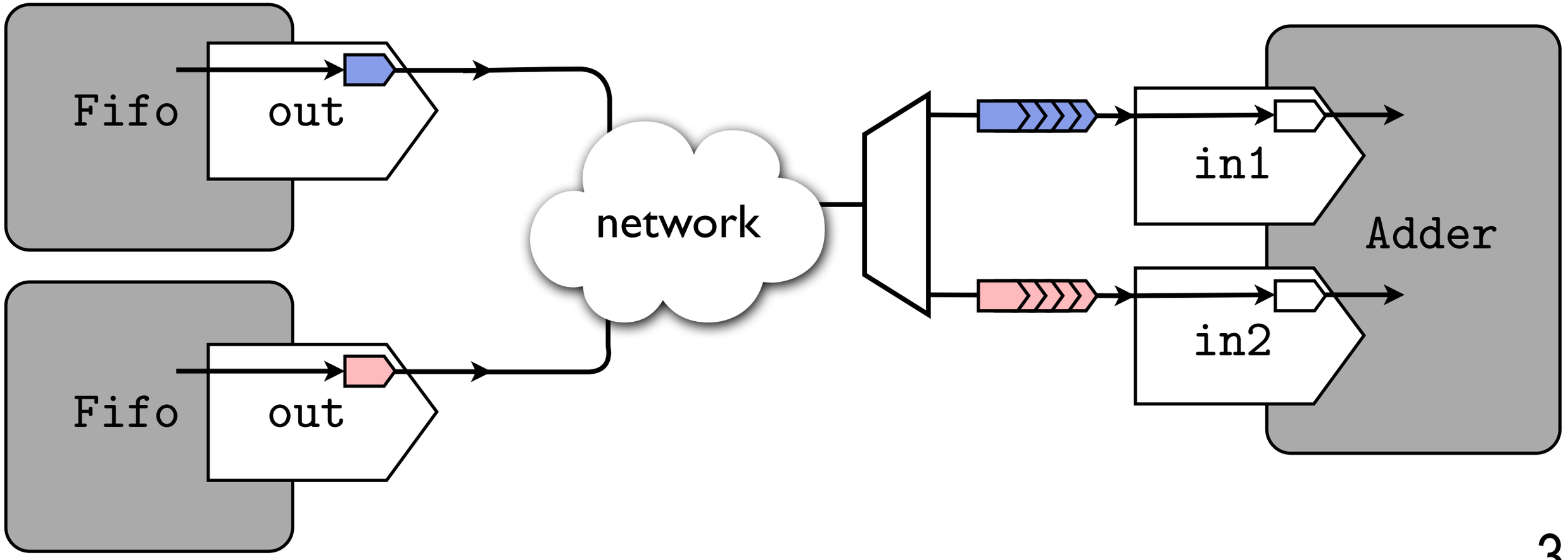

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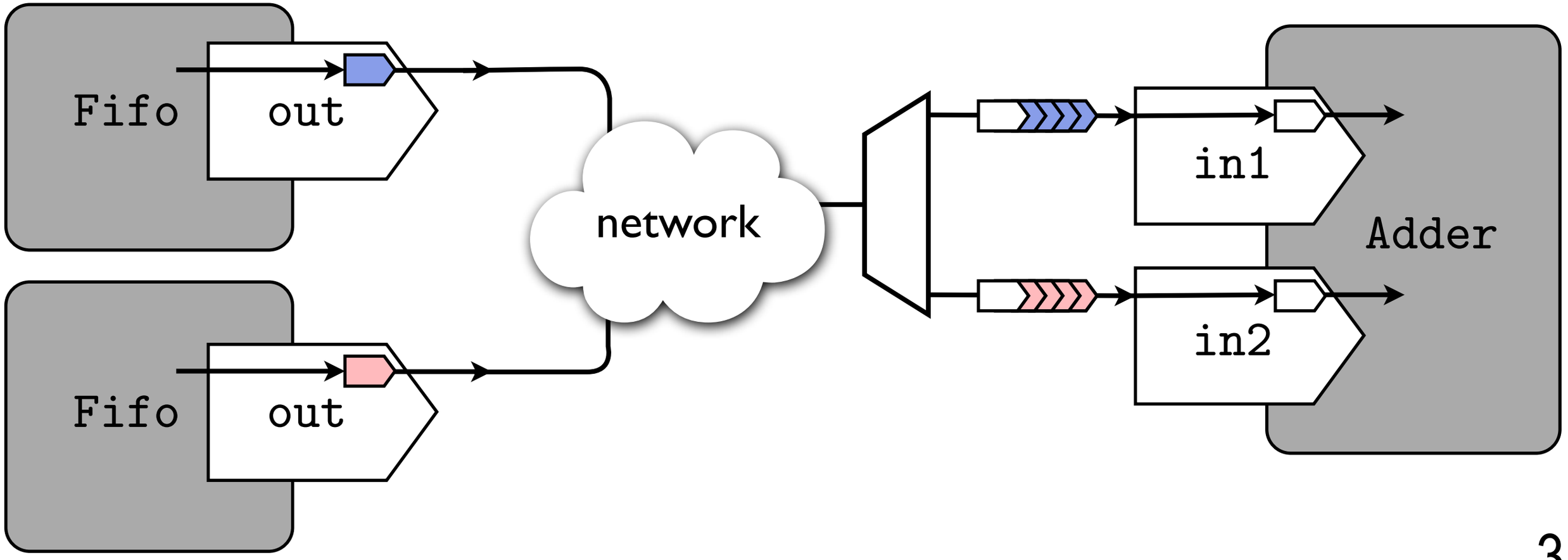

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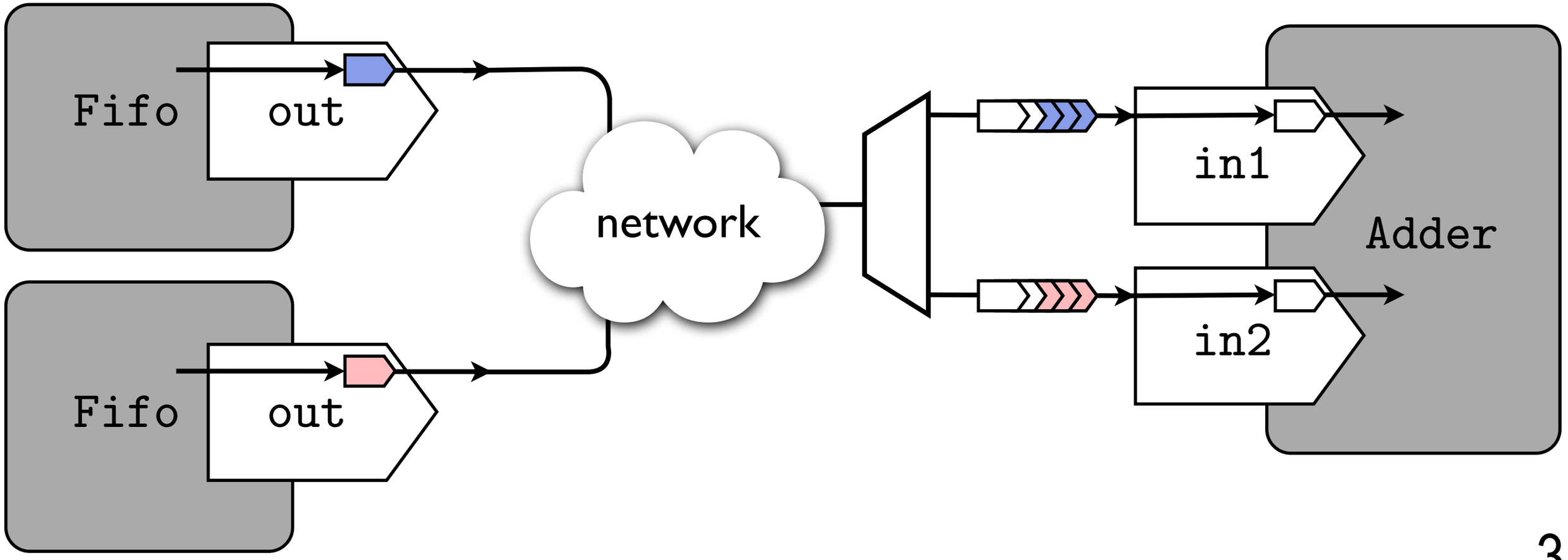

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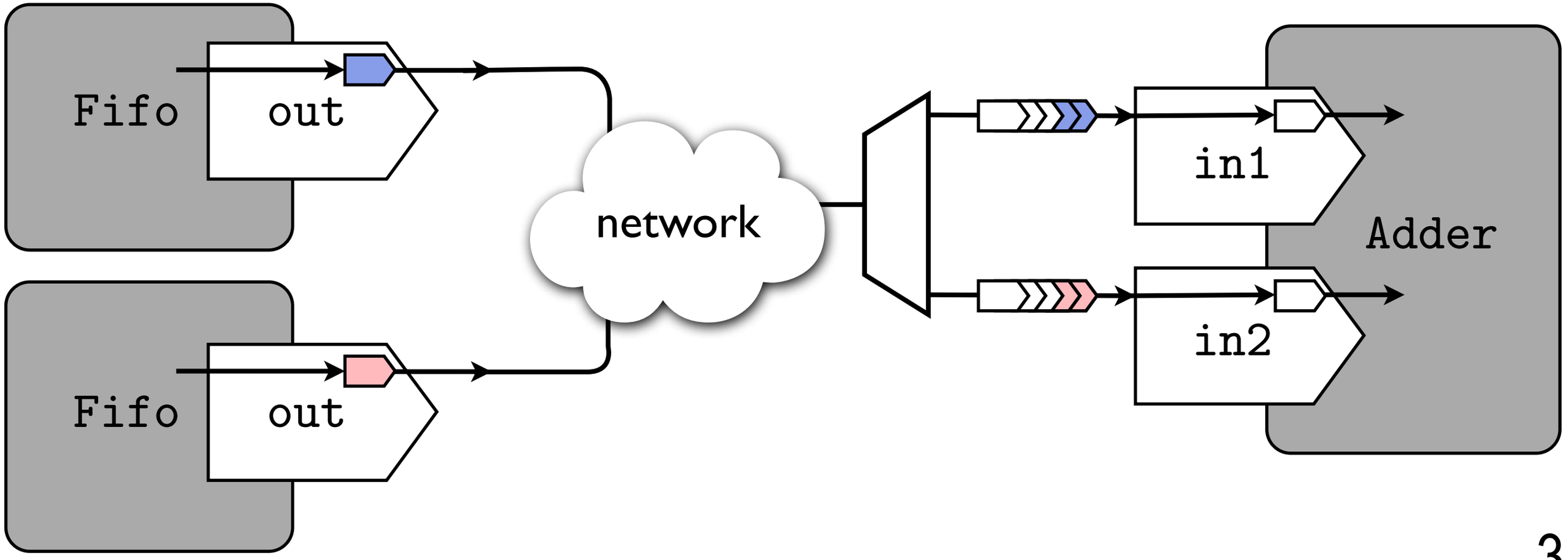

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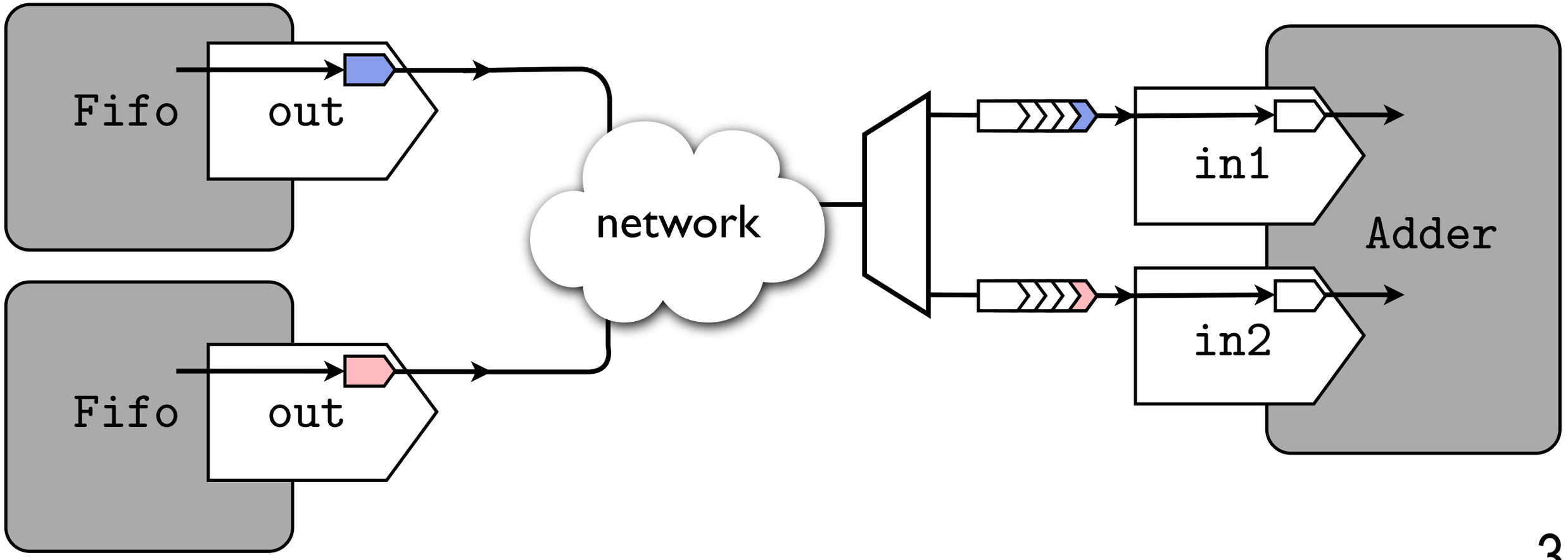

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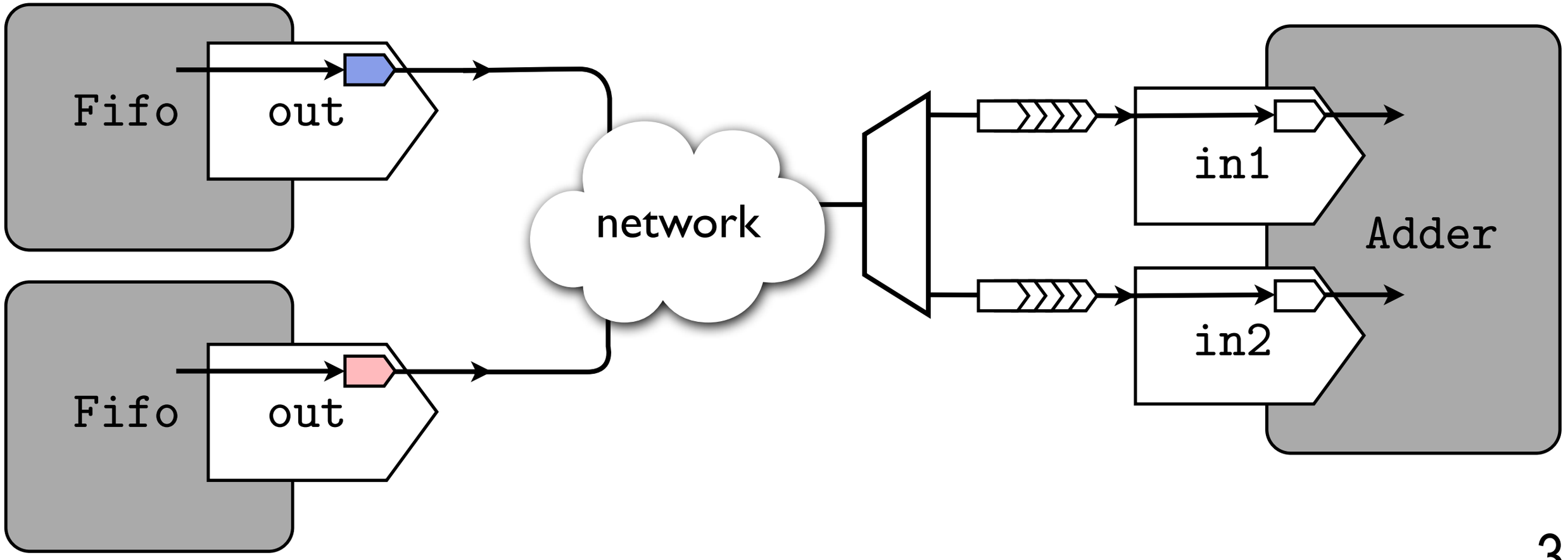

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- Delays through the network are unpredictable
  - What if all packets from one source arrive before any from the other?
  - Packets “back up into” the shared portion of the network
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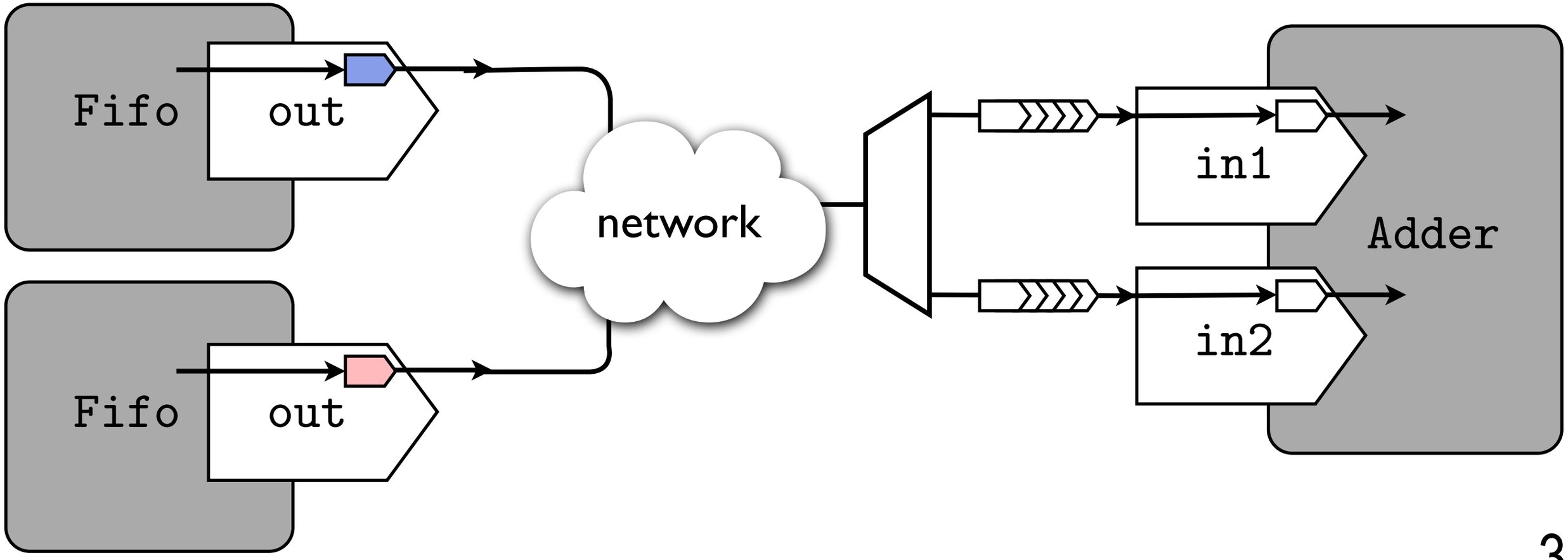

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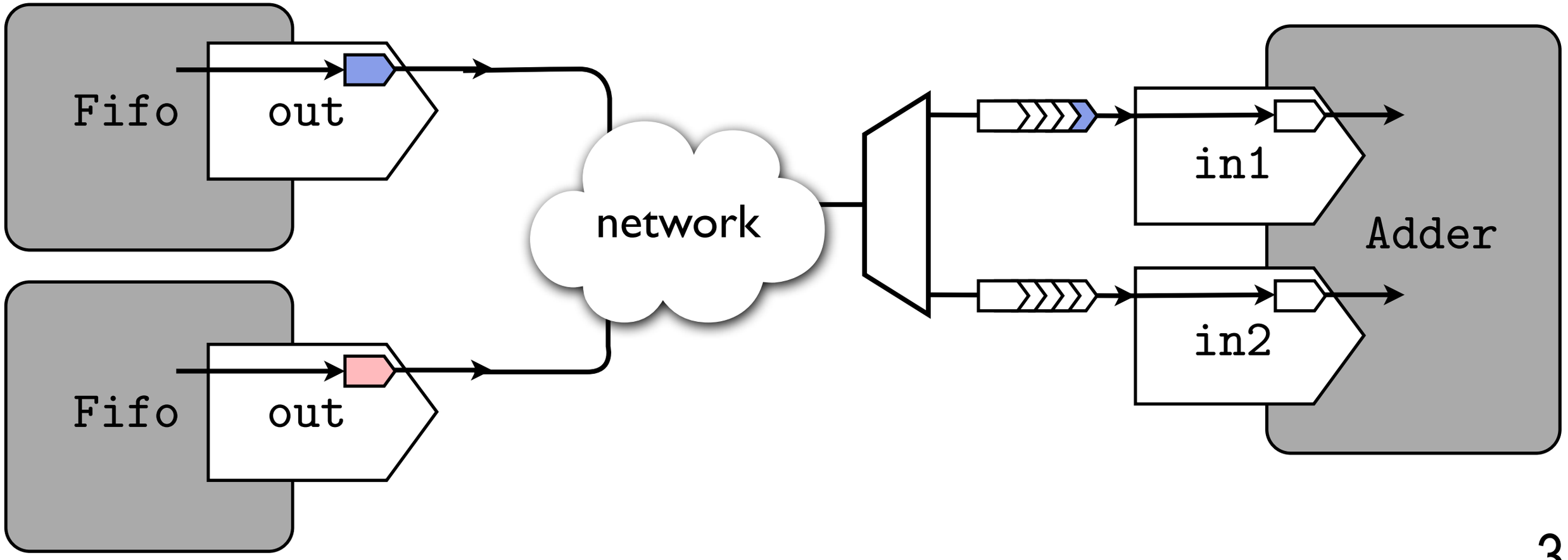

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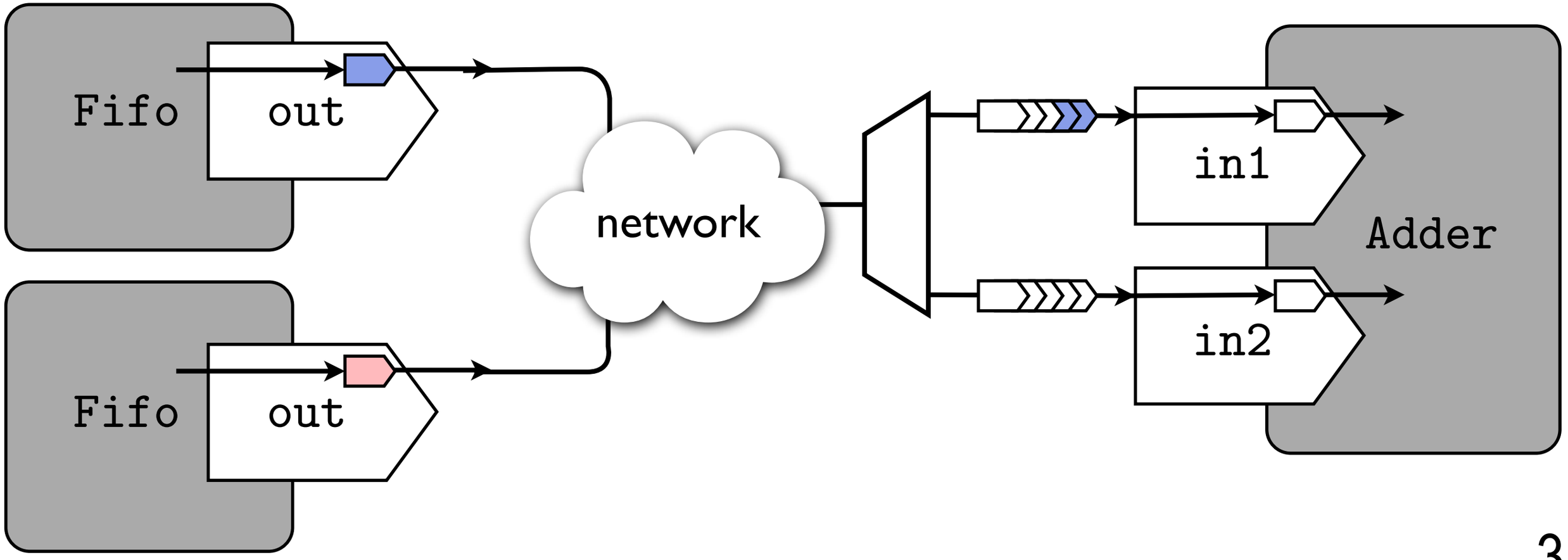

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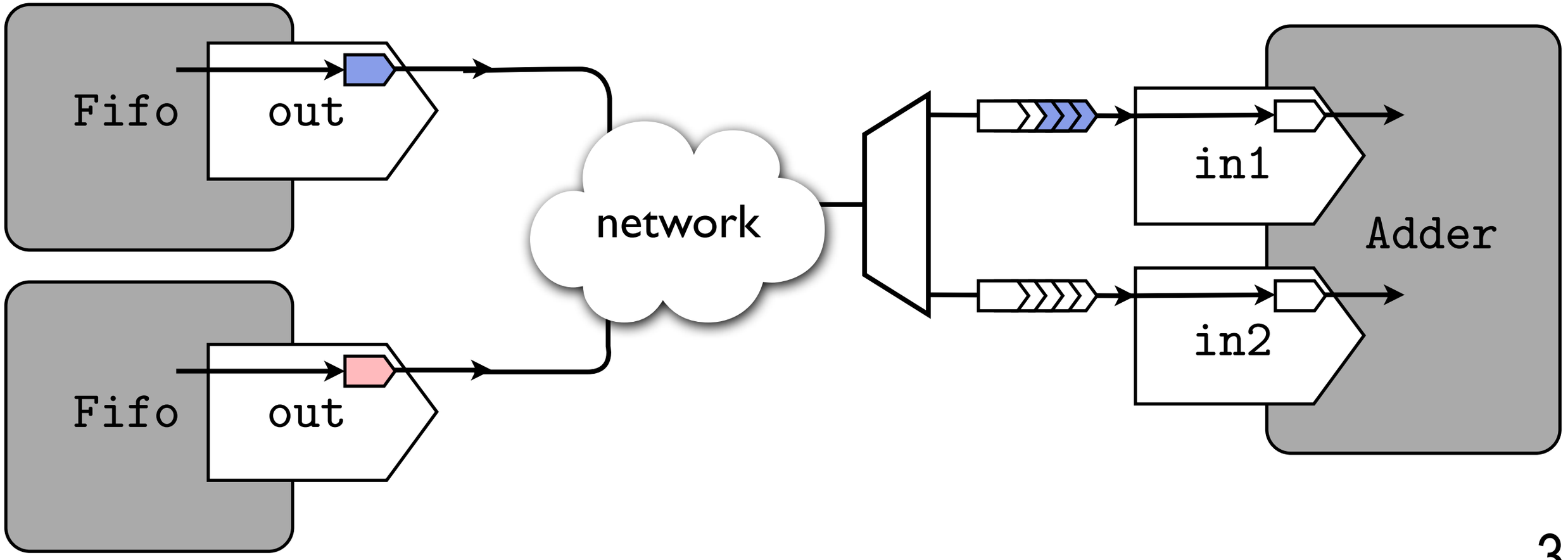

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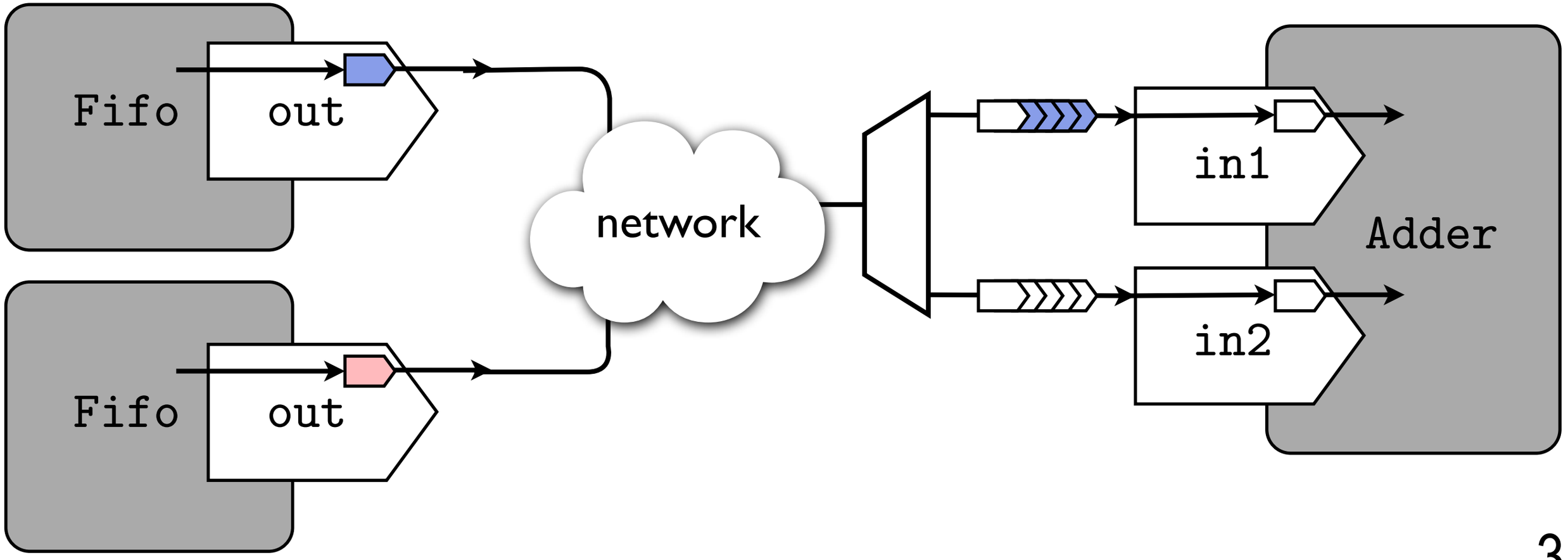

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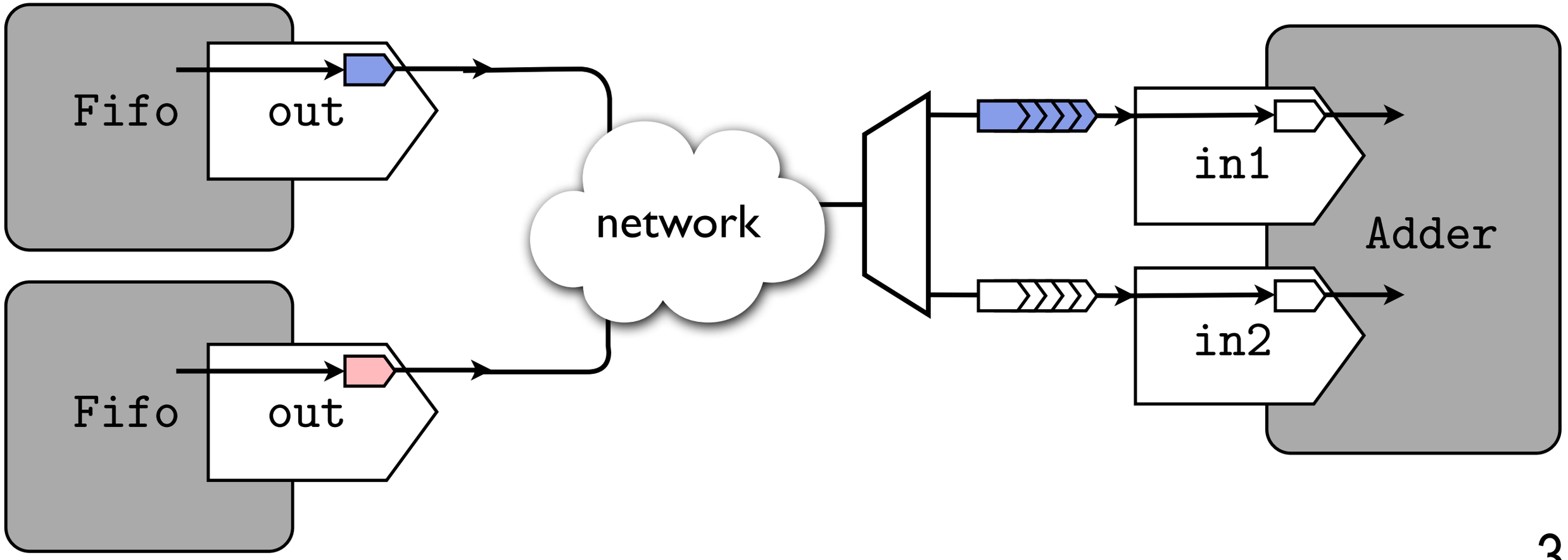

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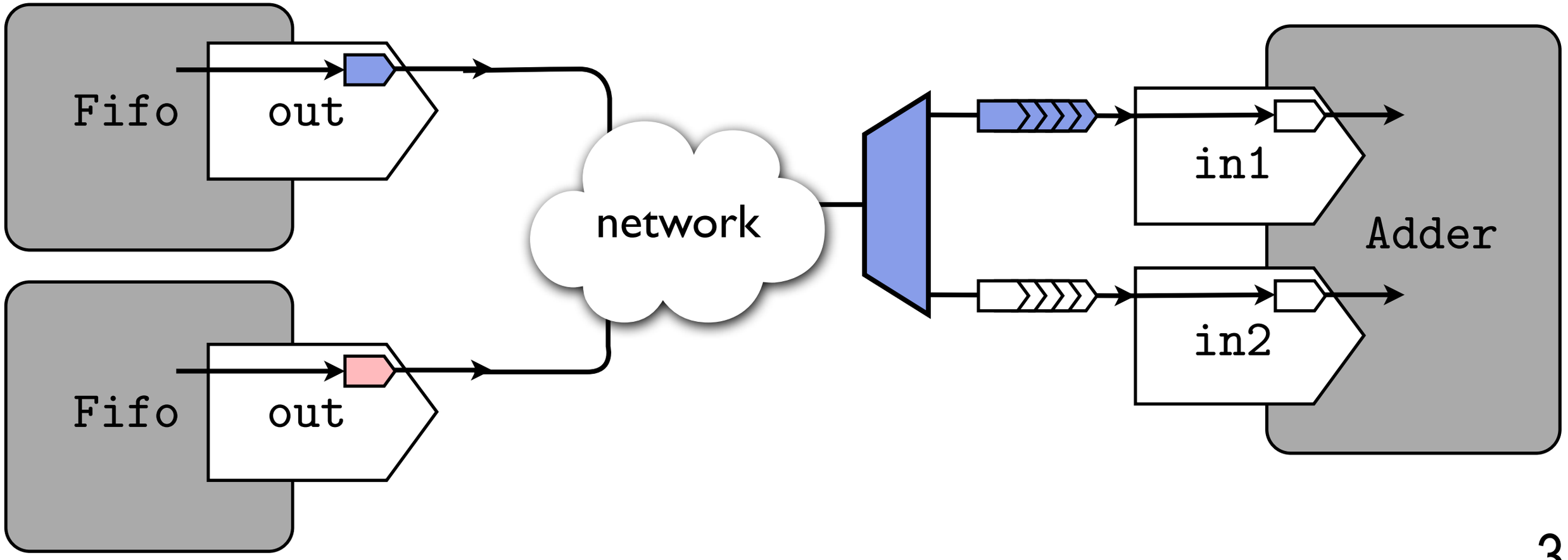

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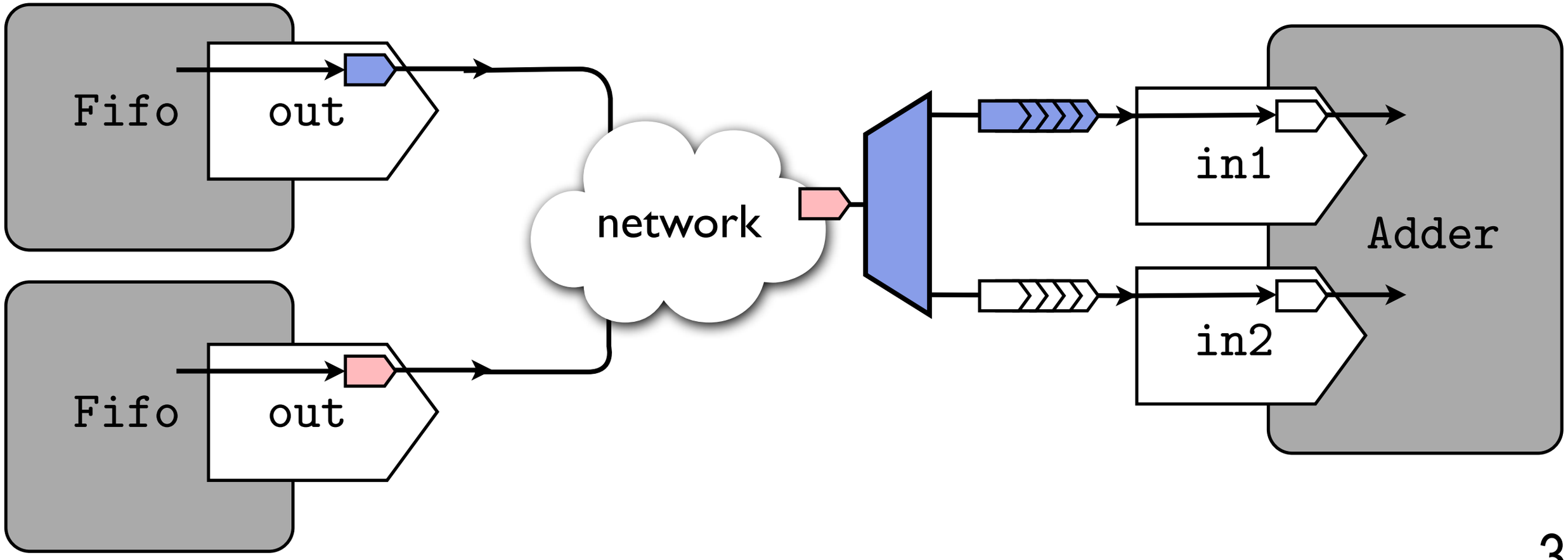

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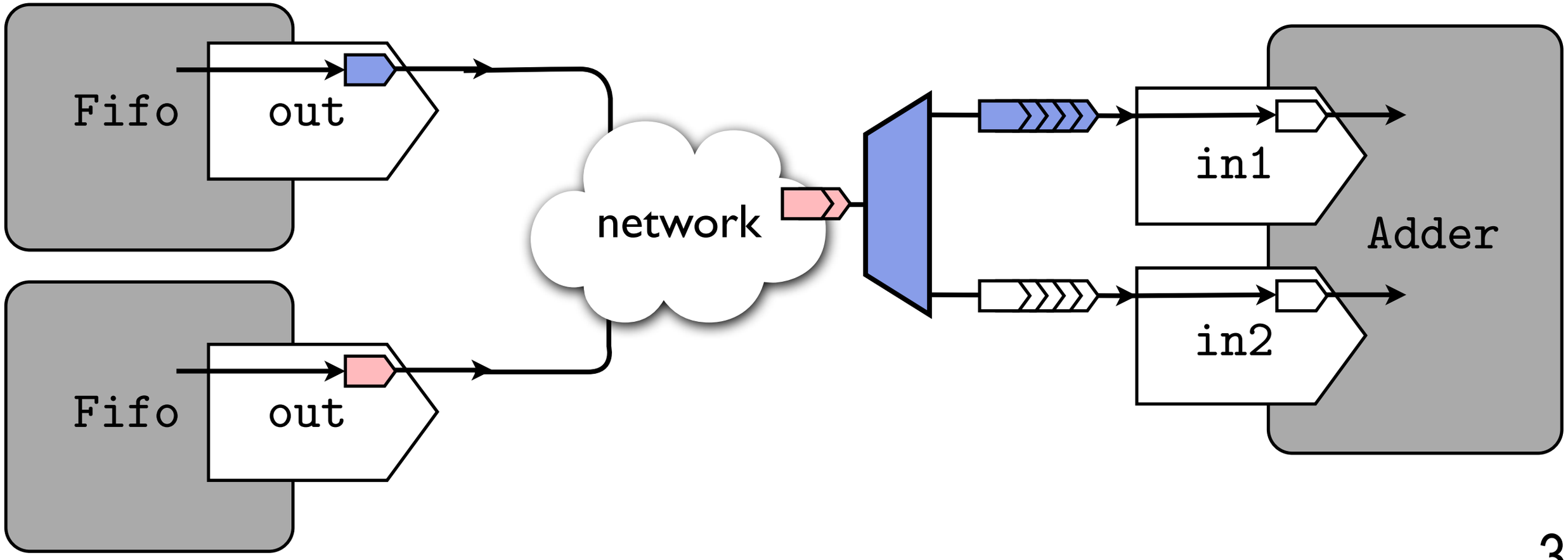

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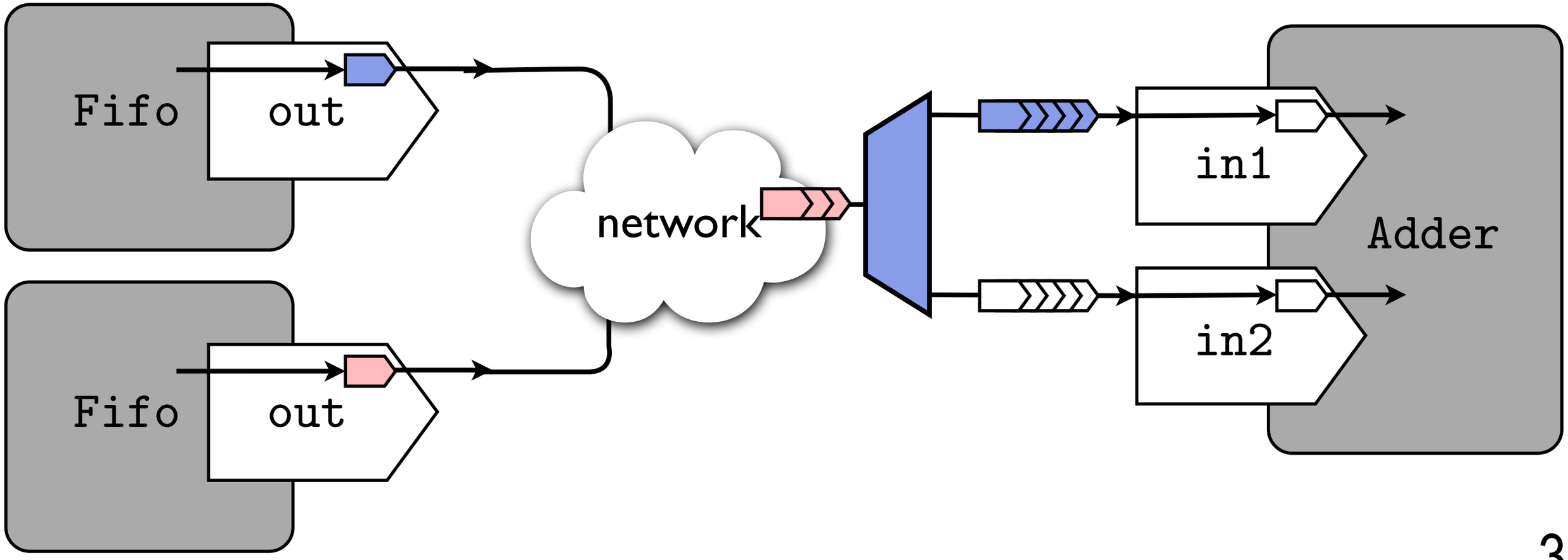

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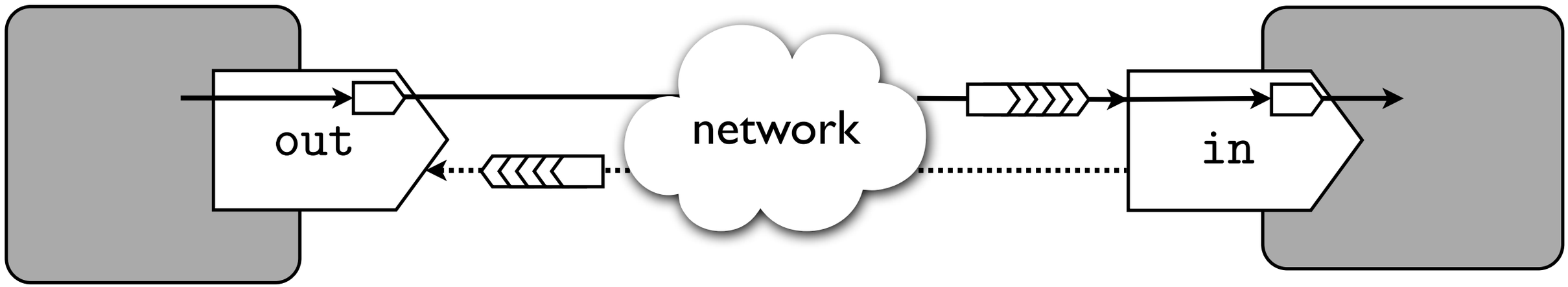
- In order to solve the clogging problem, we must establish *flow control*.
  - Ensure that the number of items in flight towards a given destination never exceeds the amount of buffering dedicated to that destination.



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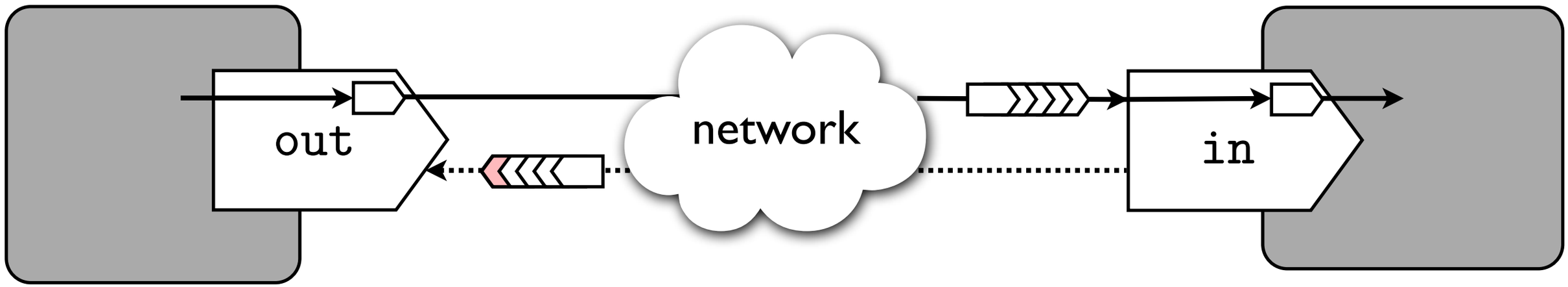

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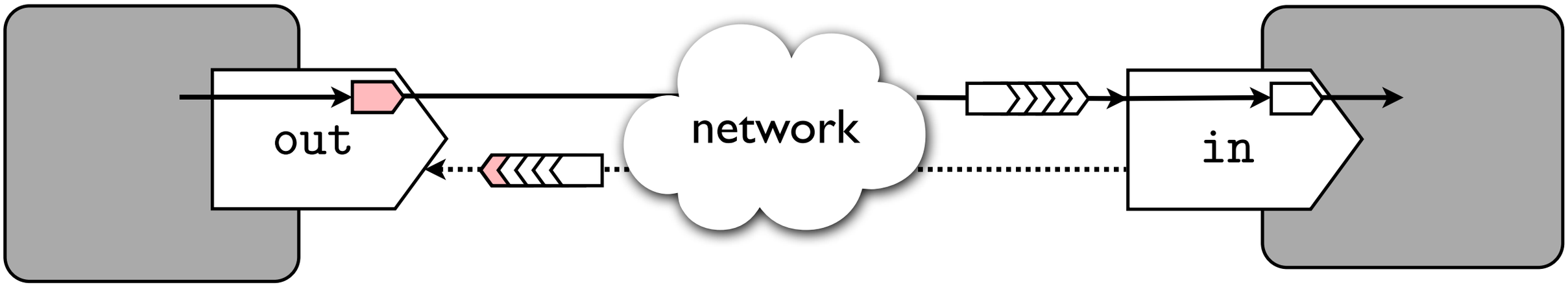

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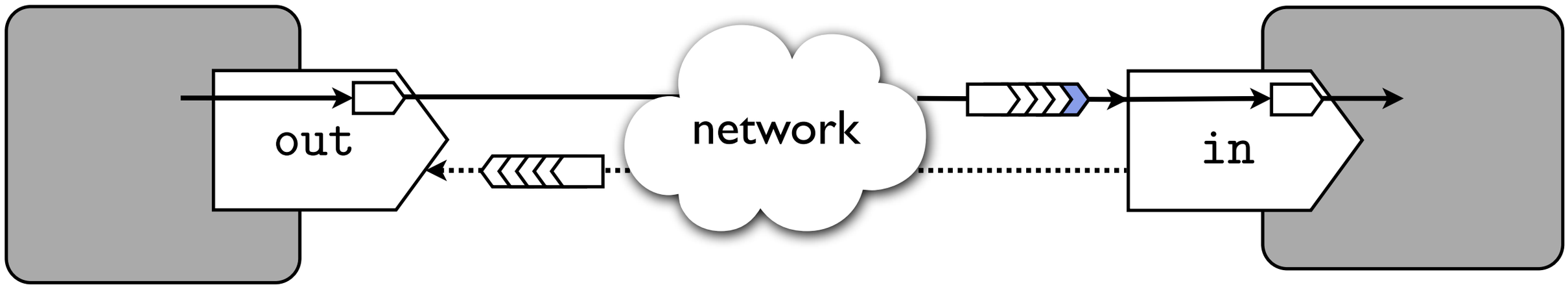

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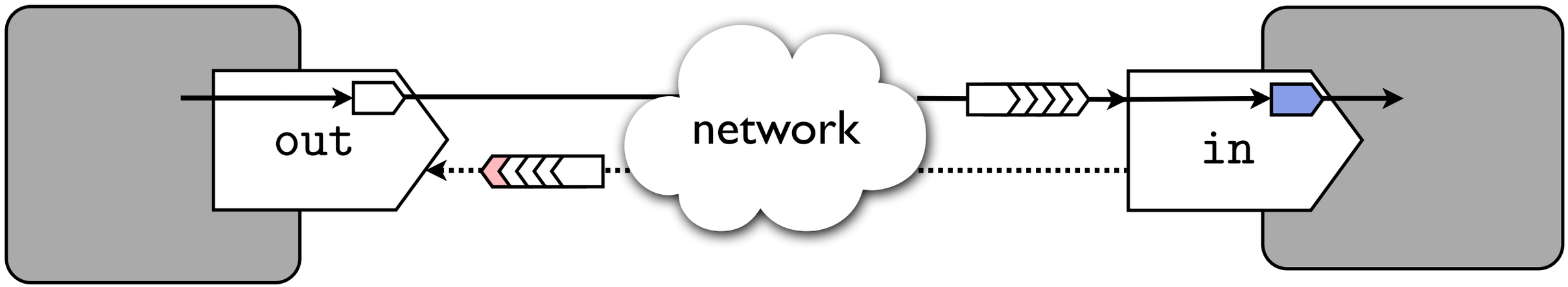

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At most one packet in the network at any time