Building a network stack for optimal throughput / low-latency trade-offs

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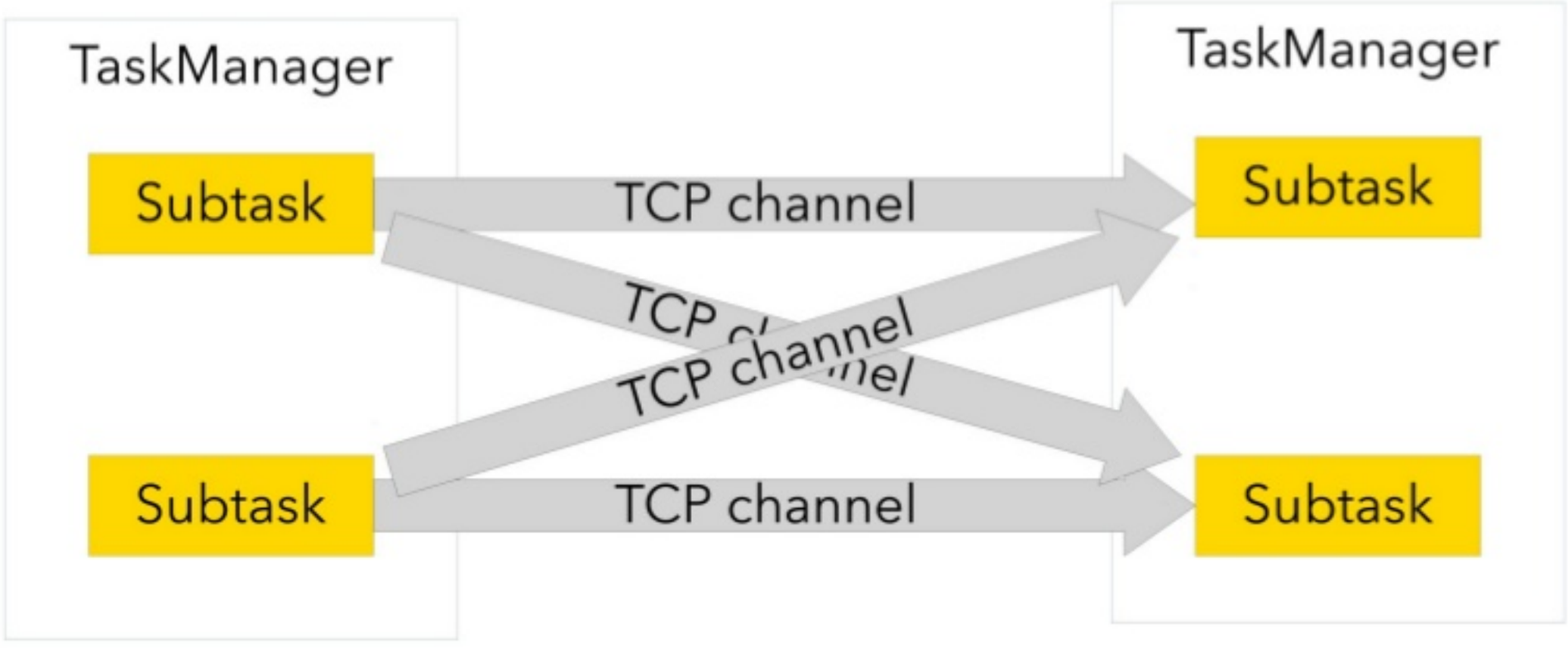
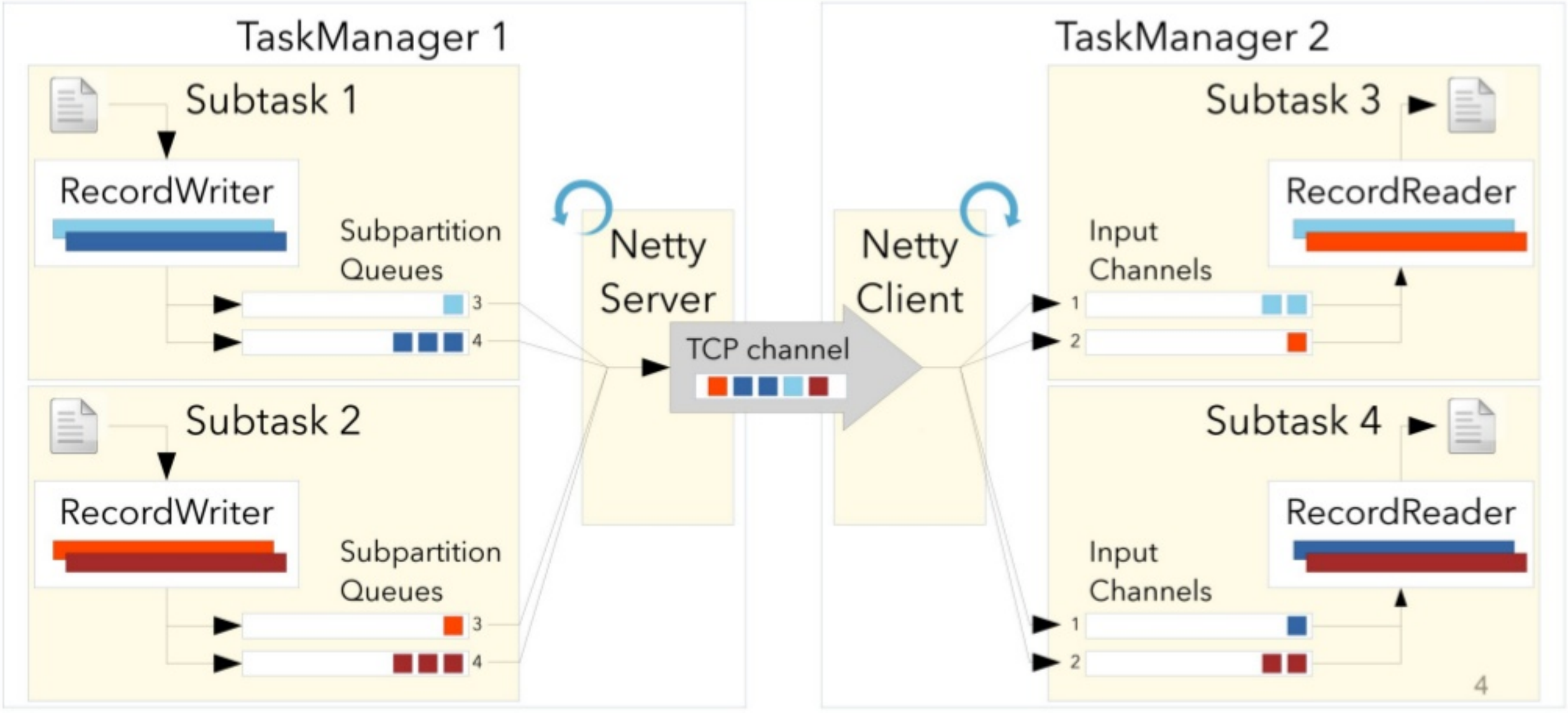
dataArtisans

Flink 1.3 Network Stack

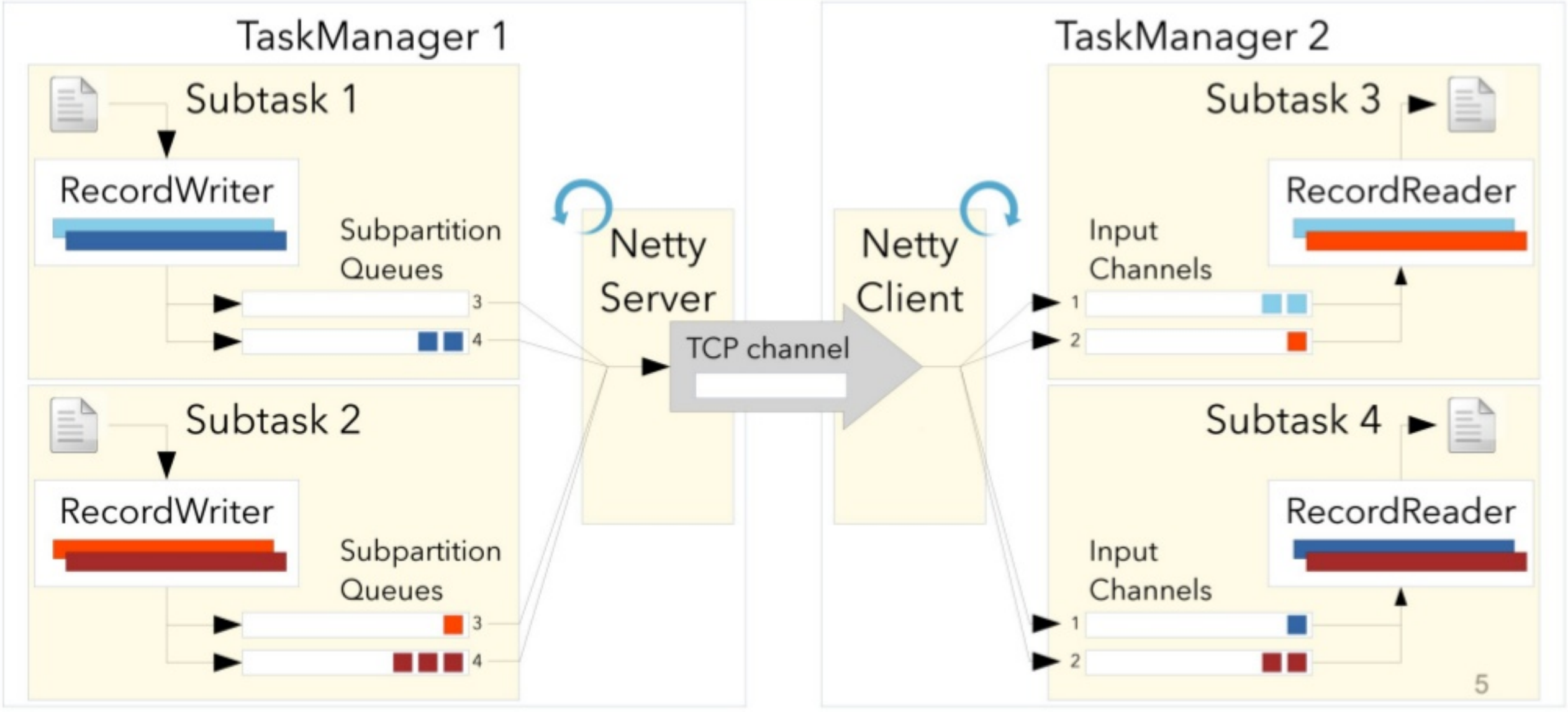
What Operators Expect...



...and what's really going on!



Record Flow with Checkpointing



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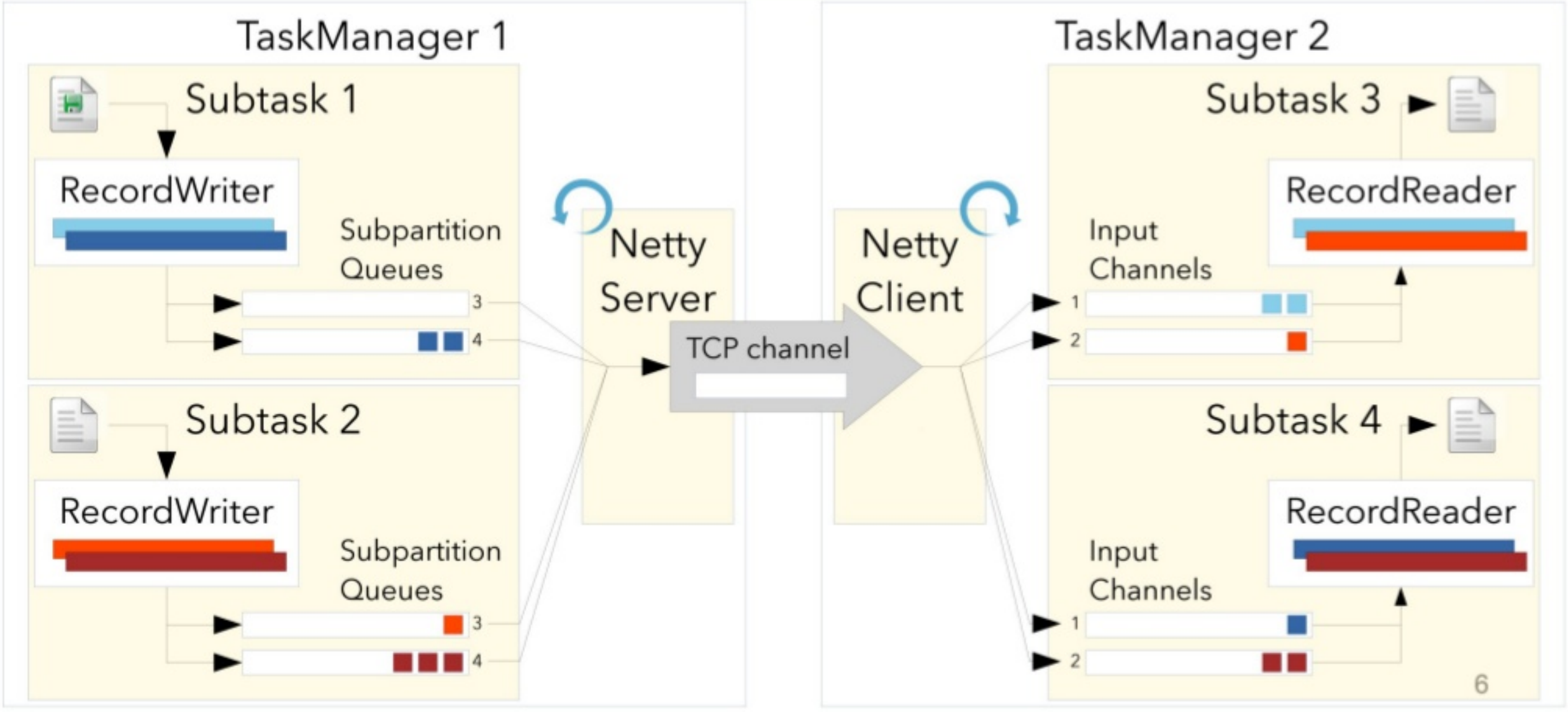

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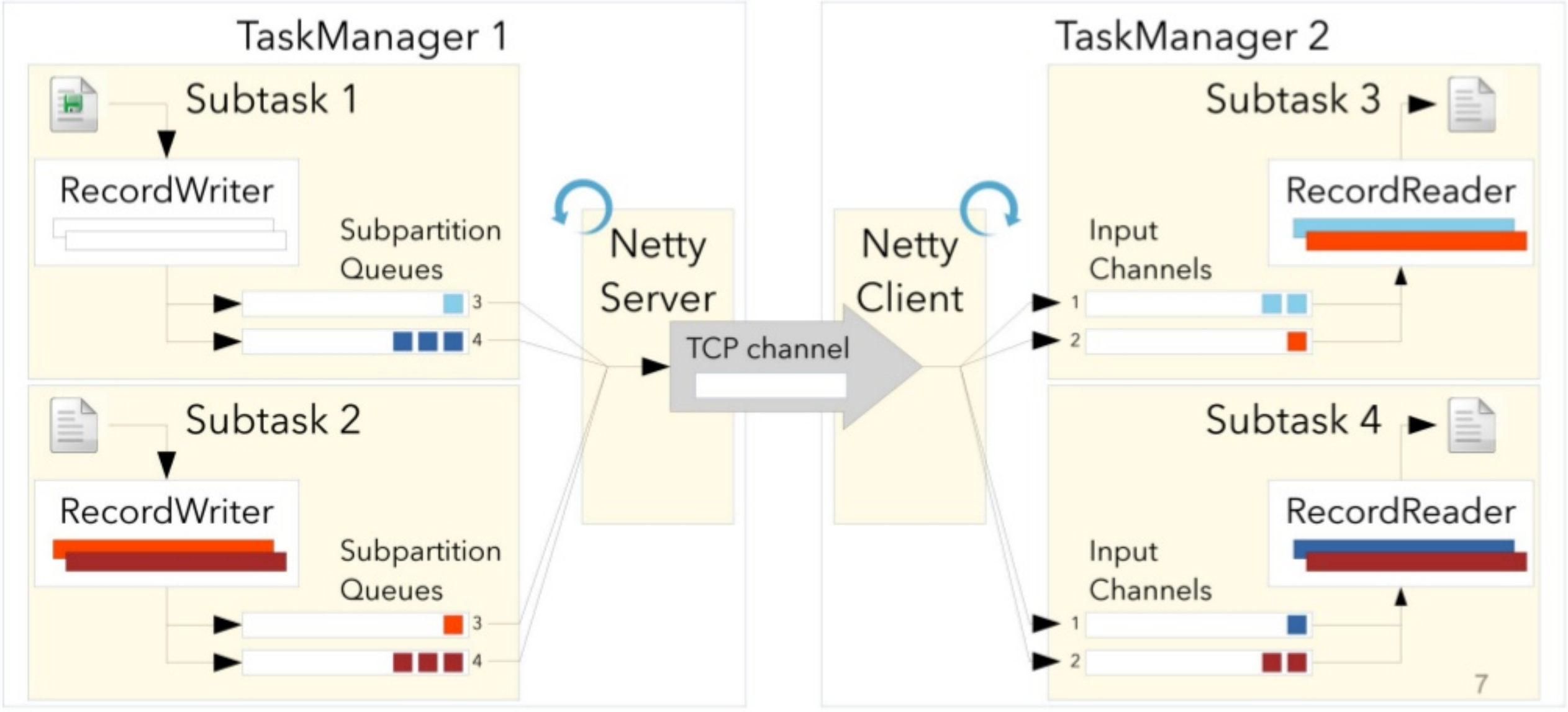

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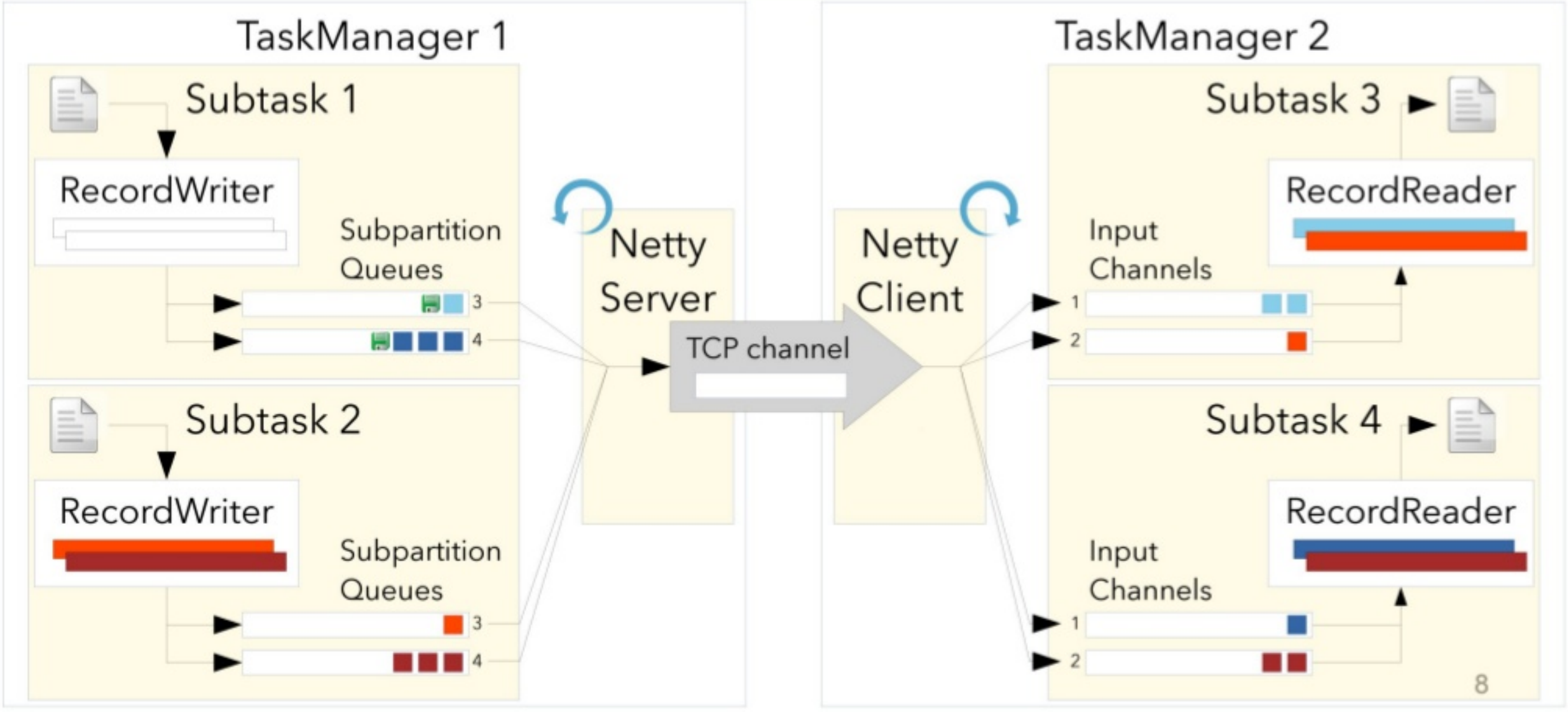

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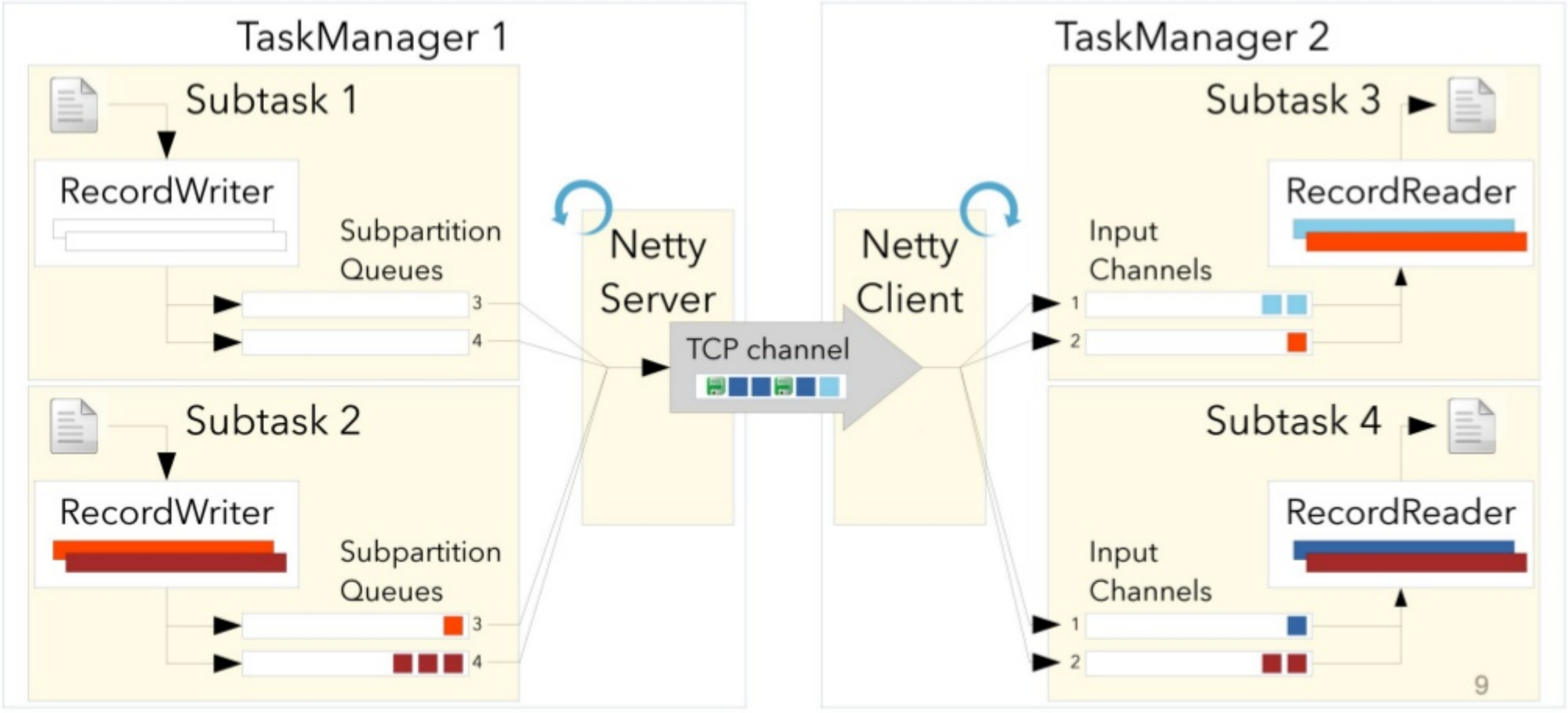

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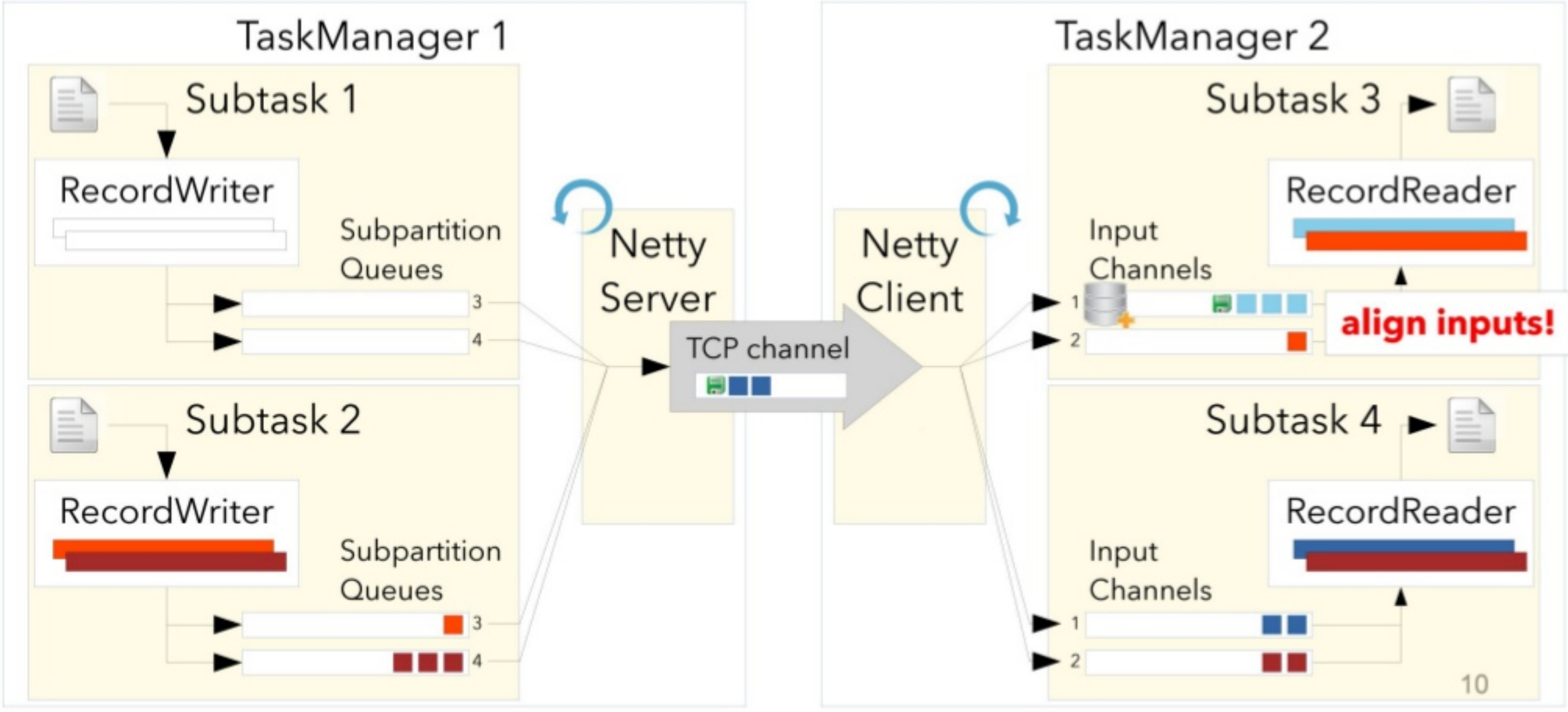

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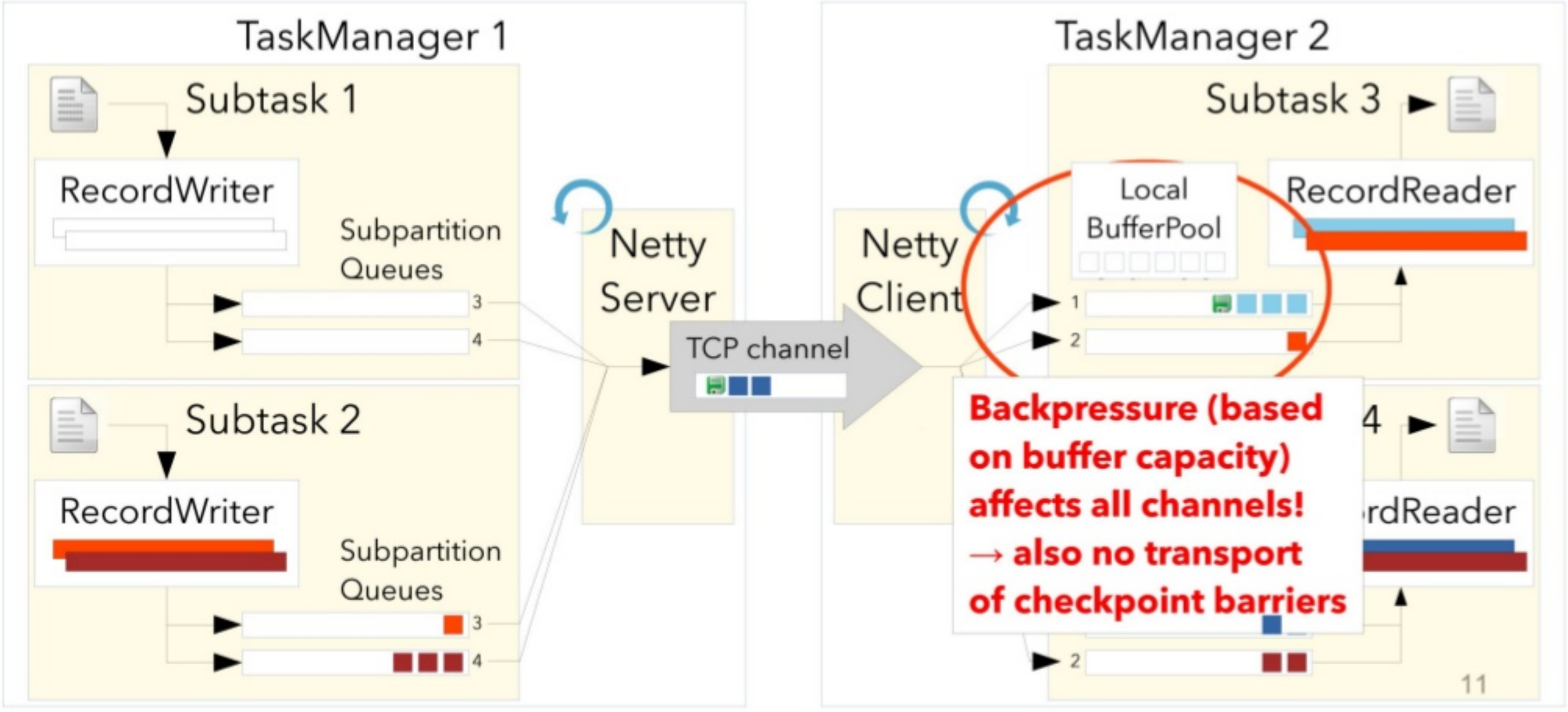
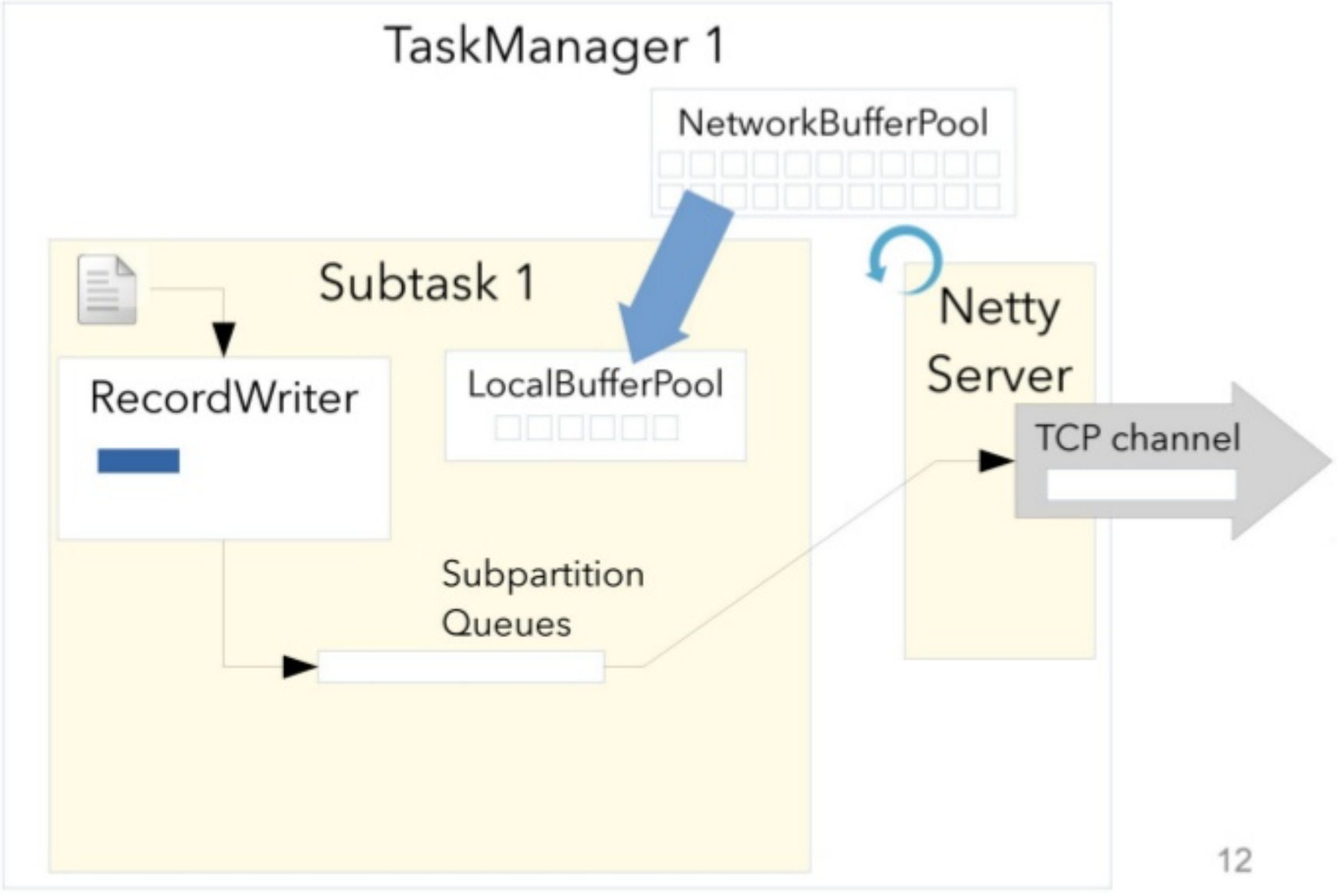


Network Buffers and Output Flusher



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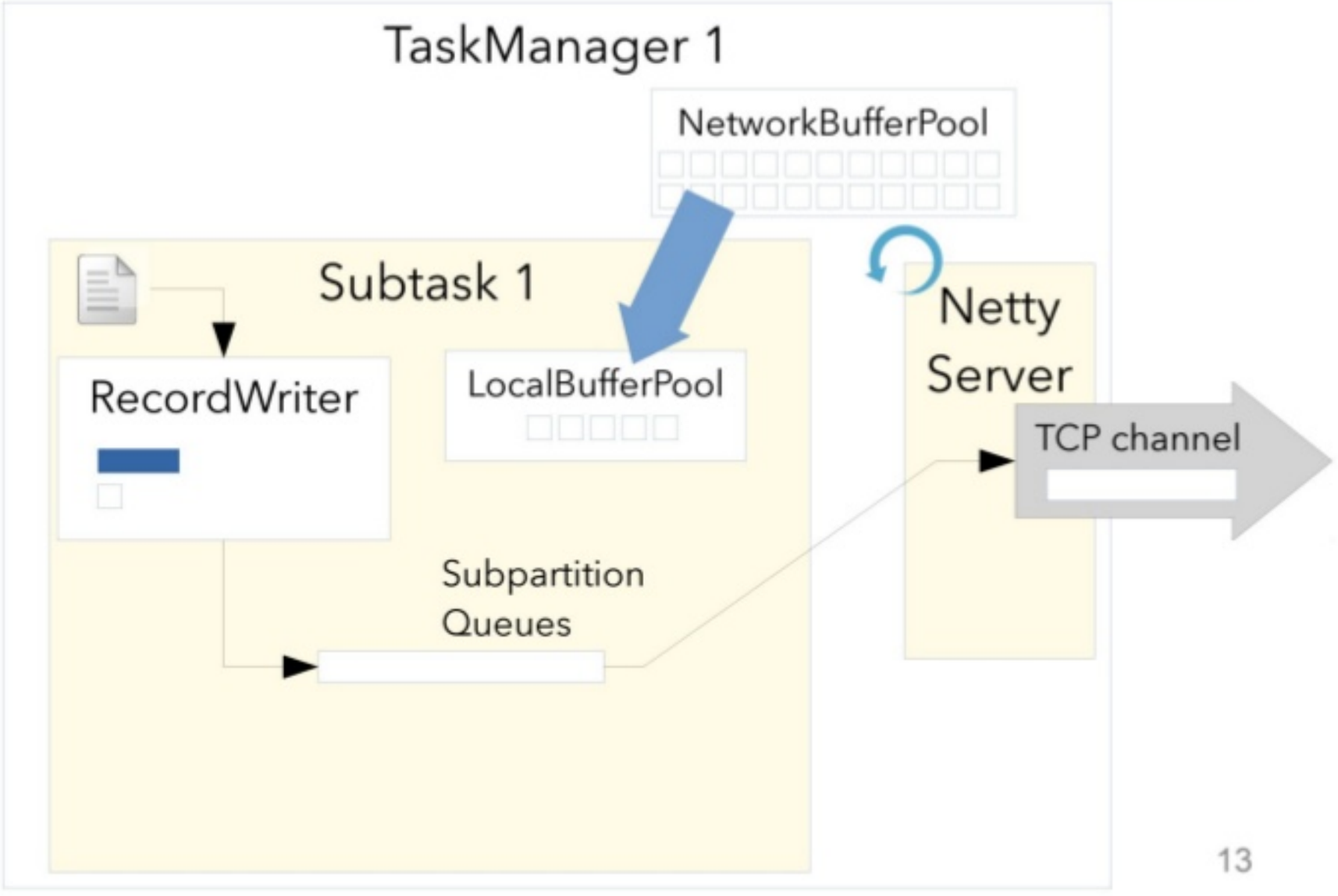

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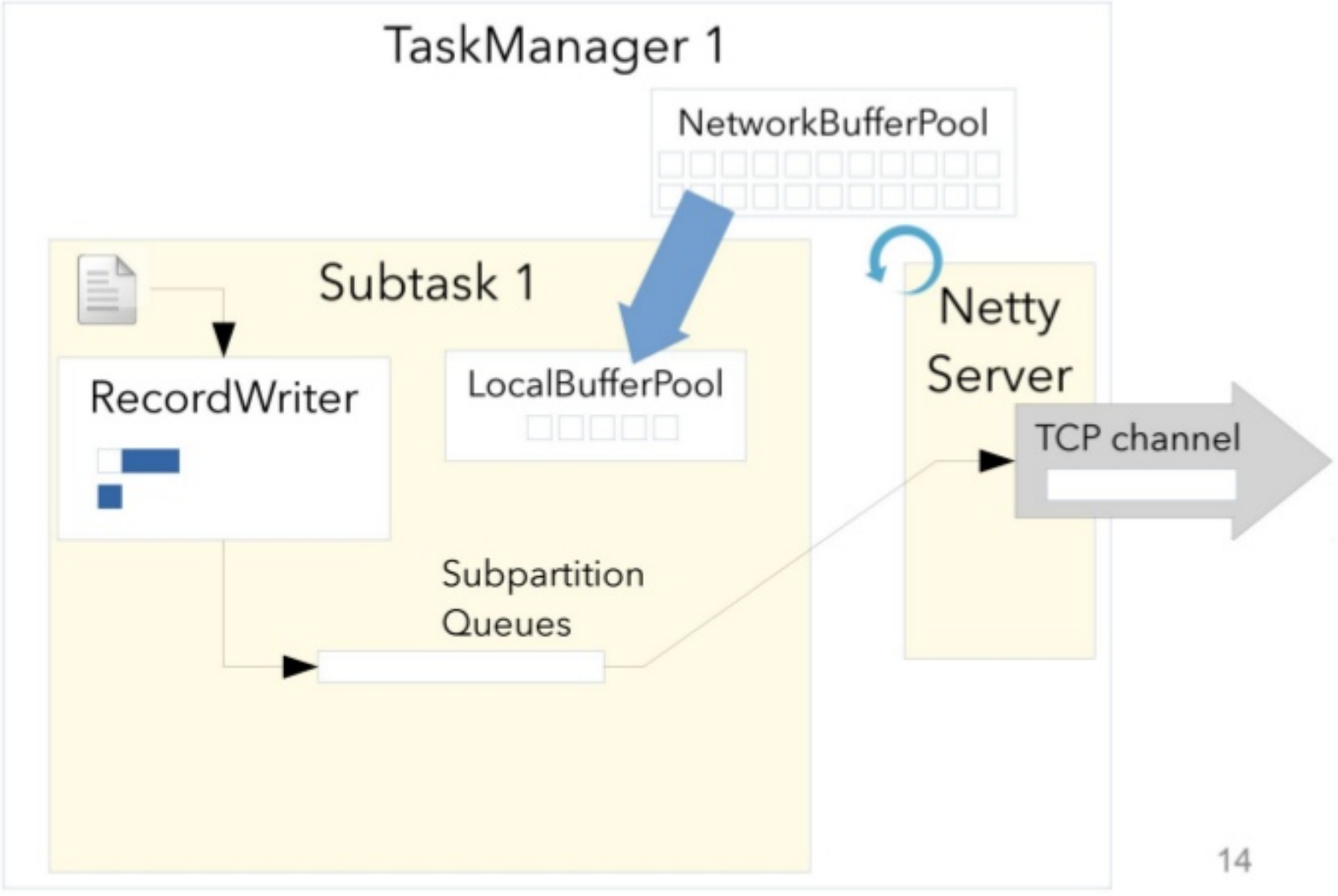

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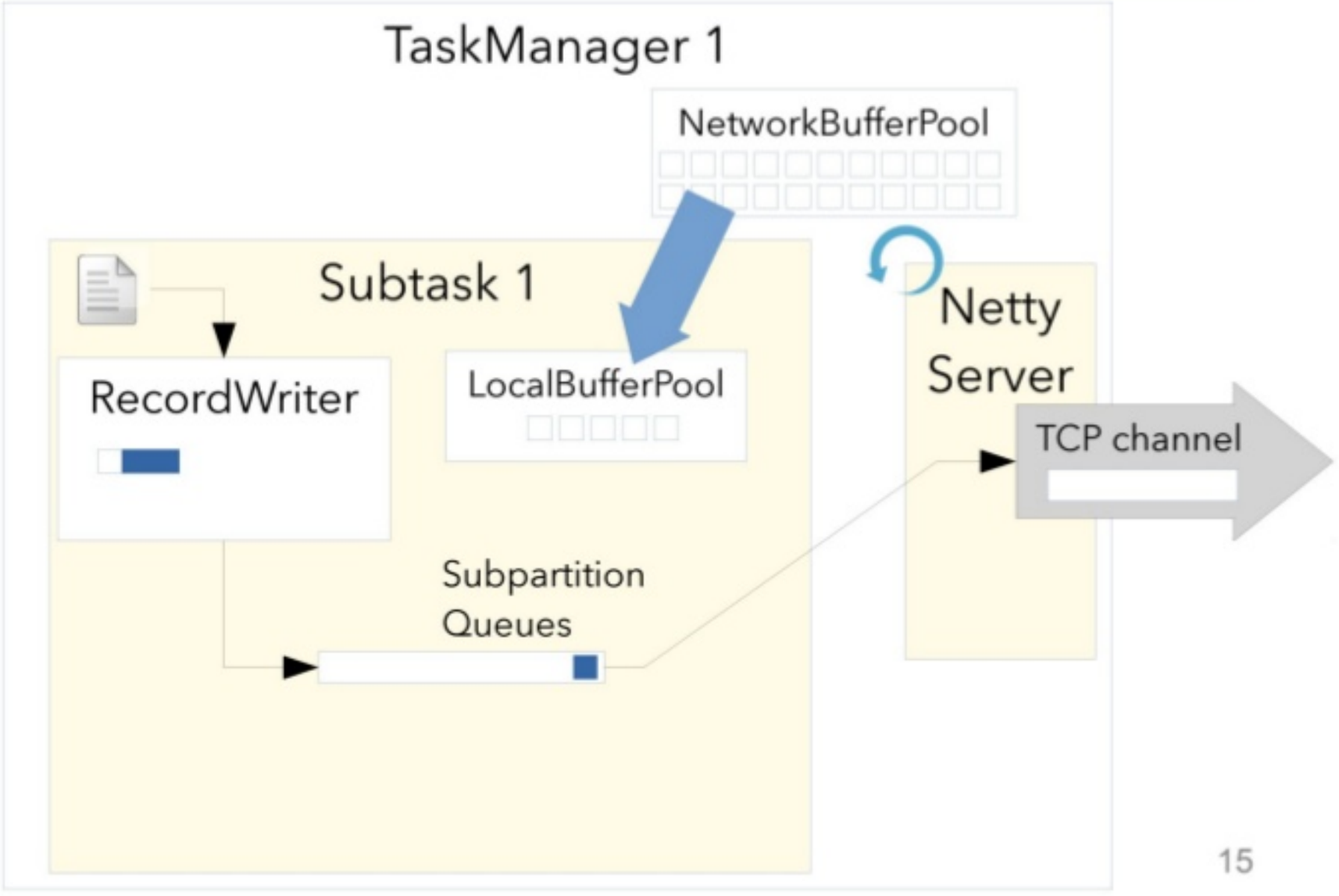

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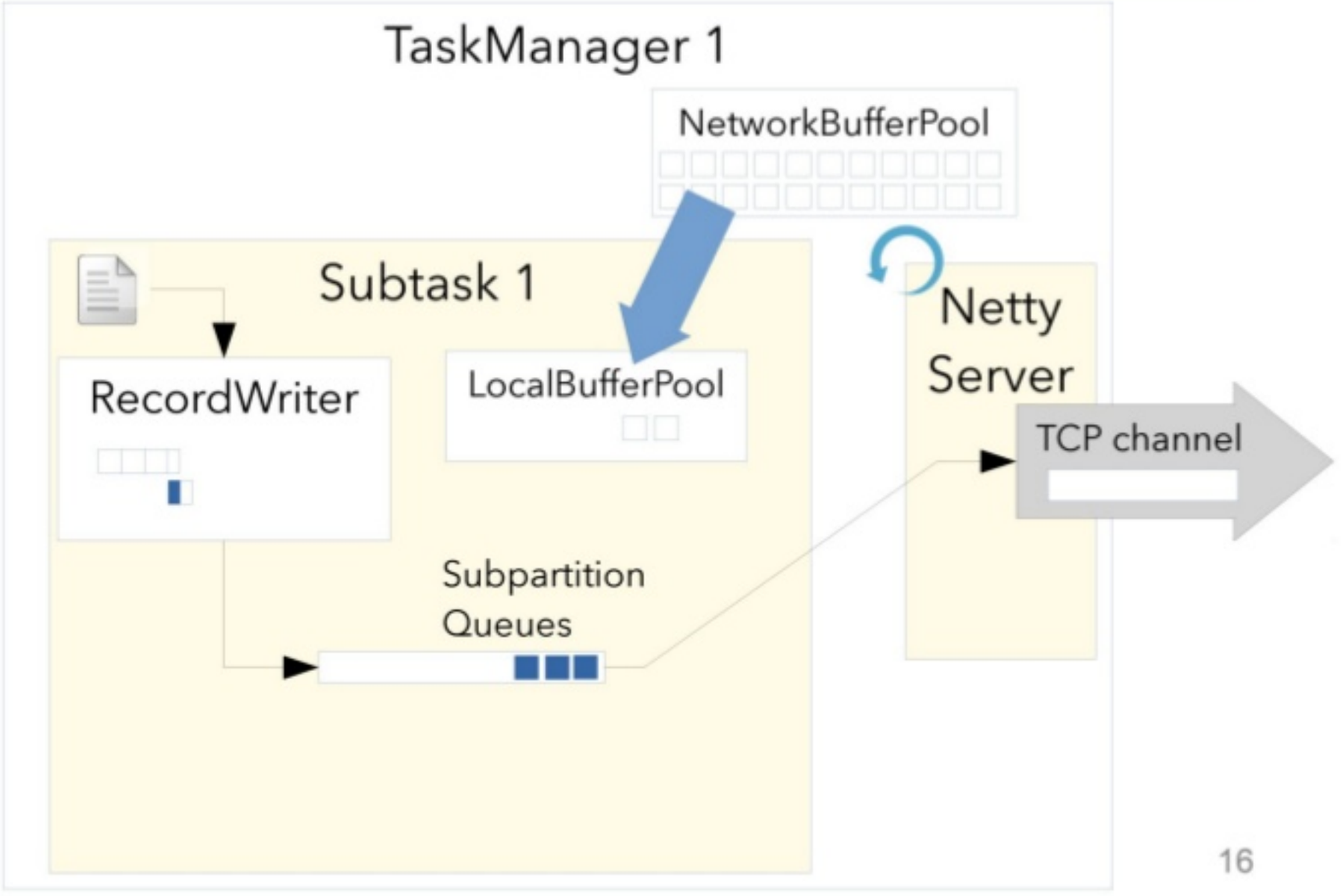
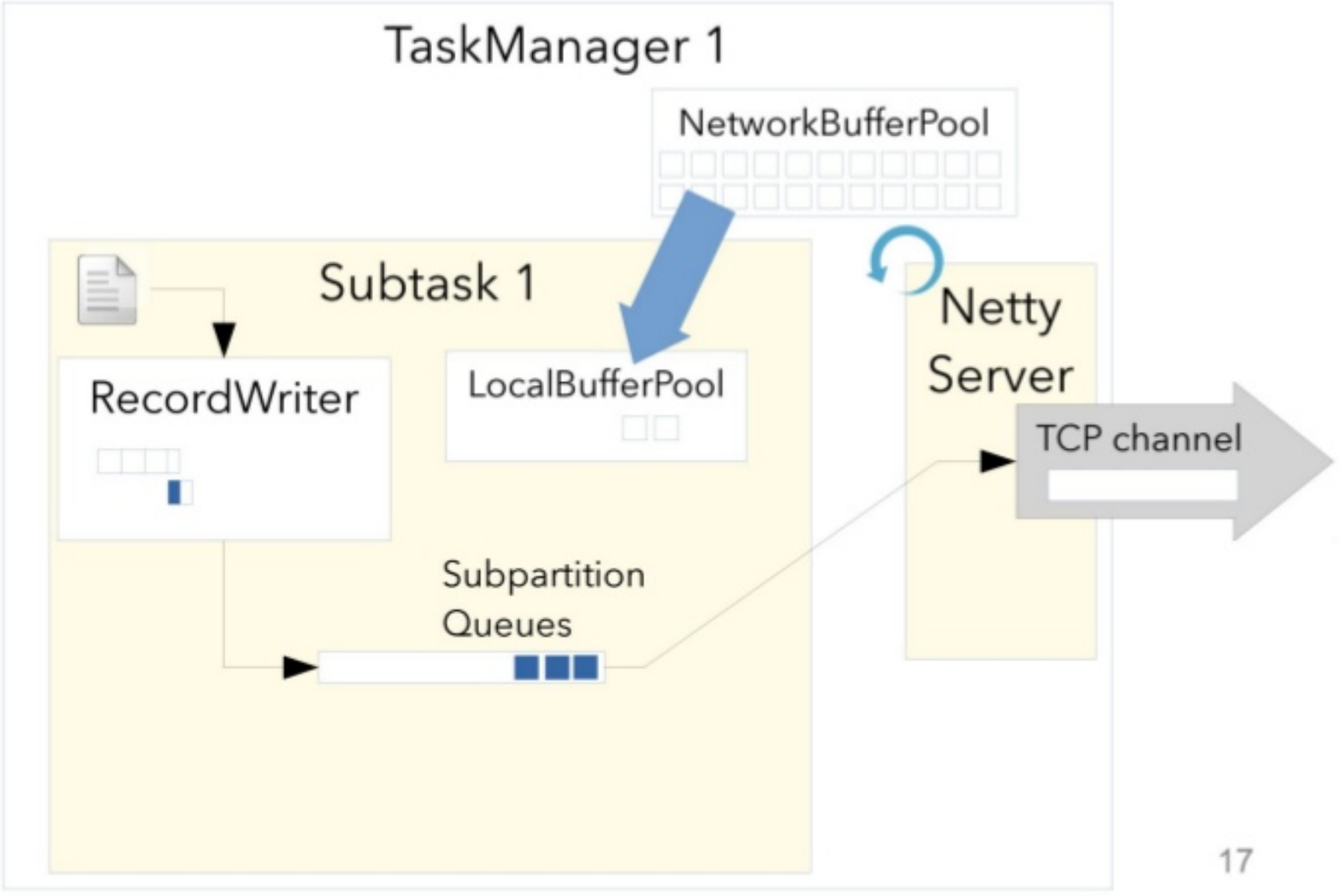


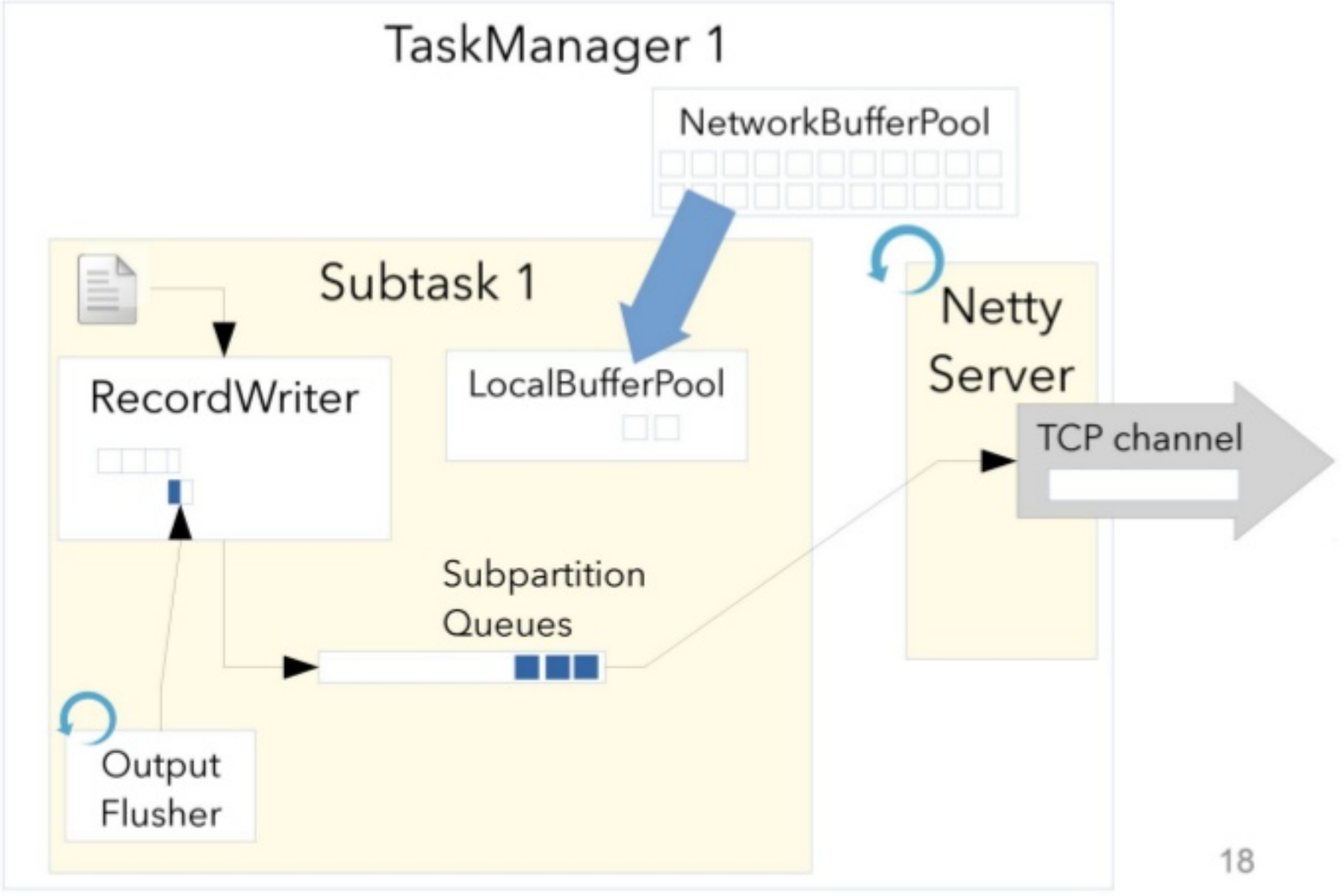
Network Buffers and Output Flusher

- Variant 1:
  send partial buffer
  right away
- Variant 2:
  wait for buffer to
  become full



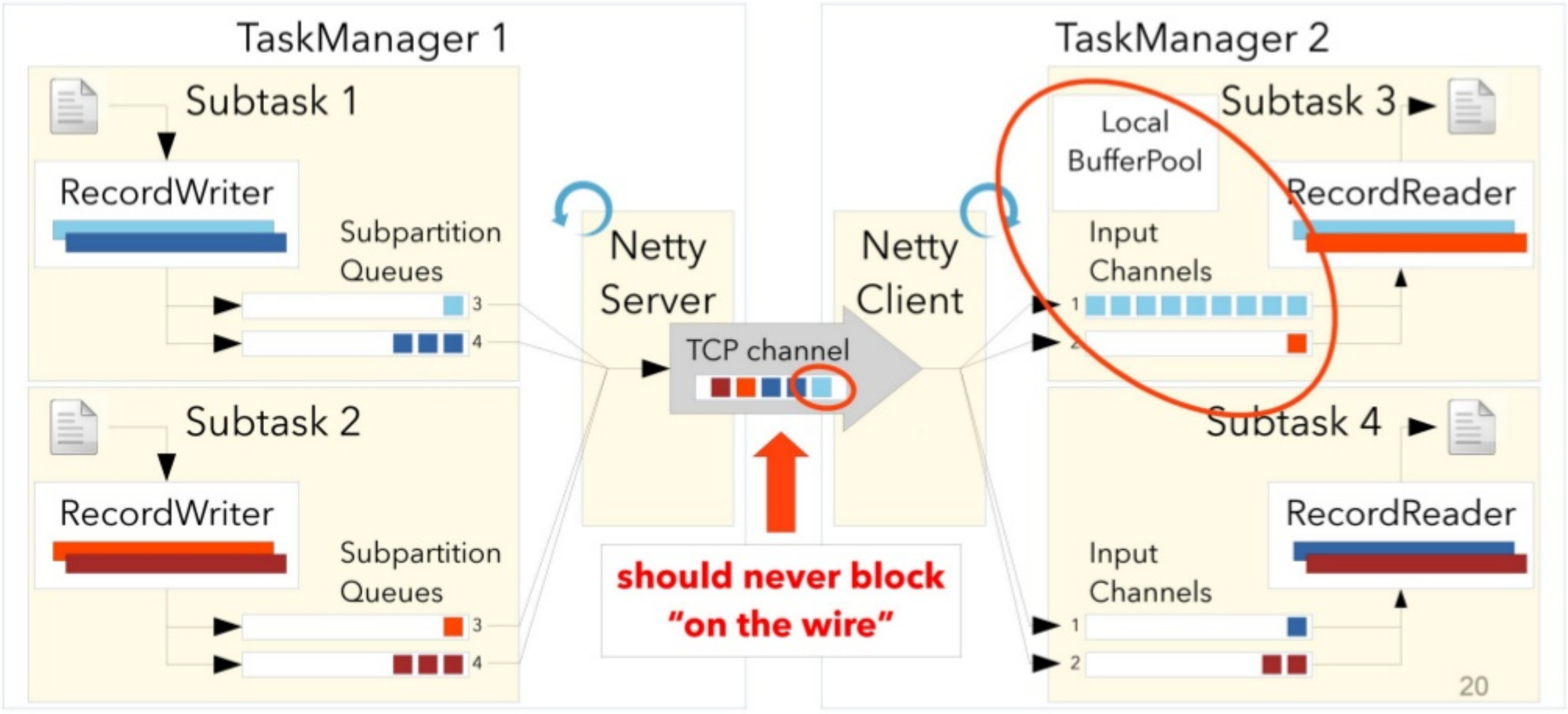
Network Buffers and Output Flusher

- Variant 1:
  send p… …ffer
  ri… …ay
  low throughput!
- Variant 2:
  wait fo… … to
  be… …e full
  high latency!
- Variant 3:
  flush buffers when full or after timeout (default: 100ms)

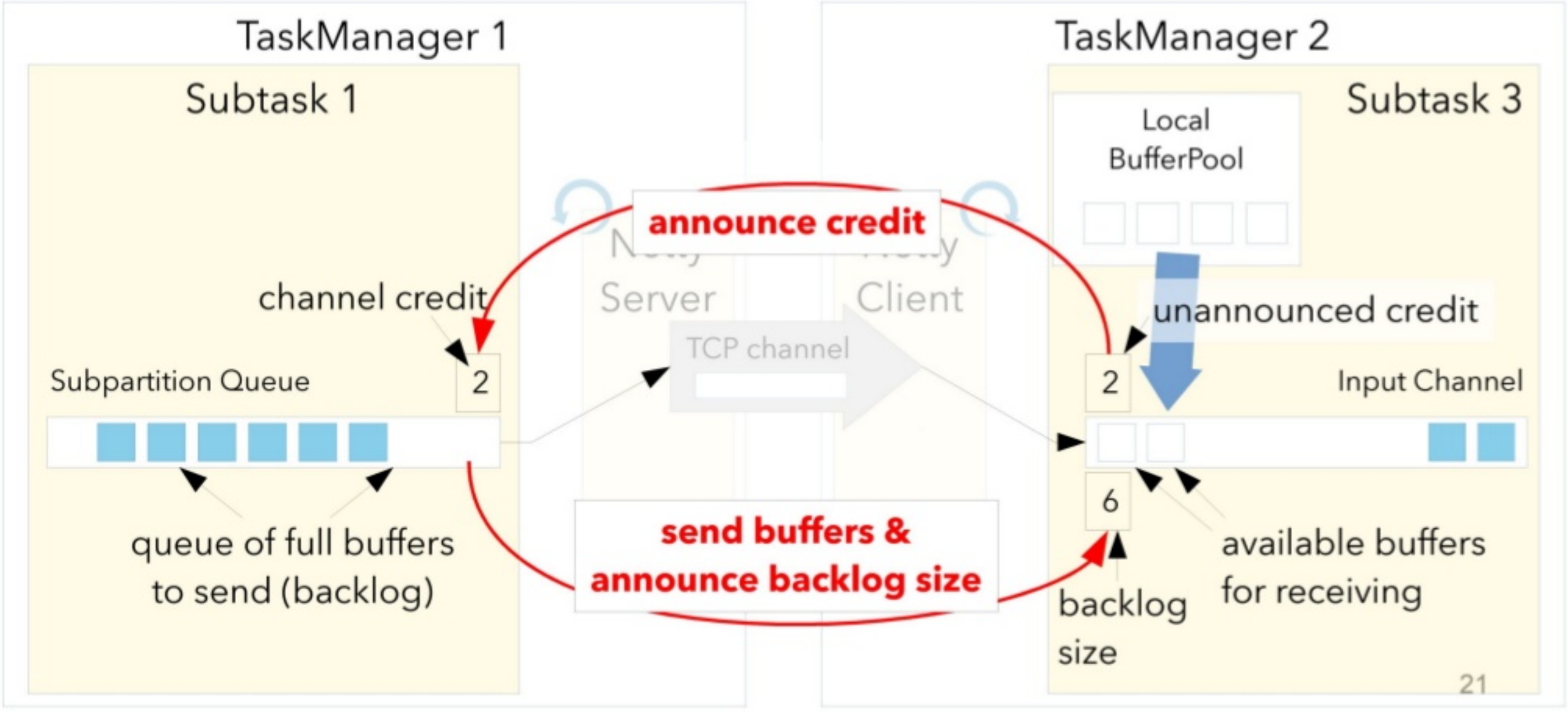


Adding Flow Control

Backpressure and Flow Control



Credit-Based Flow Control (FLINK-7282)



Credit-Based Flow Control (FLINK-7282)

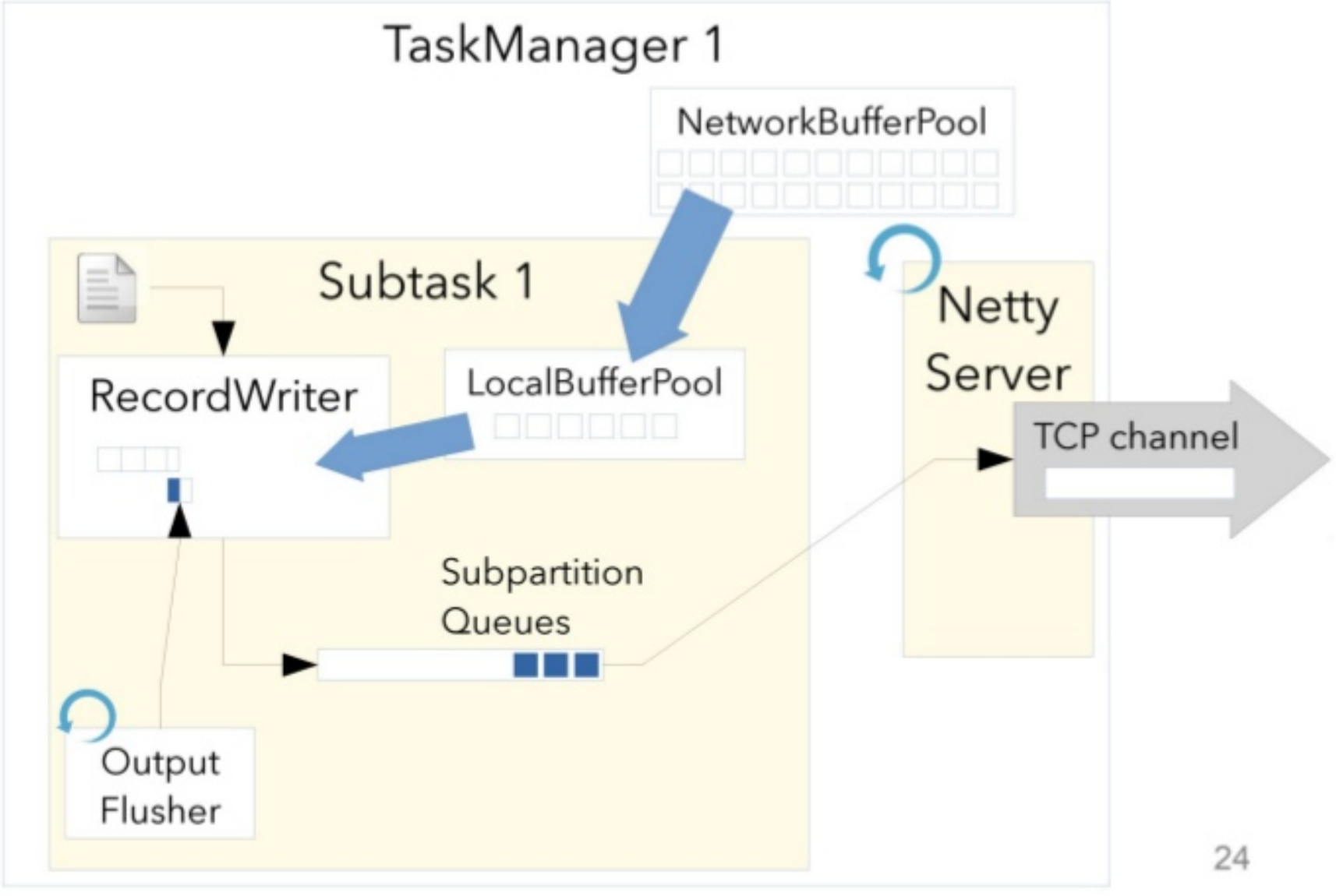
- no messages on the wire for which the receiver does not have buffers
  → single channel no longer stalls multiplexed input
- fine-grained backpressure control
- Improves checkpoint alignments
- cost: additional announce messages → piggy-backed into BufferRequest and BufferResponse messages

Event-Driven Network IO

How to remove the Output Flusher

Event-Driven Flushes (FLINK-7612)

- Variant 3:
  flush buffers when full
  or after timeout
  (default: 100ms)

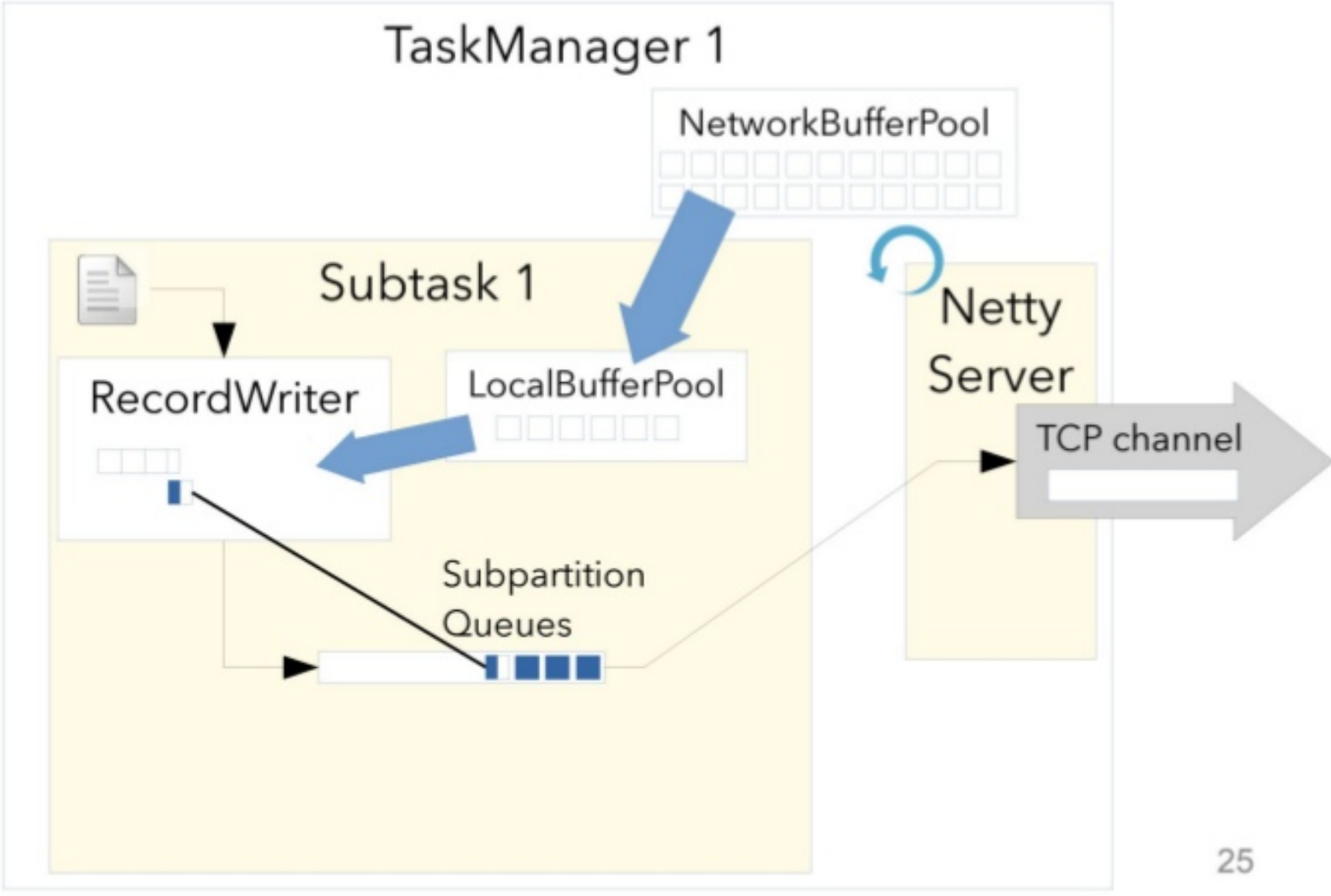


Event-Driven Flushes (FLINK-7612)

- Variant 3:
  flush buff[illegible]n full or after [illegible](default: 100ms)

Flink 1.3

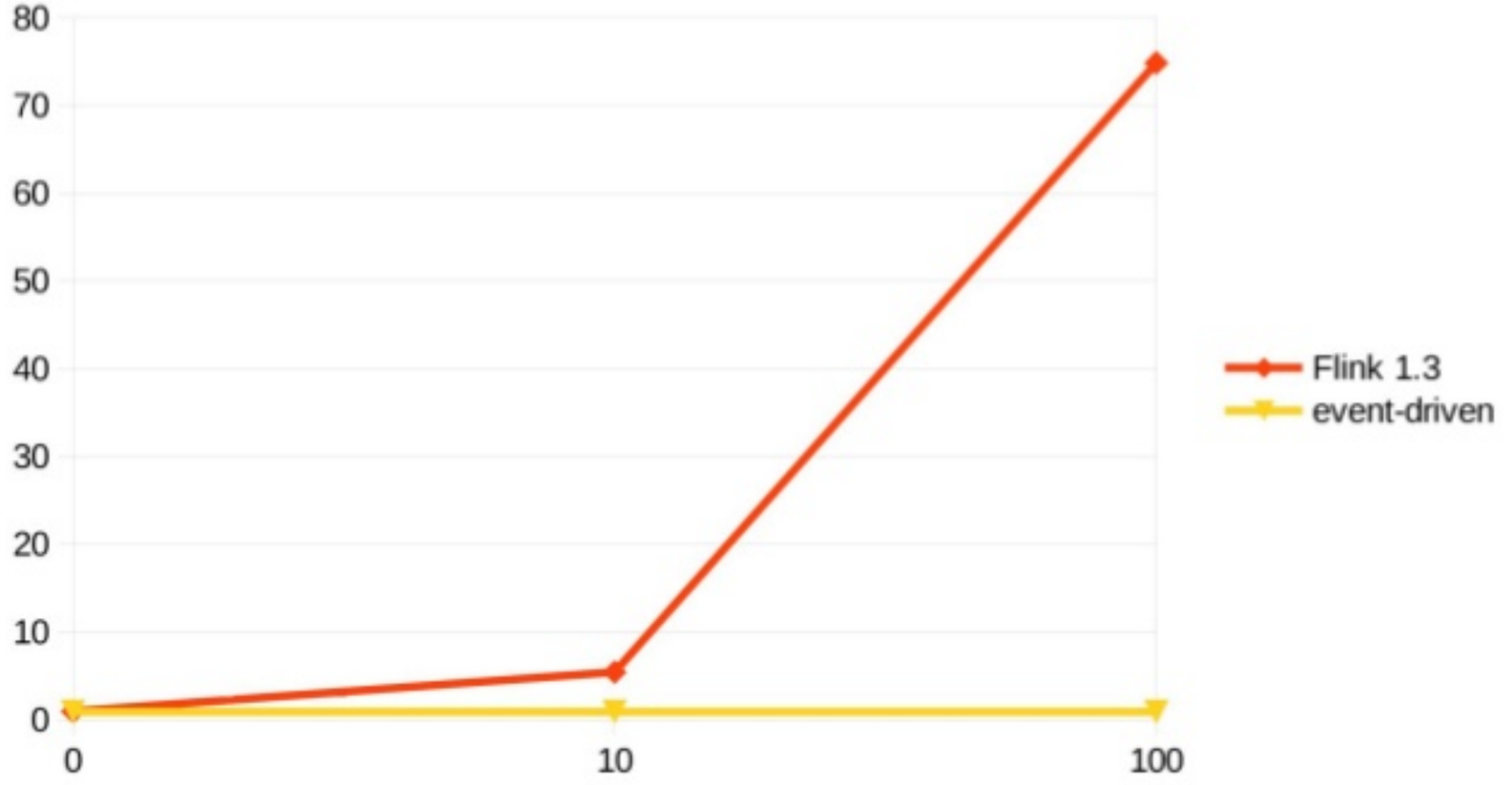
- Variant 4:
  add to subpartition queue but continue writing
  - Transmits whenever the network is ready (low latency)
  - Allows buffers to fill when not (high throughput)

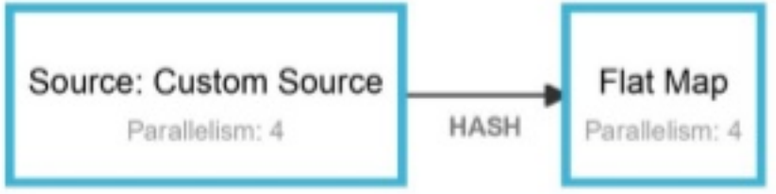


Latency with/out Output Flusher

Slow source:

- 1 event every 100ms



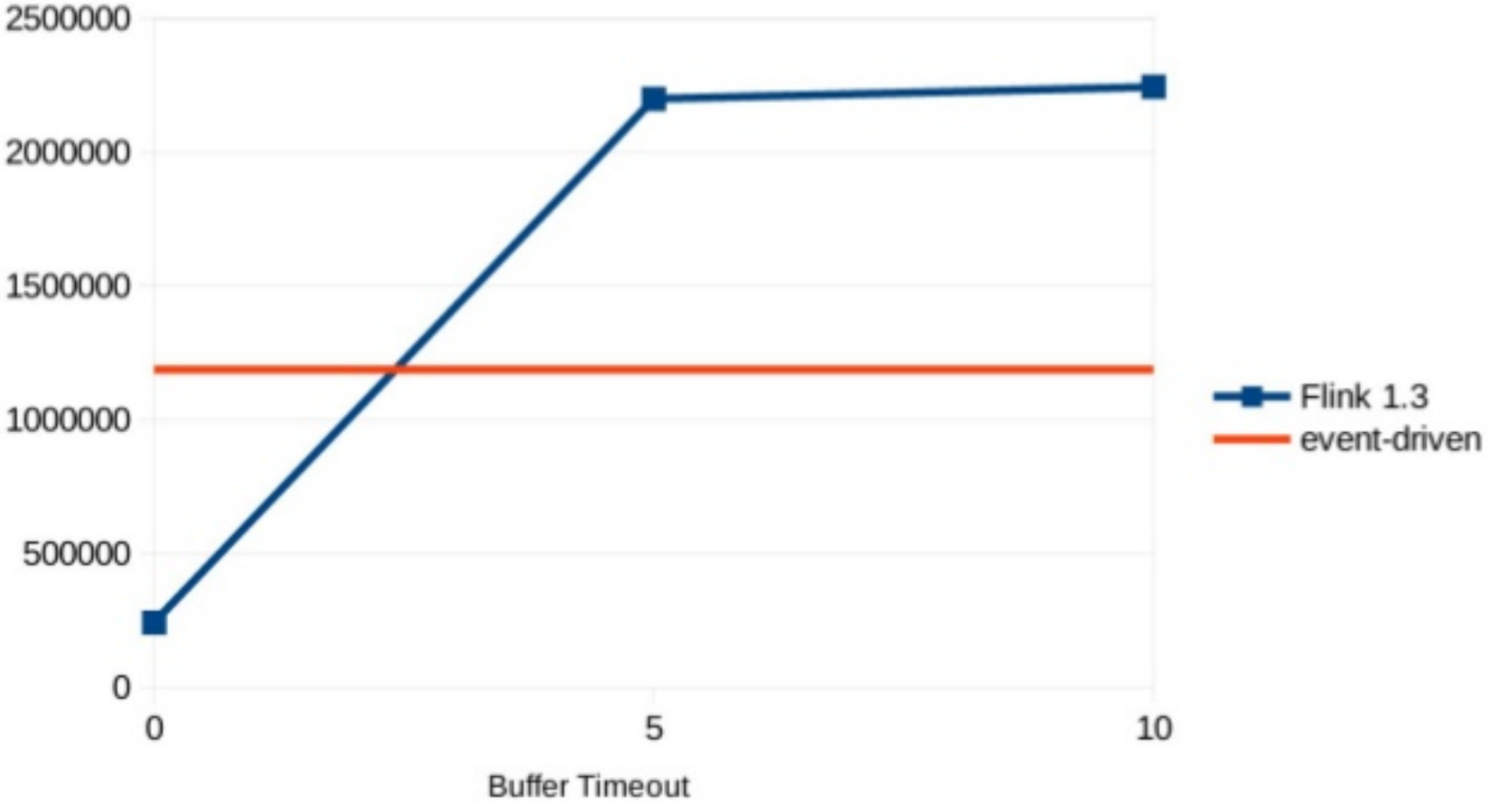


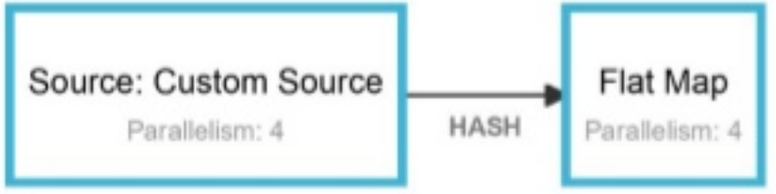
*on Amazon EC2, 5x m4.xlarge (1 JM, 4 TMs)

Throughput with/out Output Flusher

Fast source:

- generates events as fast as possible





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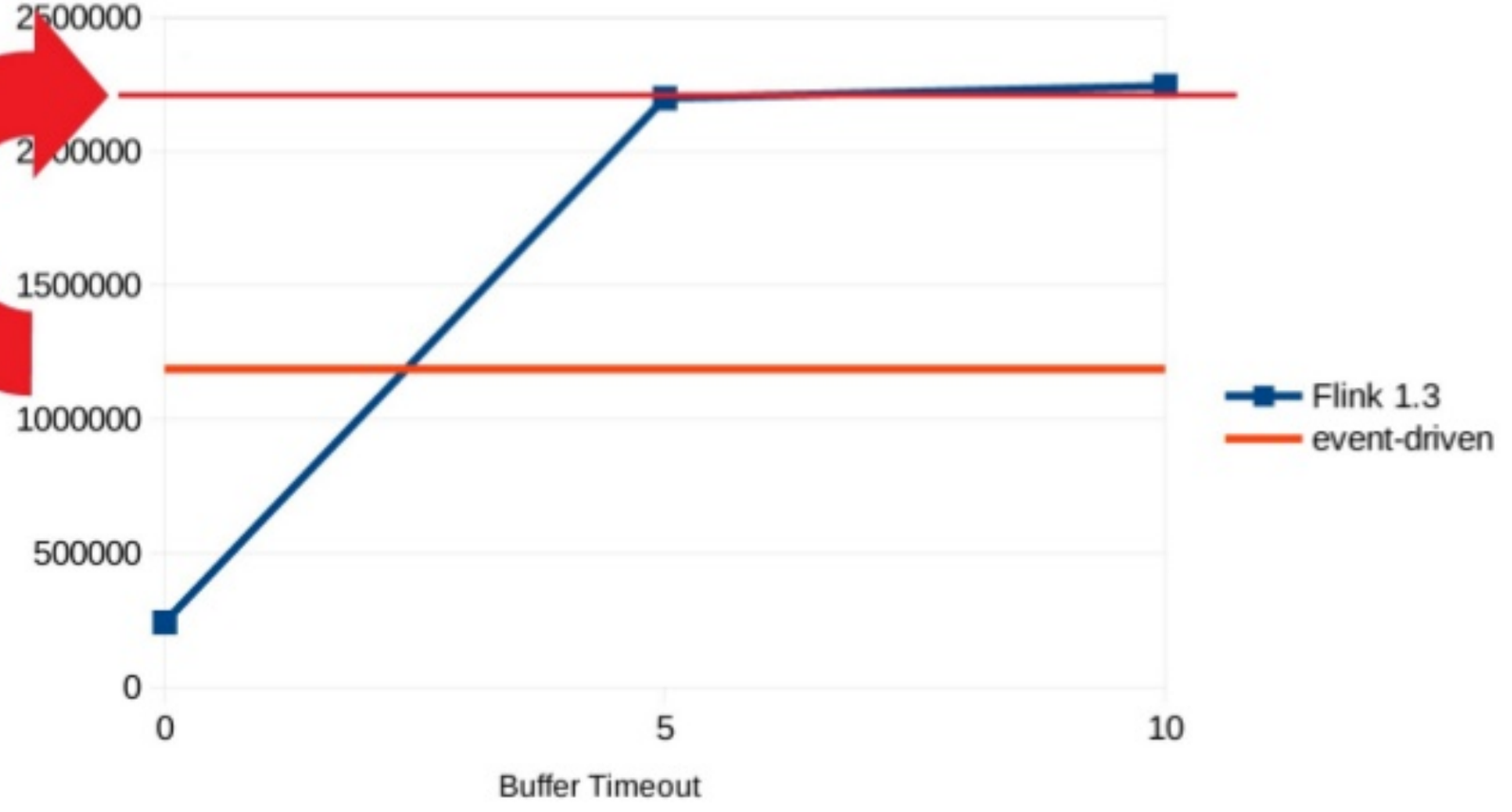
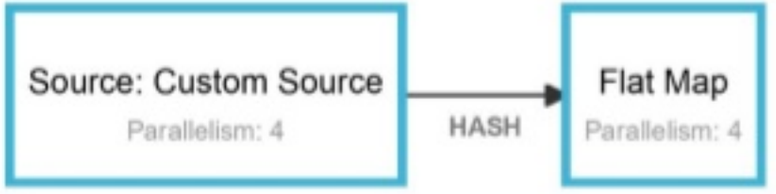
Throughput with/out Output Flusher

Target this!

Work in progress!
(FLINK-7612)





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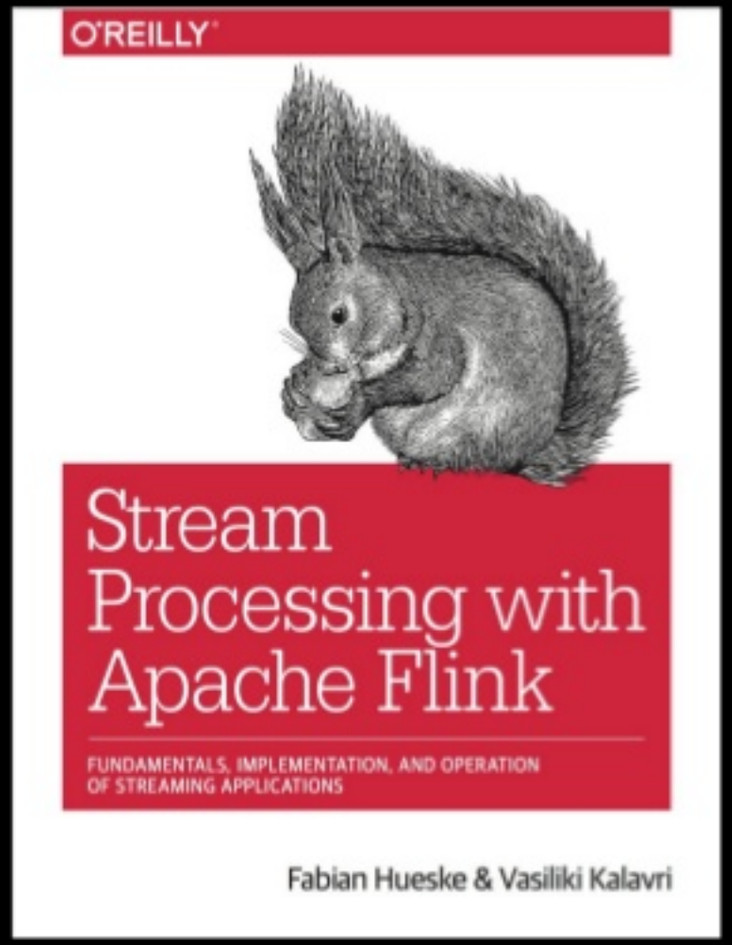
Event-Driven Flushes (FLINK-7612)

- flush based on network channel availability
- near perfect latency behaviour
- uses the all of the available capacity (expect only minor effects on the throughput)



Thank you!

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