P4air: Increasing Fairness among Competing Congestion Control Algorithms

Belma Turkovic and Fernando Kuipers

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Congestion control algorithms

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- New protocols and congestion control algorithms are continuously being developed

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→ It is impossible to take their interactions with other protocols and algorithms into account

Why is this important?

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	HS-TCP	STCP	HTCP	BIC	Cubic	New Reno	Hybla	YeAH	Illinois	Veno	Westwood+	BBR	Vegas	LoLa
HS-TCP	0.98	0.75	0.92	0.95	0.88	0.94	0.72	0.73	0.76	0.66	0.70	0.60	0.53	0.58
STCP	0.75	0.99	0.80	0.83	0.83	0.81	0.77	0.78	0.83	0.71	0.70	0.58	0.53	0.57
HTCP	0.92	0.80	0.99	0.84	0.96	0.99	0.81	0.88	0.88	0.78	0.86	0.57	0.52	0.56
BIC	0.95	0.83	0.84	0.98	0.80	0.85	0.66	0.68	0.66	0.61	0.67	0.59	0.53	0.67
Cubic	0.88	0.83	0.96	0.80	0.99	0.97	0.87	0.89	0.88	0.82	0.88	0.58	0.53	0.56
New Reno	0.94	0.81	0.99	0.85	0.97	0.99	0.83	0.88	0.89	0.78	0.87	0.57	0.53	0.55
Hybla	0.72	0.77	0.81	0.66	0.87	0.83	0.99	0.96	0.98	0.92	0.97	0.58	0.52	0.56
YeAH	0.73	0.78	0.88	0.68	0.89	0.88	0.96	0.99	0.98	0.92	0.97	0.62	0.52	0.56
Illinois	0.76	0.83	0.88	0.66	0.88	0.89	0.98	0.98	0.99	0.92	0.95	0.58	0.52	0.54
Veno	0.66	0.71	0.78	0.61	0.82	0.78	0.92	0.92	0.92	0.98	0.93	0.60	0.52	0.54
Westwood+	0.70	0.70	0.86	0.67	0.88	0.87	0.97	0.97	0.95	0.93	1.00	0.58	0.52	0.54
BBR	0.60	0.58	0.57	0.59	0.58	0.57	0.58	0.62	0.58	0.60	0.58	0.94	0.65	0.79
Vegas	0.53	0.53	0.52	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.65	1.00	0.67
LoLa	0.58	0.57	0.56	0.67	0.56	0.55	0.56	0.56	0.54	0.54	0.54	0.79	0.67	0.80

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	HS-TCP	STCP	HTCP	BIC	Cubic	New Reno	Hybla	YeAH	Illinois	Veno	Westwood+	BBR	Vegas	LoLa
0 ms	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.98	1.00	0.94	1.00	0.80
20 ms	0.79	0.92	0.94	0.74	0.84	0.85	0.89	0.86	0.92	0.91	0.86	0.56	0.83	0.73
40 ms	0.70	0.83	0.89	0.68	0.80	0.74	0.89	0.78	0.82	0.85	0.77	0.54	0.82	0.59
60 ms	0.67	0.79	0.88	0.66	0.72	0.69	0.94	0.74	0.77	0.83	0.71	0.55	0.78	0.59
80 ms	0.62	0.73	0.87	0.63	0.75	0.67	0.95	0.74	0.74	0.80	0.69	0.56	0.82	0.59
100 ms	0.59	0.74	0.84	0.63	0.73	0.66	0.95	0.73	0.80	0.79	0.65	0.56	0.80	0.62
120 ms	0.59	0.68	0.82	0.60	0.82	0.60	0.96	0.74	0.82	0.78	0.63	0.58	0.82	0.56
140 ms	0.57	0.65	0.80	0.59	0.78	0.59	0.95	0.71	0.83	0.76	0.61	0.57	0.85	0.57
160 ms	0.56	0.64	0.79	0.58	0.76	0.60	0.95	0.69	0.83	0.75	0.59	0.58	0.72	0.55
180 ms	0.56	0.63	0.74	0.56	0.78	0.59	0.95	0.82	0.79	0.72	0.59	0.58	0.81	0.55
200 ms	0.54	0.61	0.70	0.55	0.73	0.58	0.95	0.90	0.78	0.74	0.57	0.59	0.77	0.54
220 ms	0.54	0.61	0.69	0.55	0.76	0.59	0.95	0.79	0.64	0.65	0.56	0.58	0.79	0.59
240 ms	0.56	0.55	0.70	0.56	0.71	0.58	0.94	0.82	0.68	0.65	0.55	0.58	0.8	0.59
260 ms	0.55	0.54	0.65	0.56	0.69	0.56	0.94	0.80	0.63	0.56	0.55	0.58	0.73	0.56

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→ and by taking into account limitations on actions and/or memory accesses

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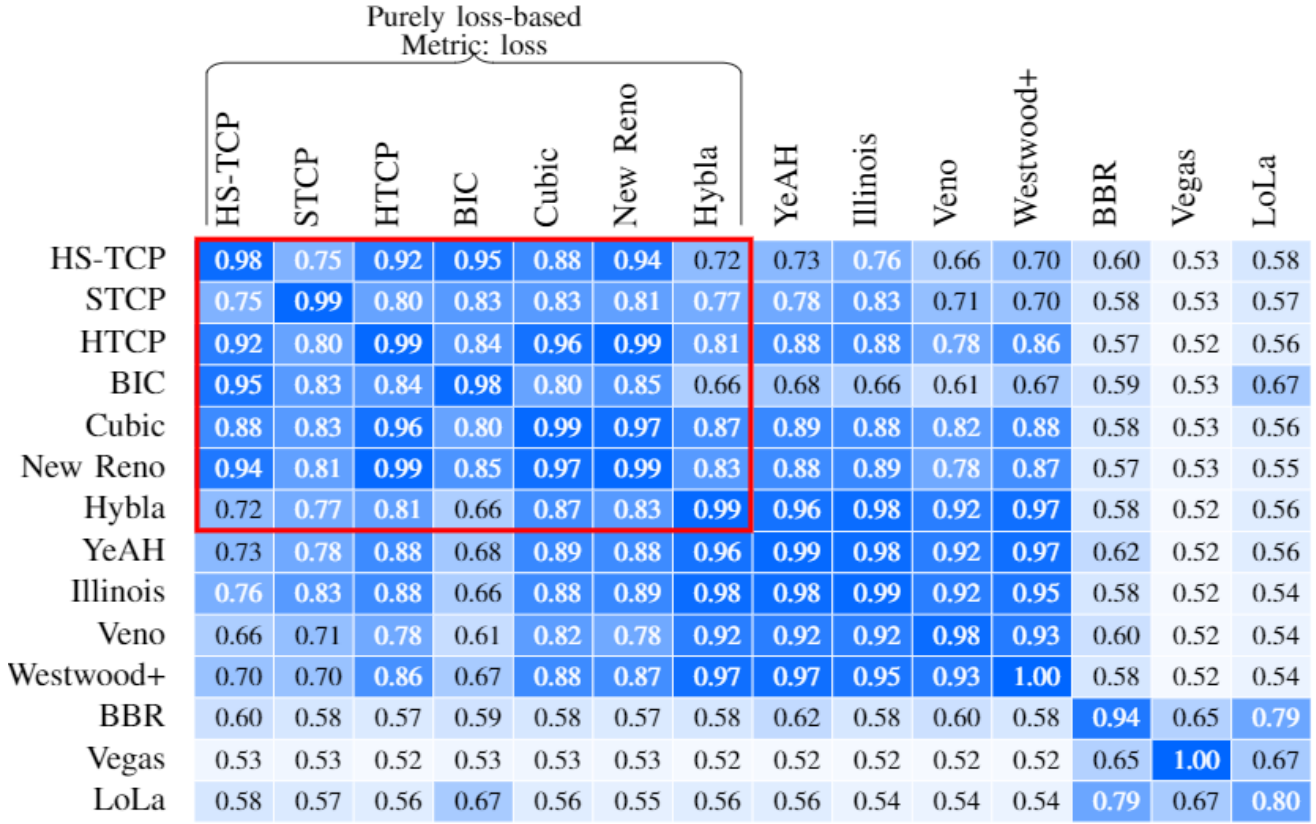

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P4air

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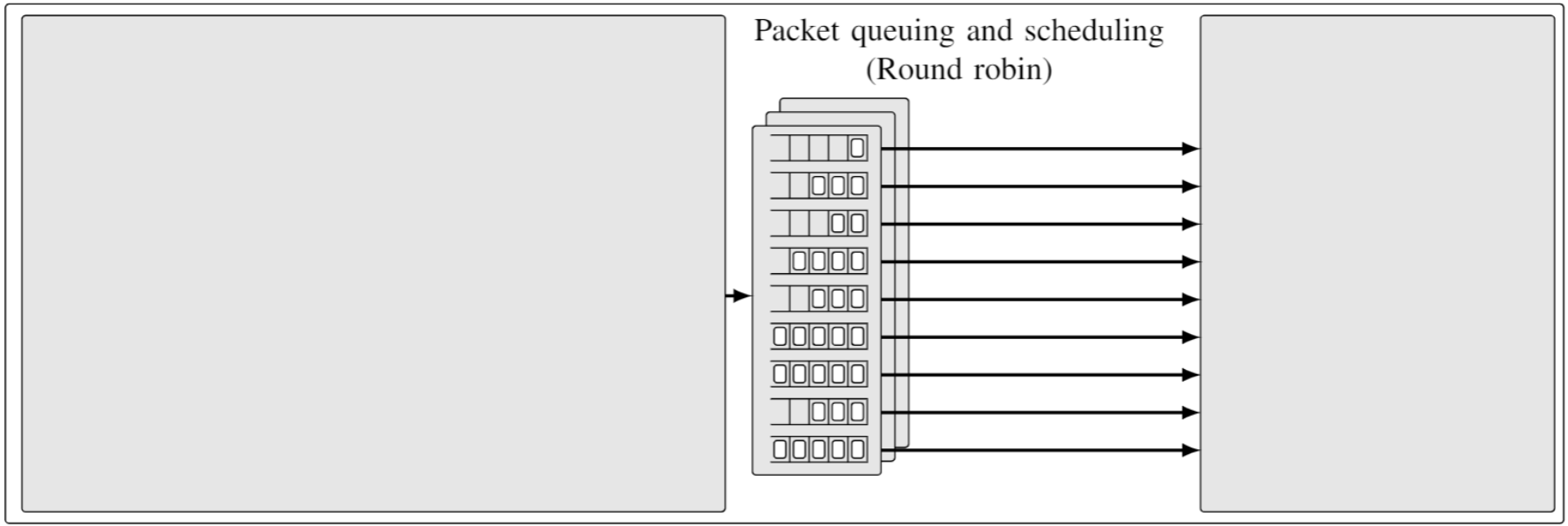

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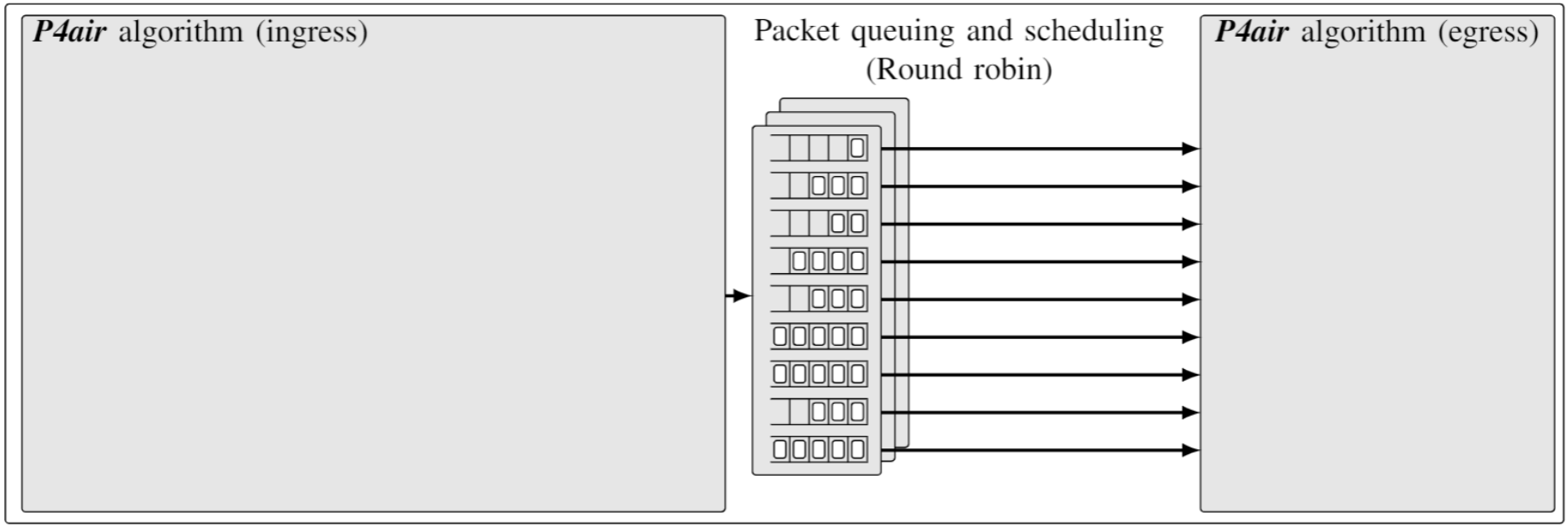
P4air algorithm (ingress)
Packet queuing and scheduling
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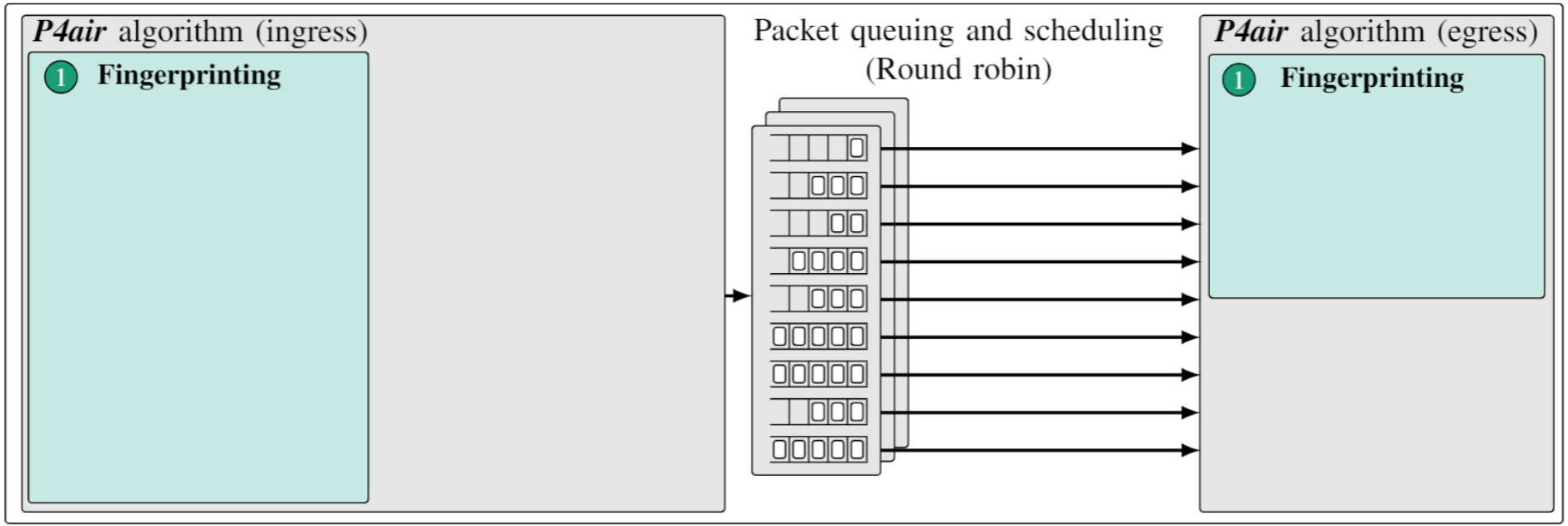
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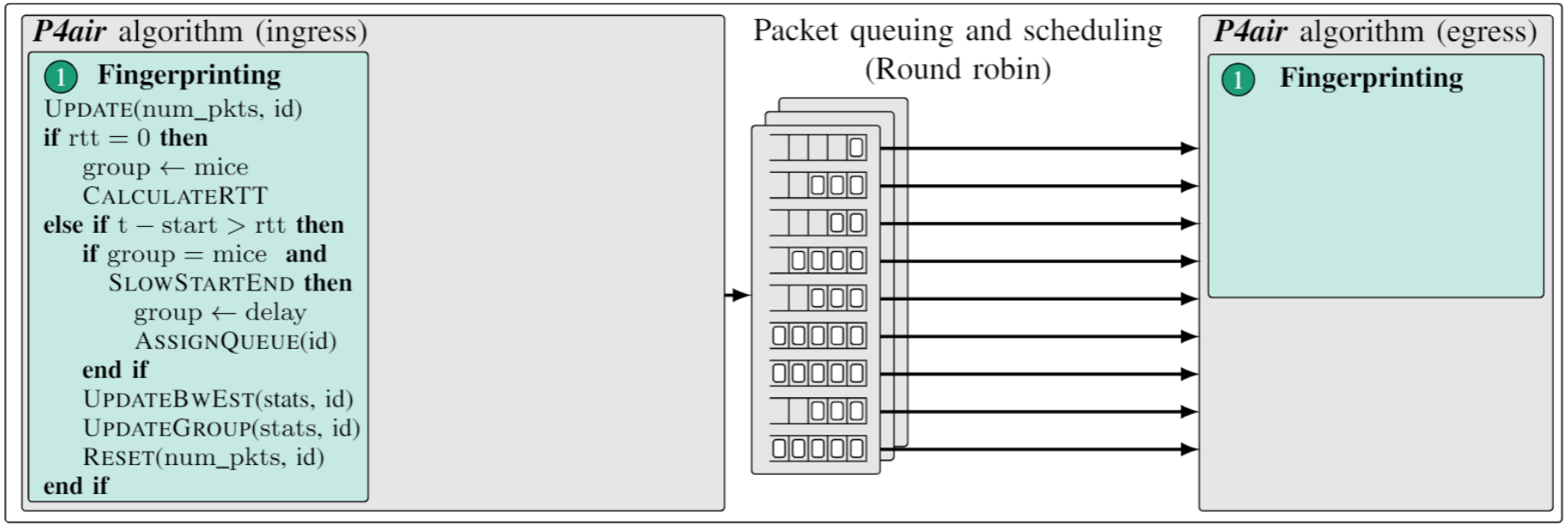
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group ← mice
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else if t − start > rtt then
if group = mice and
SLOWSTARTEND then
group ← delay
ASSIGNQUEUE(id)
end if
UPDATEBWEST(stats, id)
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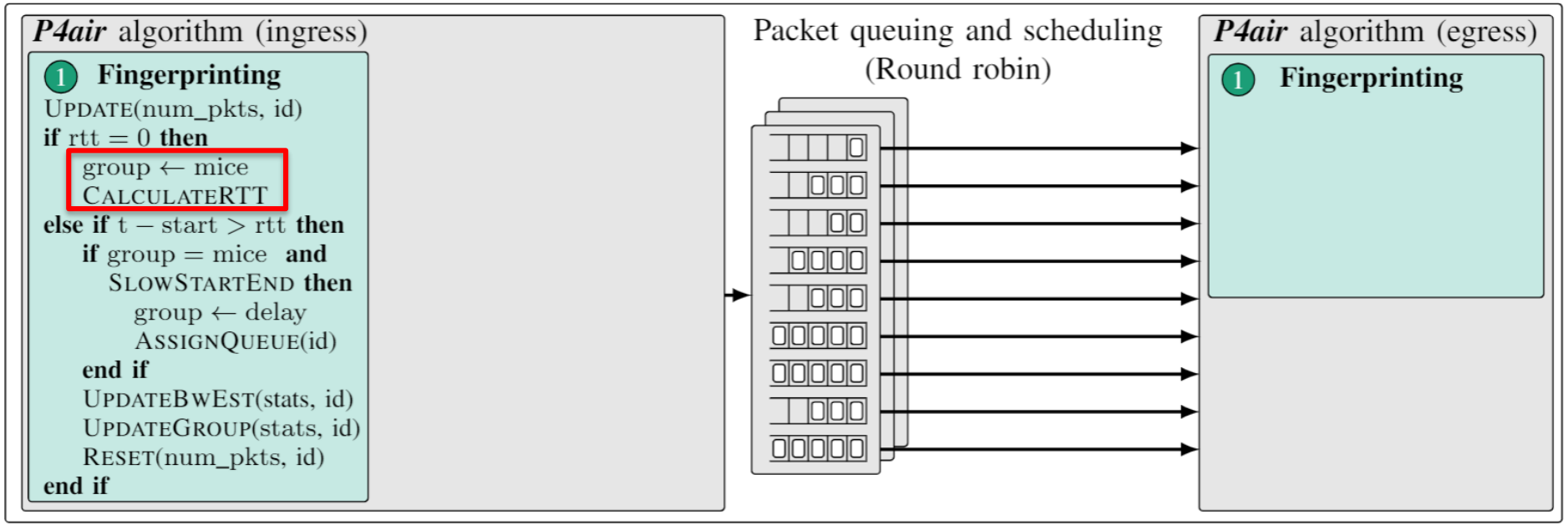
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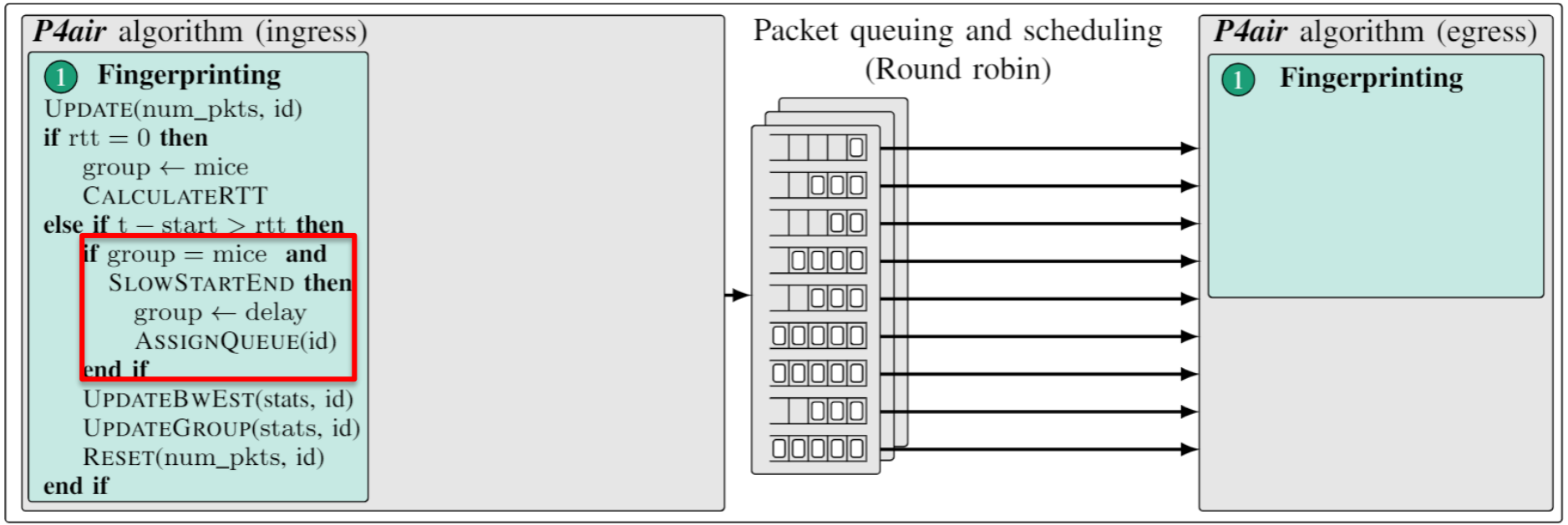
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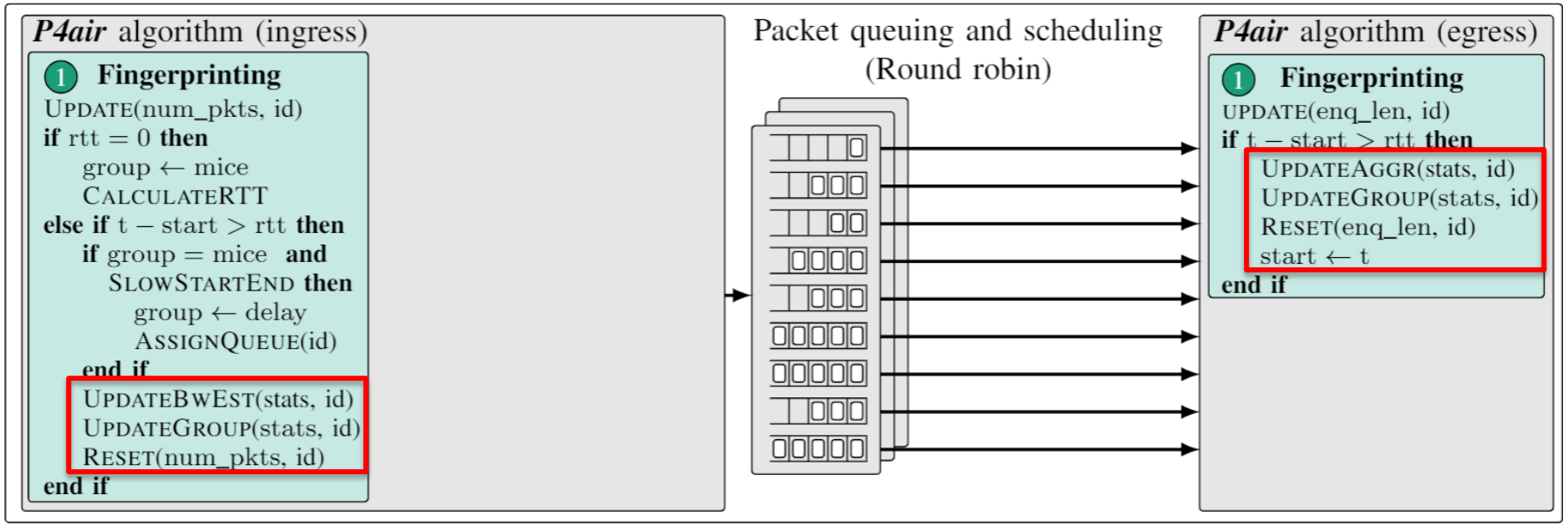
P4air algorithm (egress)
1 Fingerprinting

P4air


P4air algorithm (ingress)
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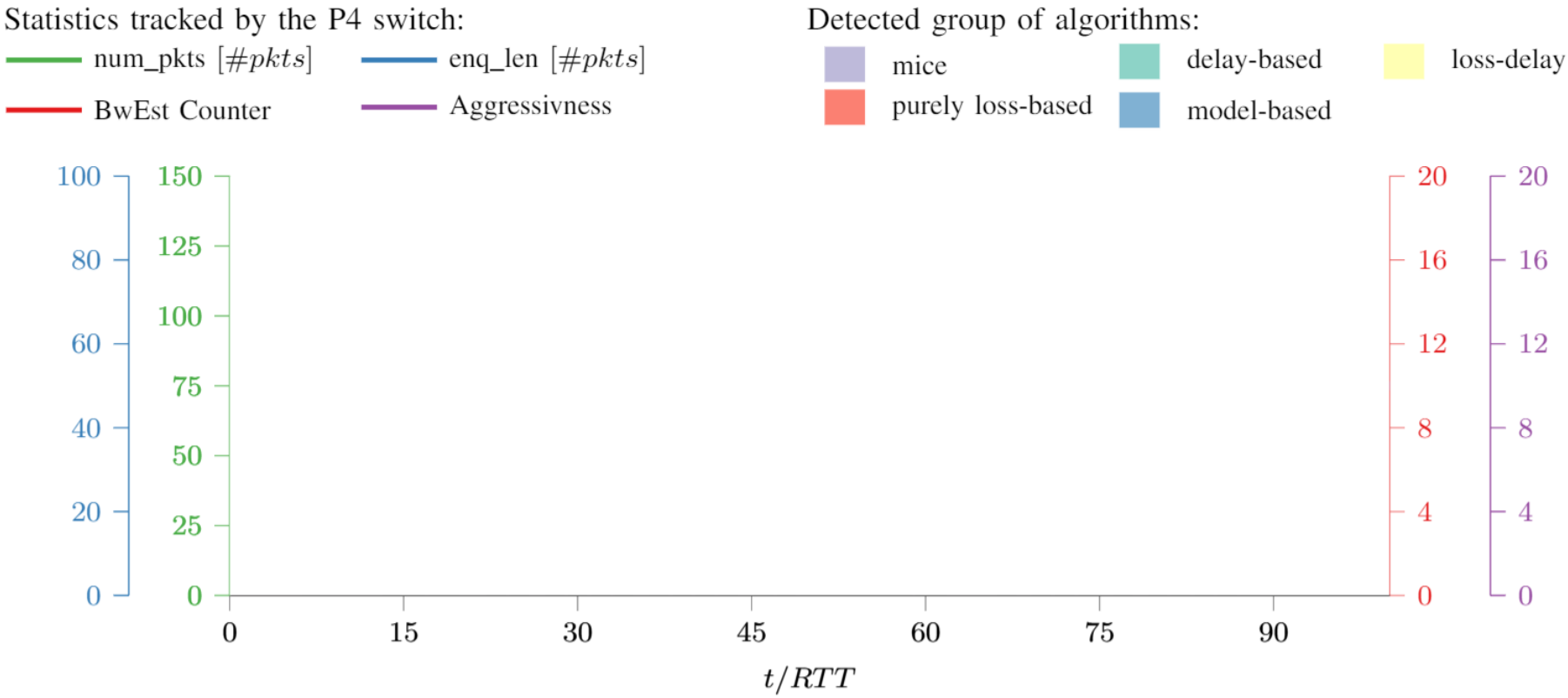
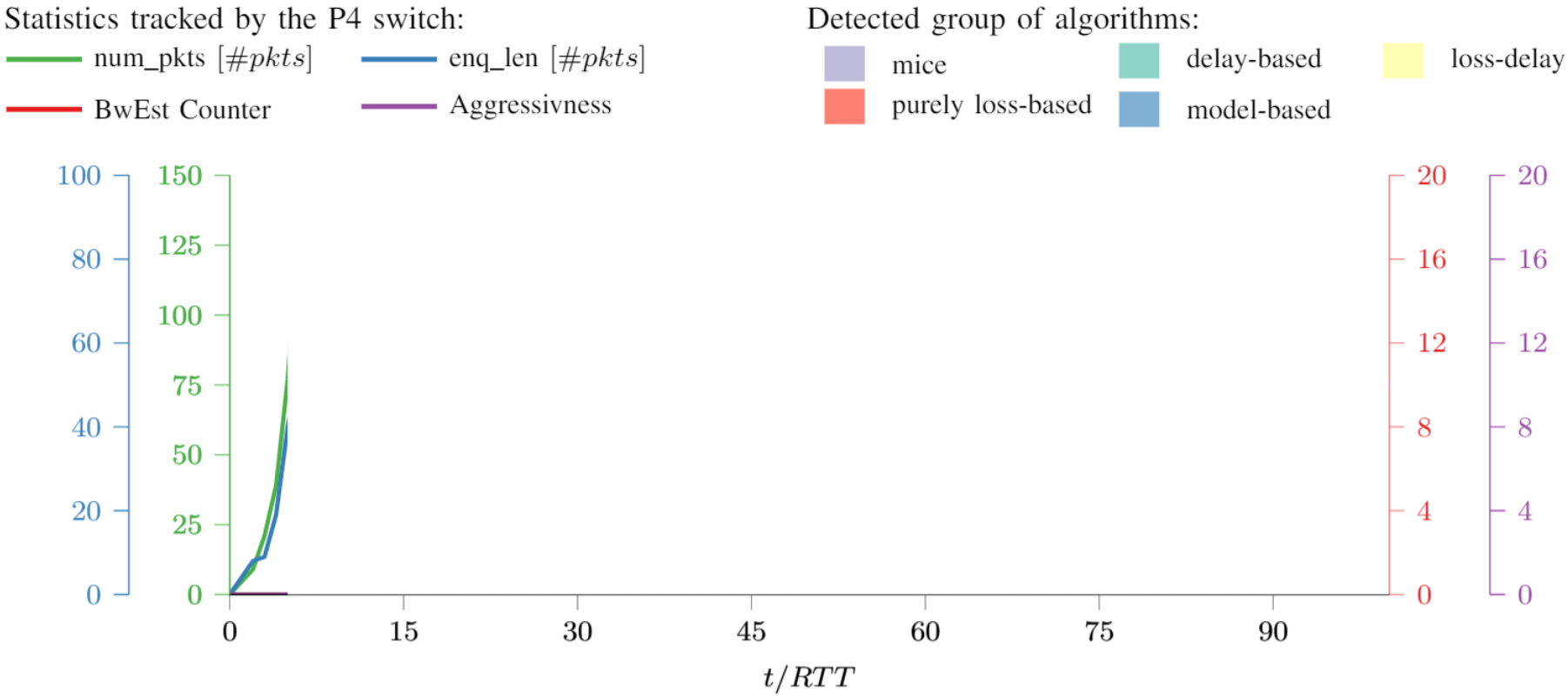
UPDATE(num_pkts, id)
if rtt = 0 then
group ← mice
CALCULATERTT
else if t − start > rtt then
if group = mice and
SLOWSTARTEND then
group ← delay
ASSIGNQUEUE(id)
end if
UPDATEBWEST(stats, id)
UPDATEGROUP(stats, id)
RESET(num_pkts, id)
end if
Packet queuing and scheduling
(Round robin)
P4air algorithm (egress)
1 Fingerprinting
UPDATE(enq_len, id)
if t − start > rtt then
UPDATEAGGR(stats, id)
UPDATEGROUP(stats, id)
RESET(enq_len, id)
start ← t
end if

Fingerprinting

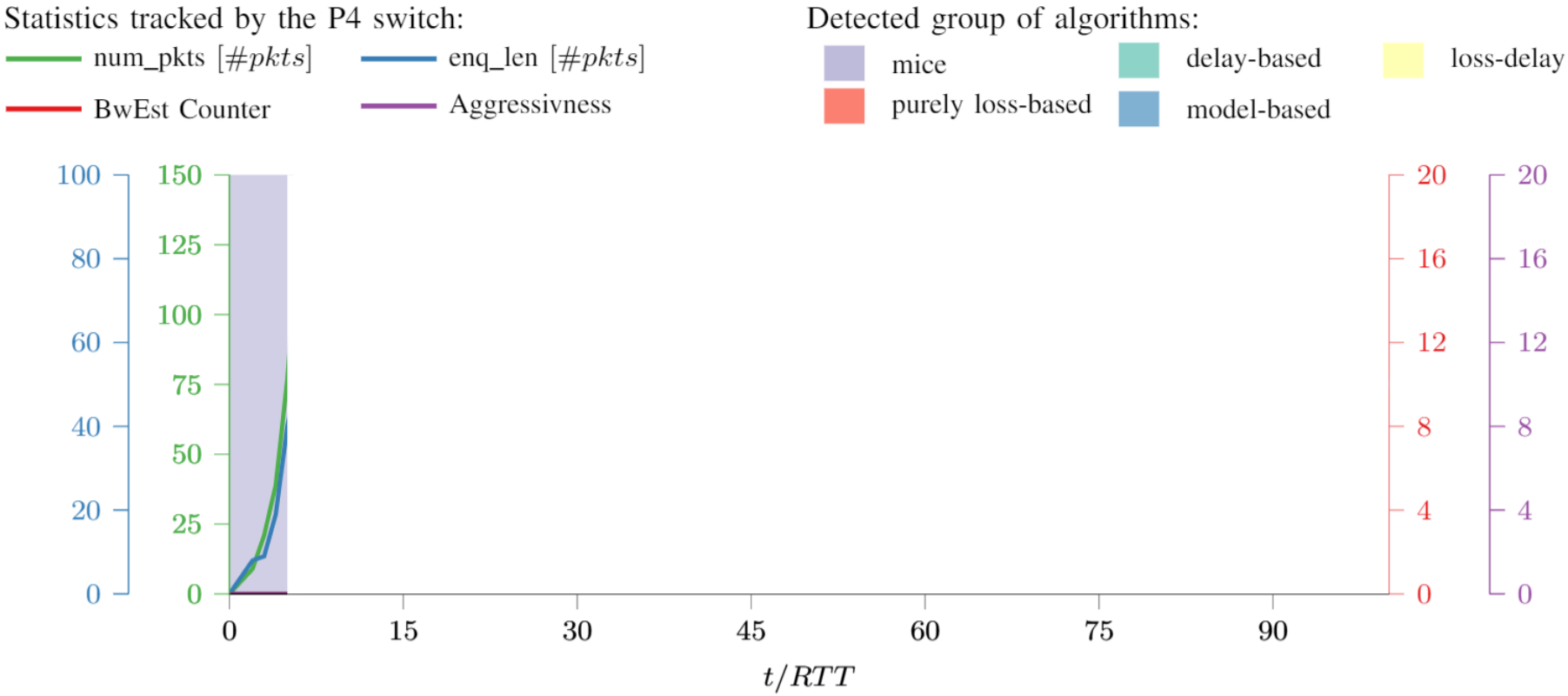
Fingerprinting - Cubic



Fingerprinting - Cubic



Fingerprinting - Cubic



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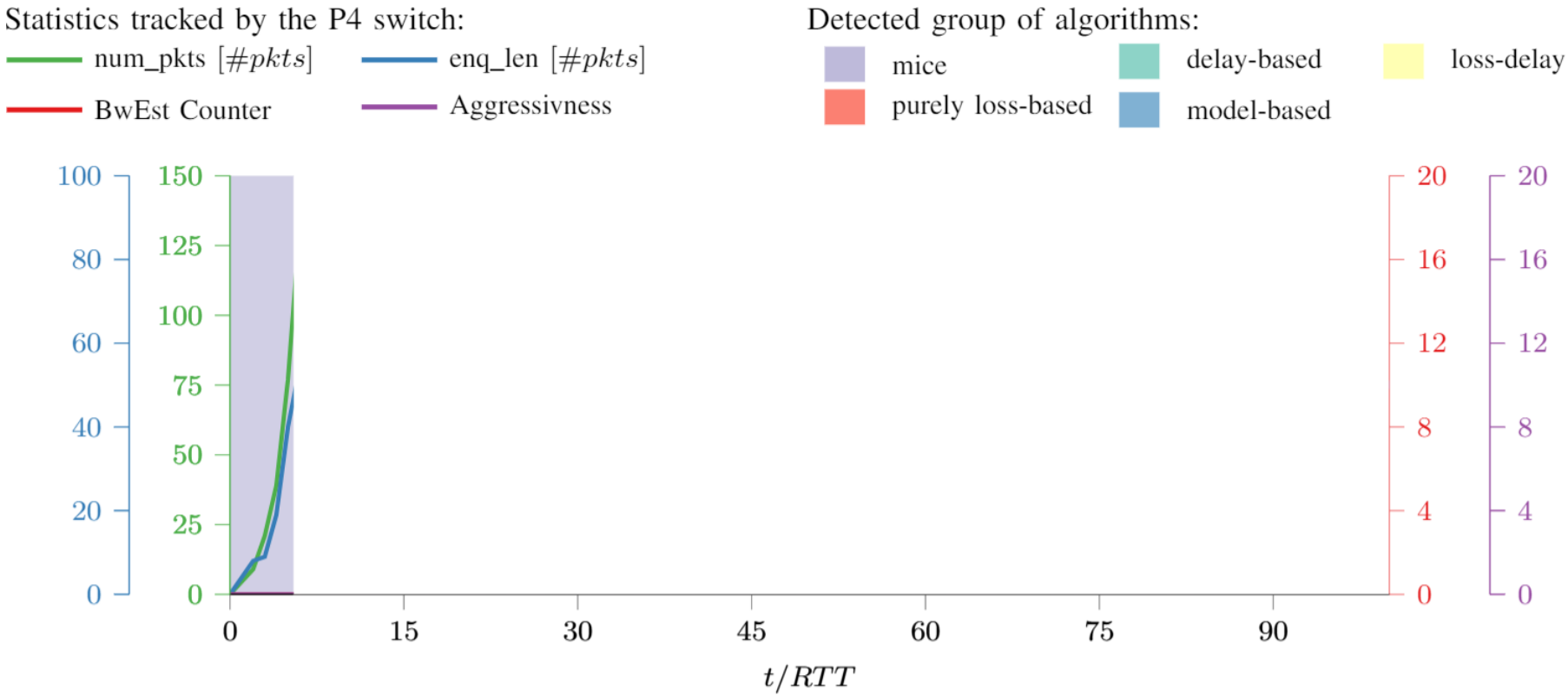

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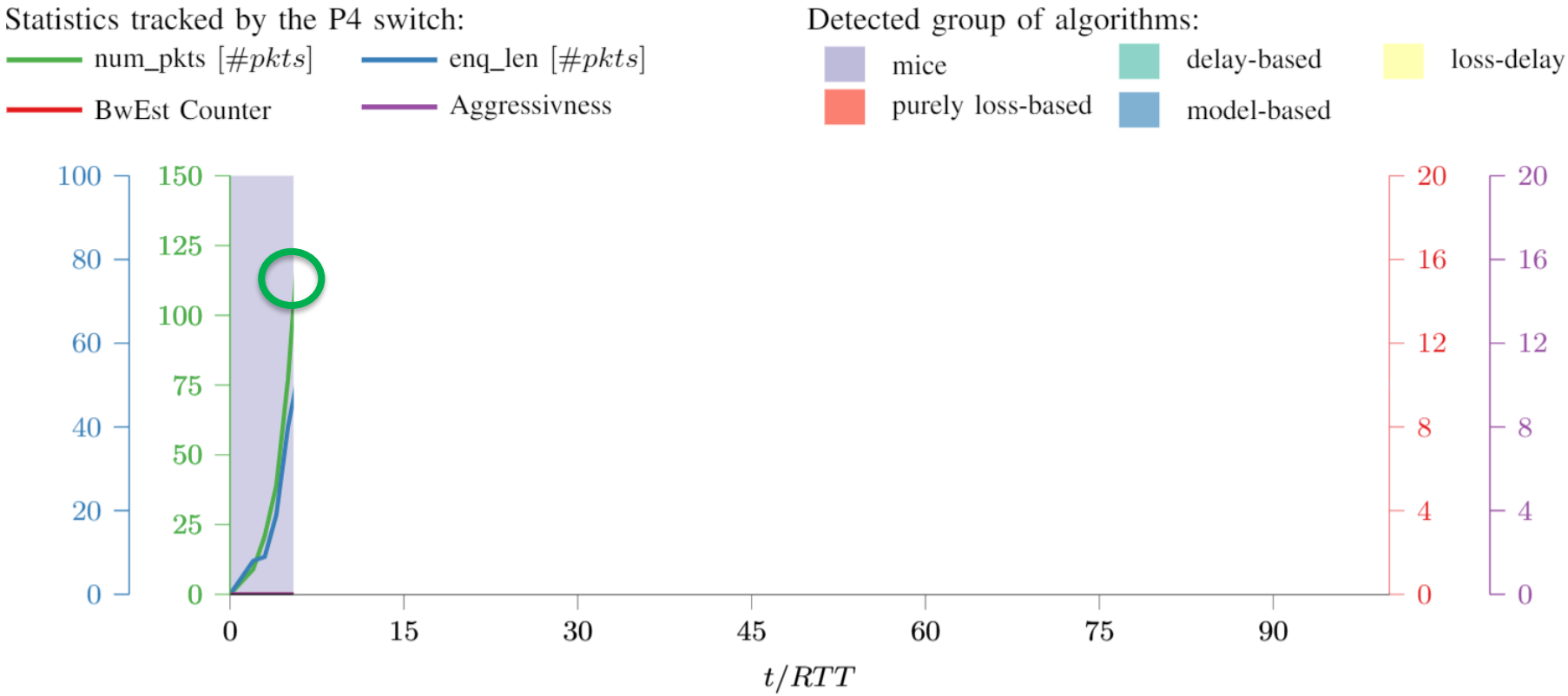

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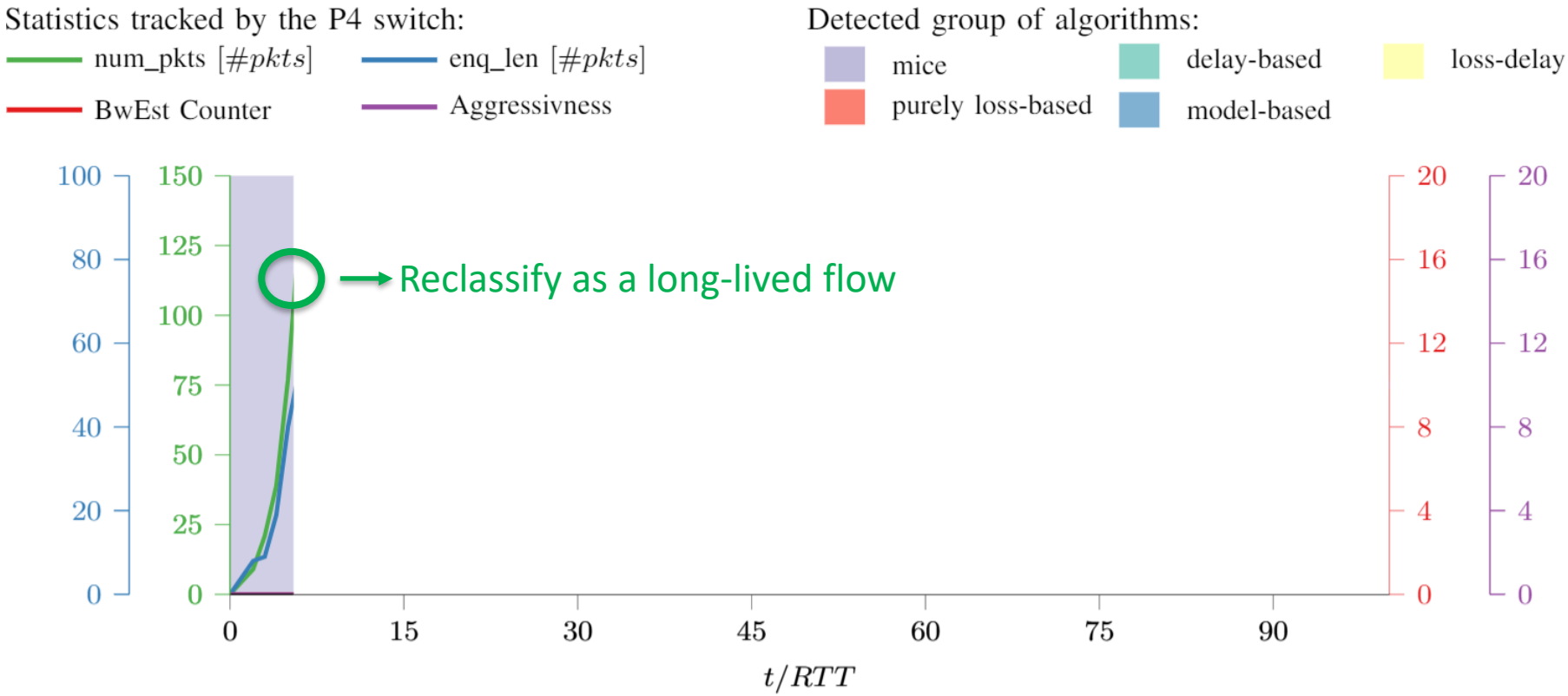

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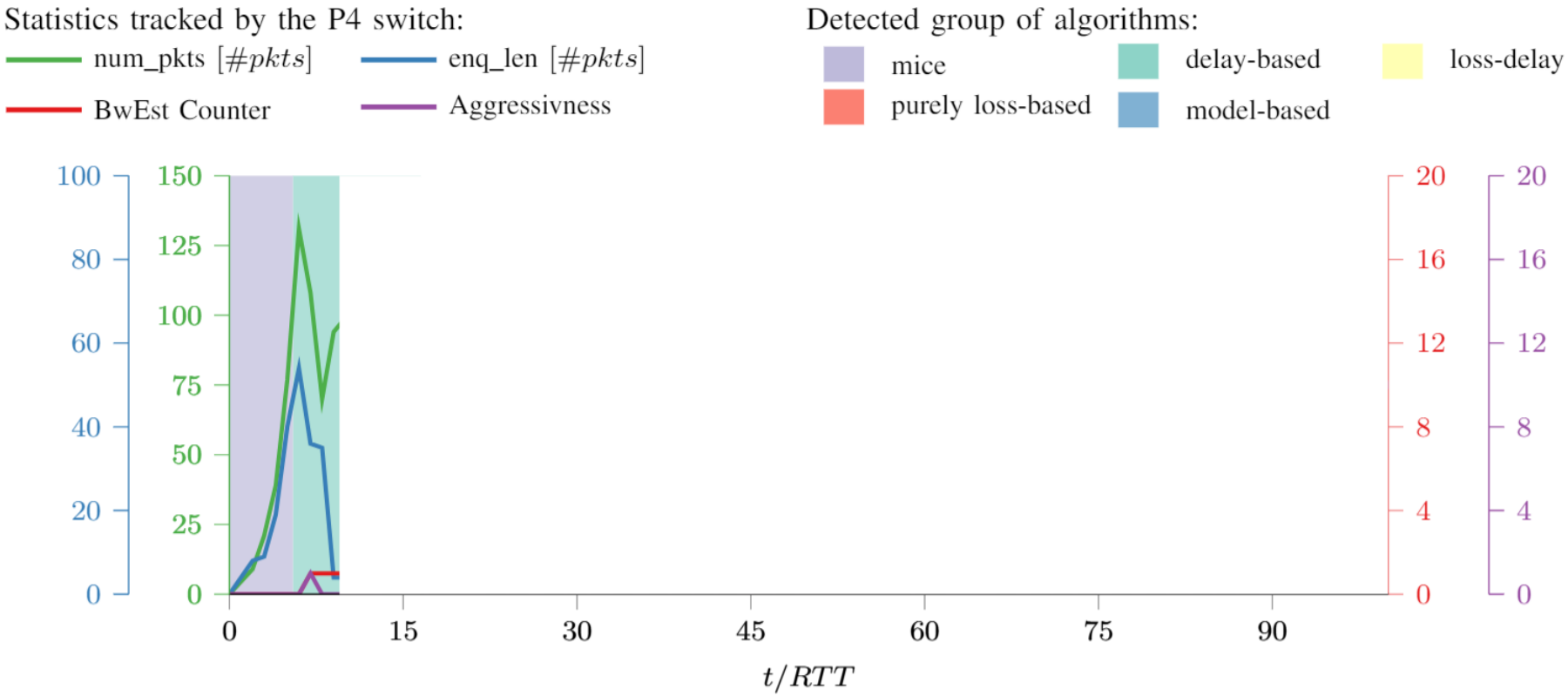

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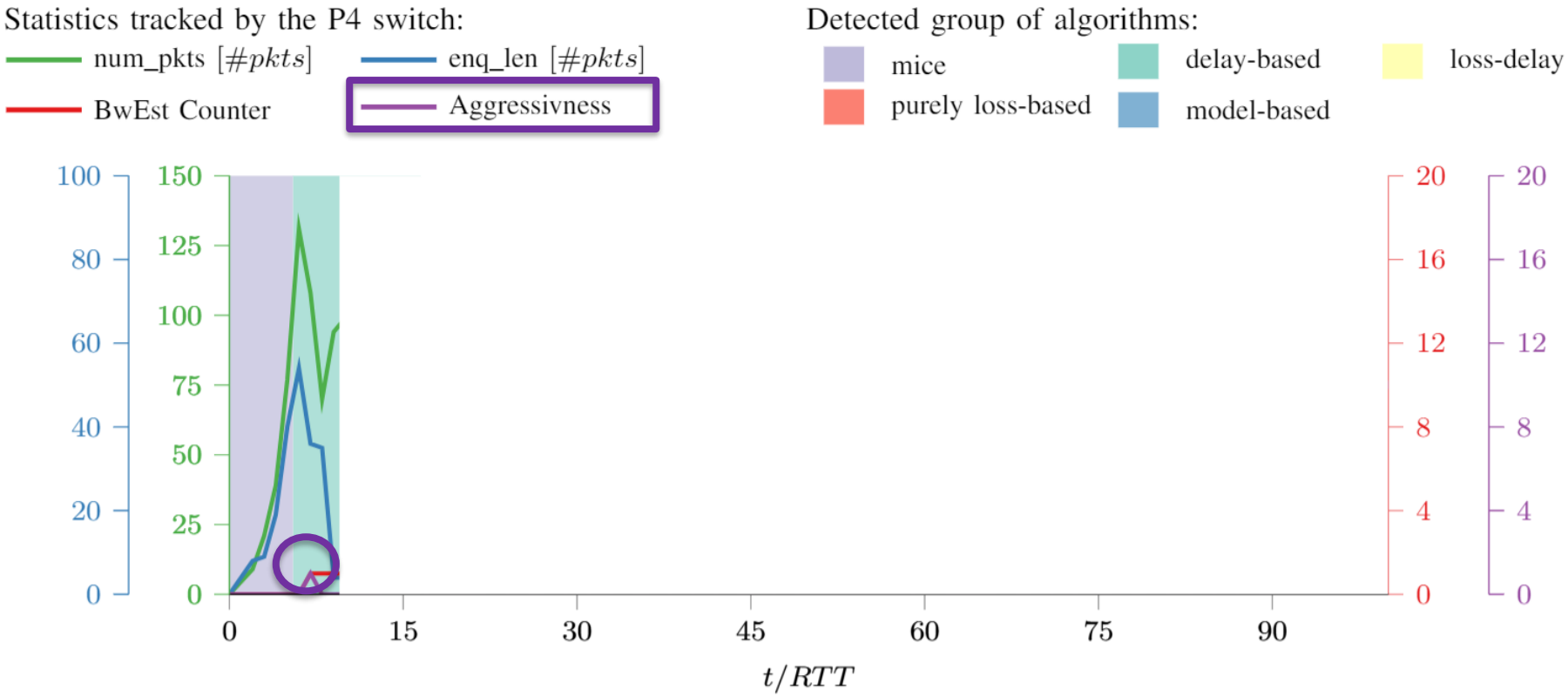

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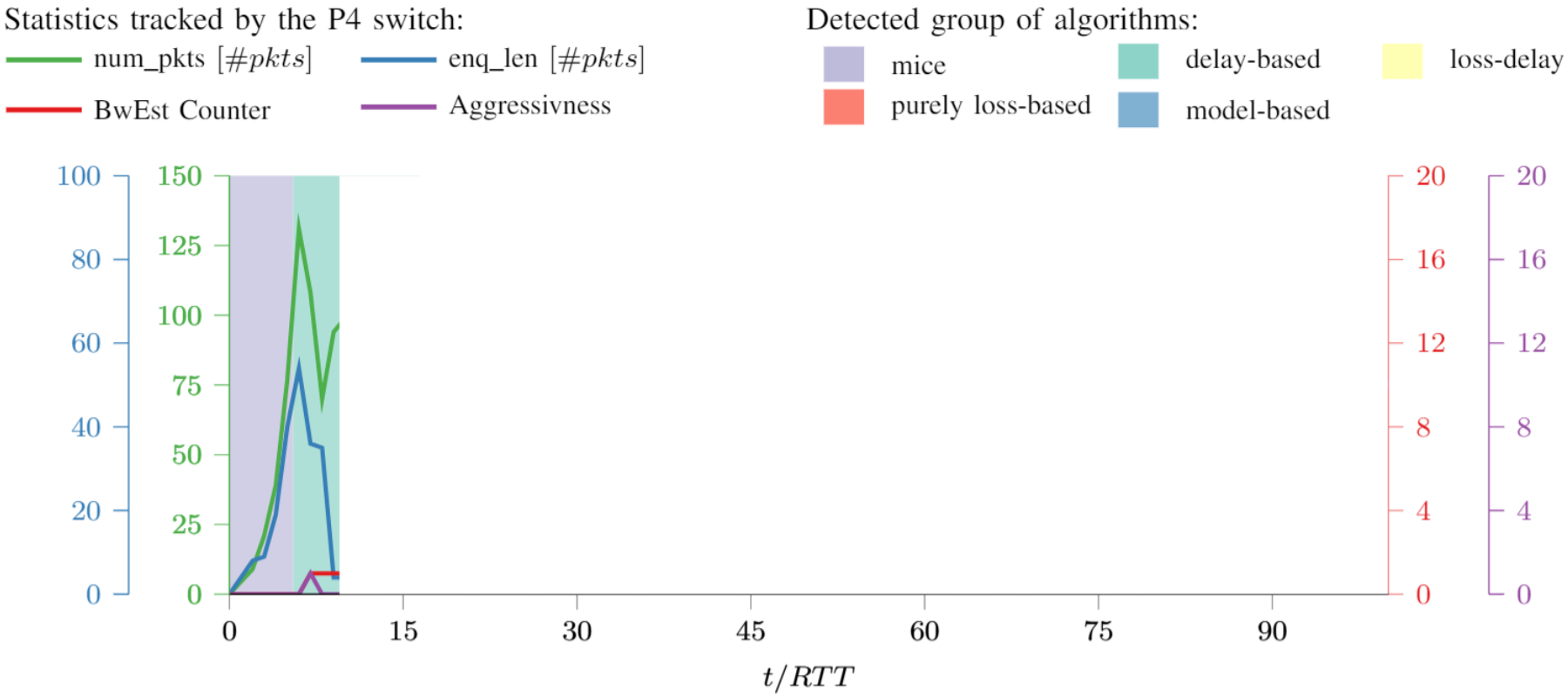

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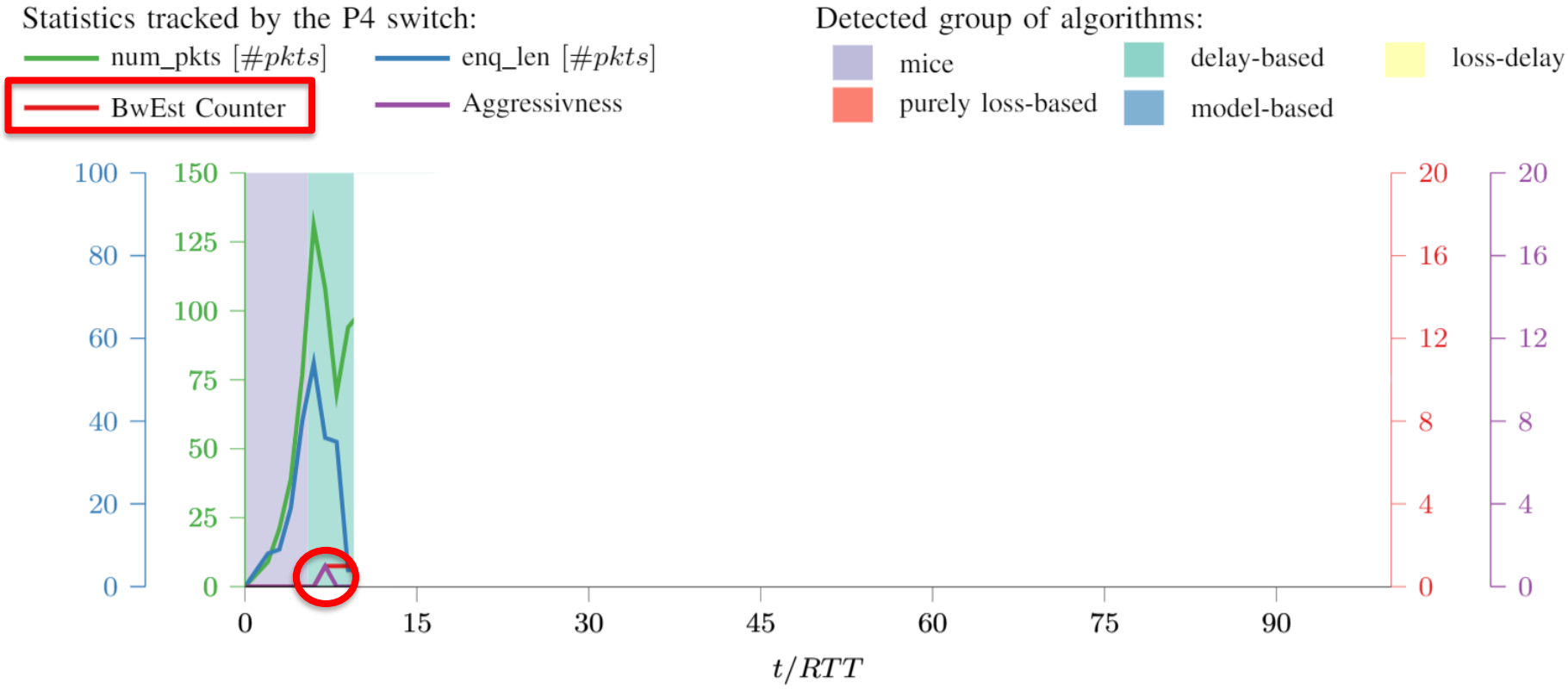

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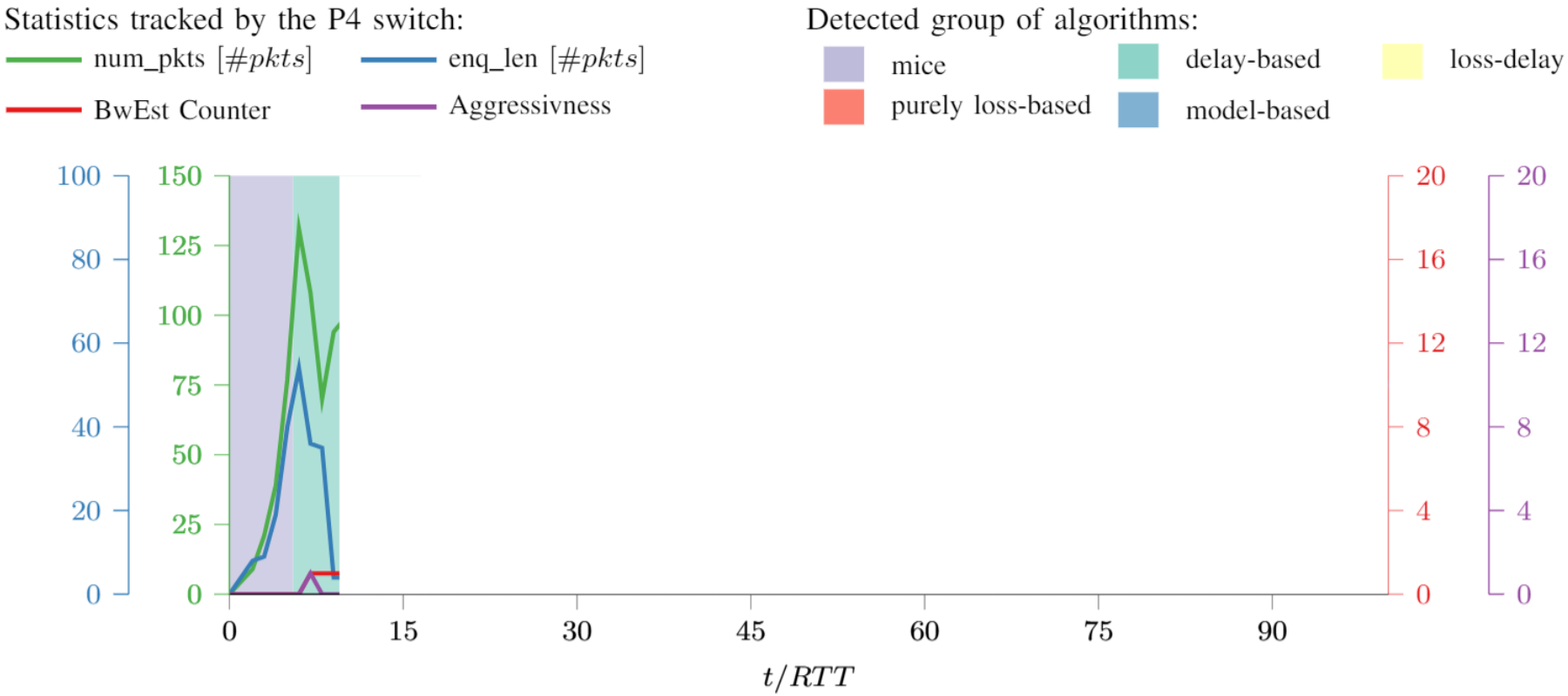

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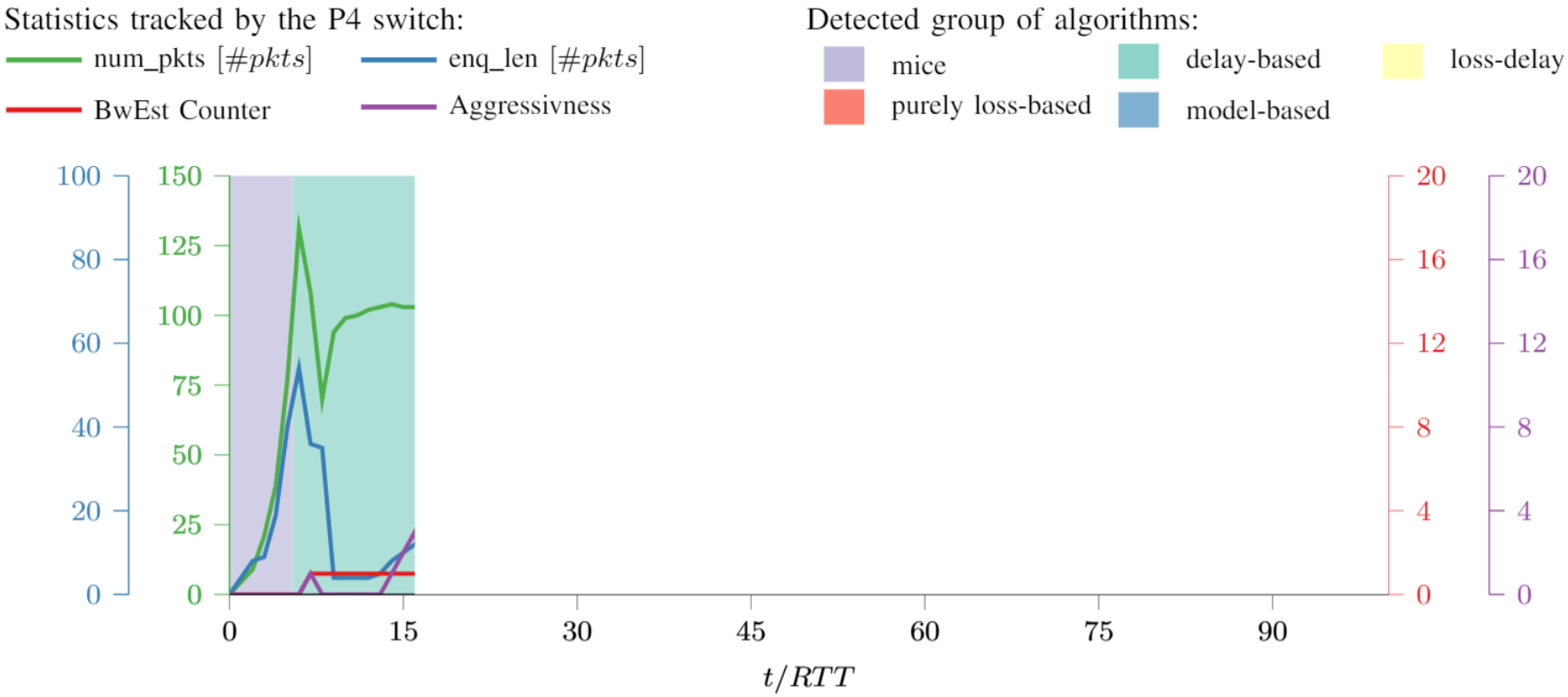

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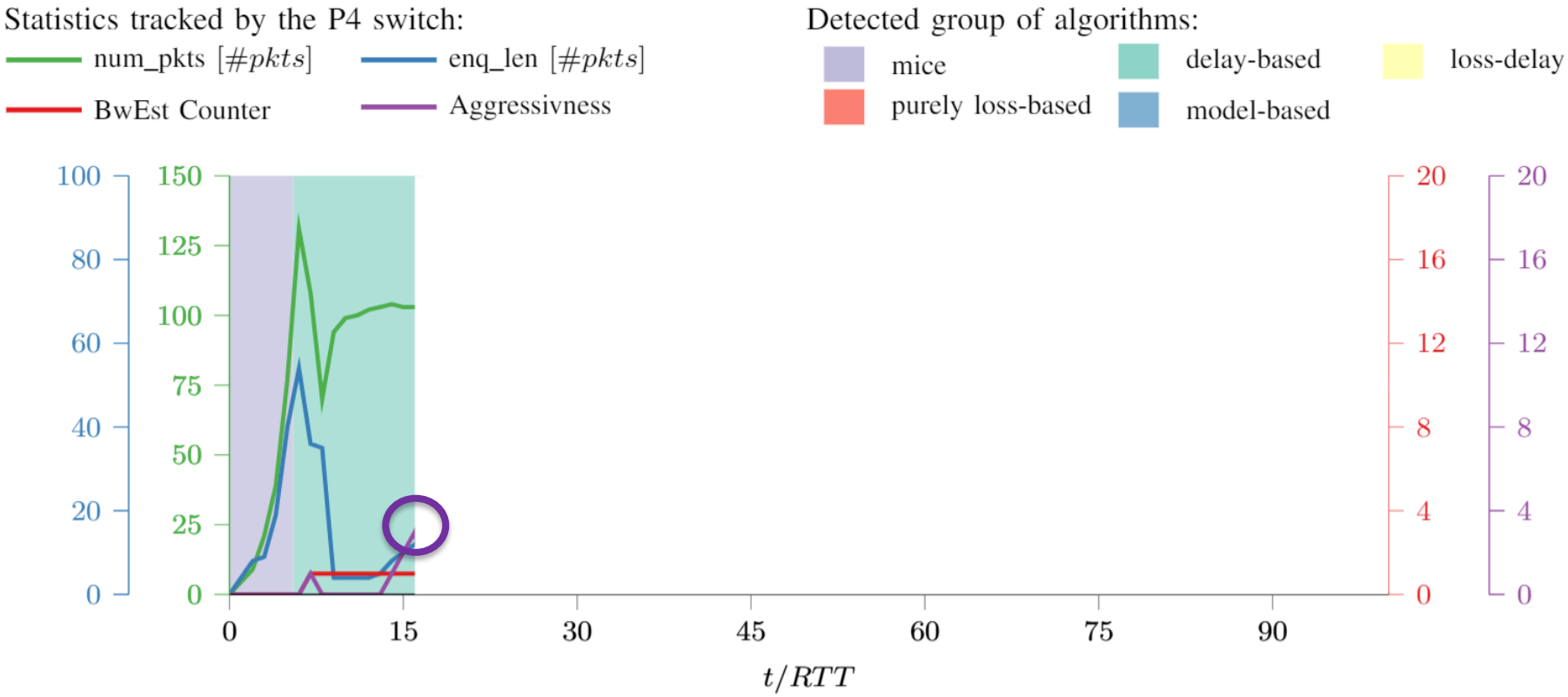

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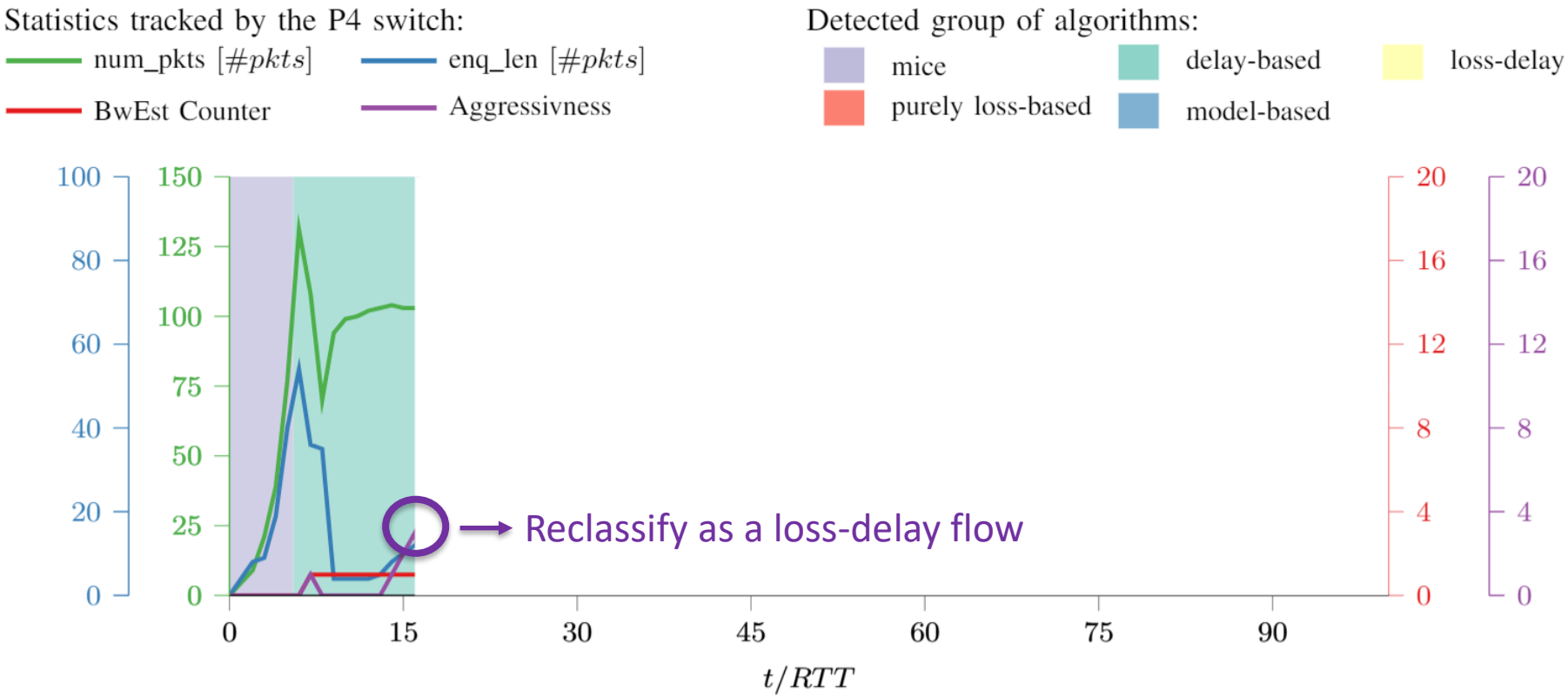

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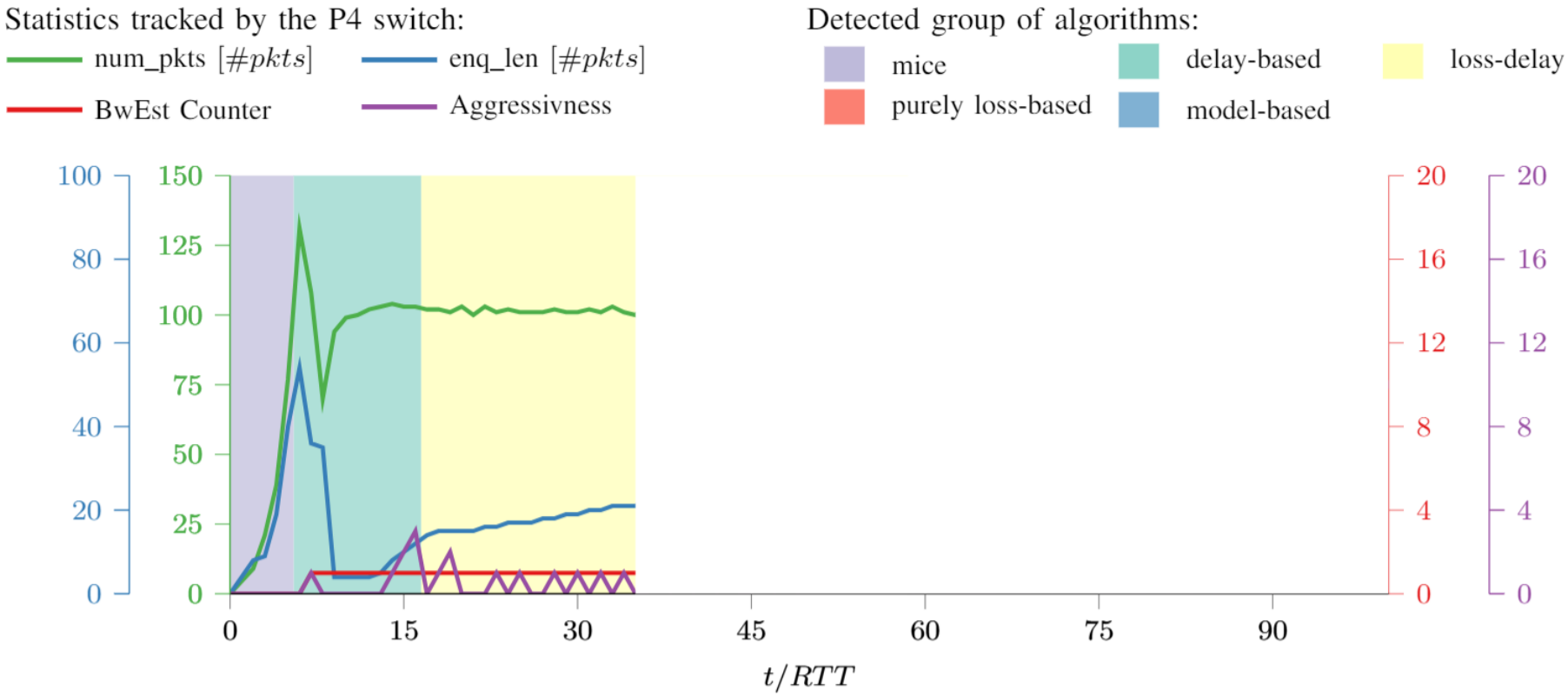

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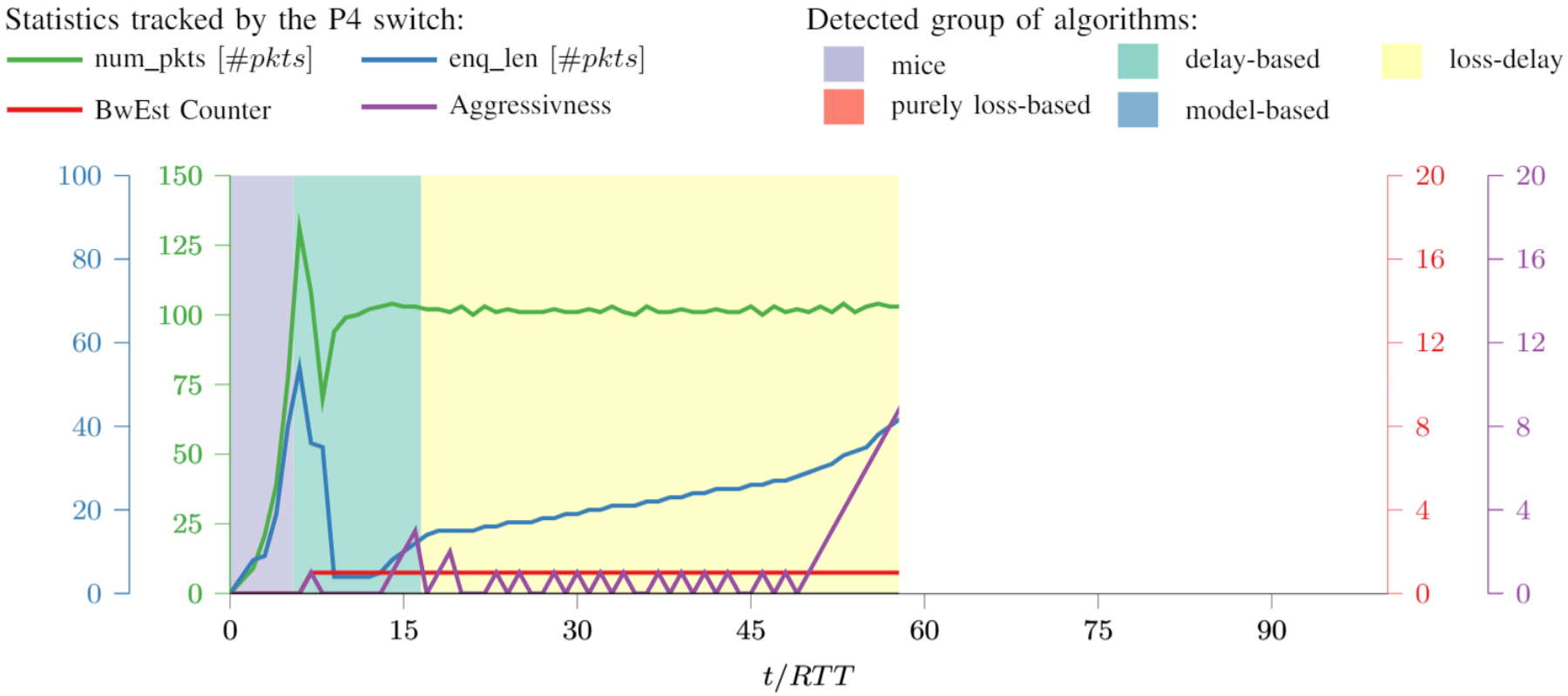

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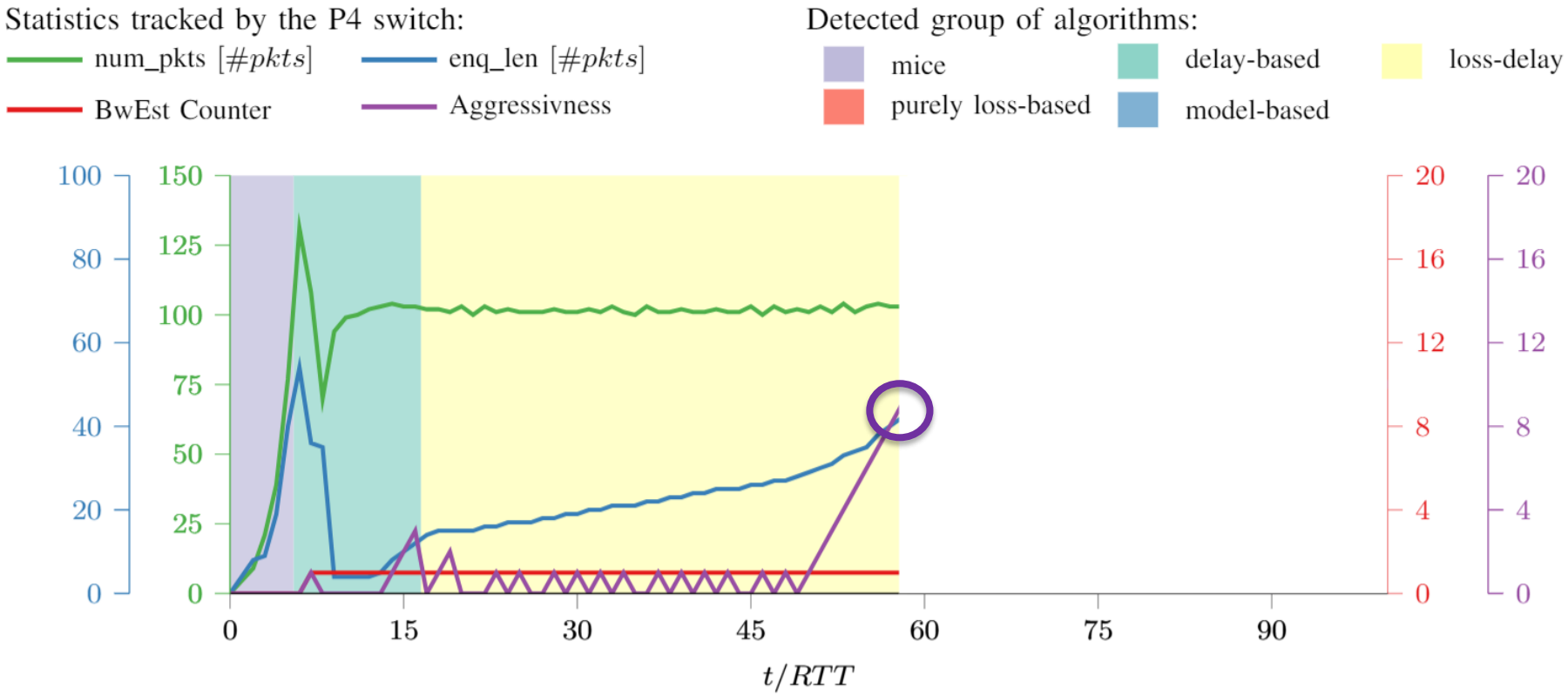
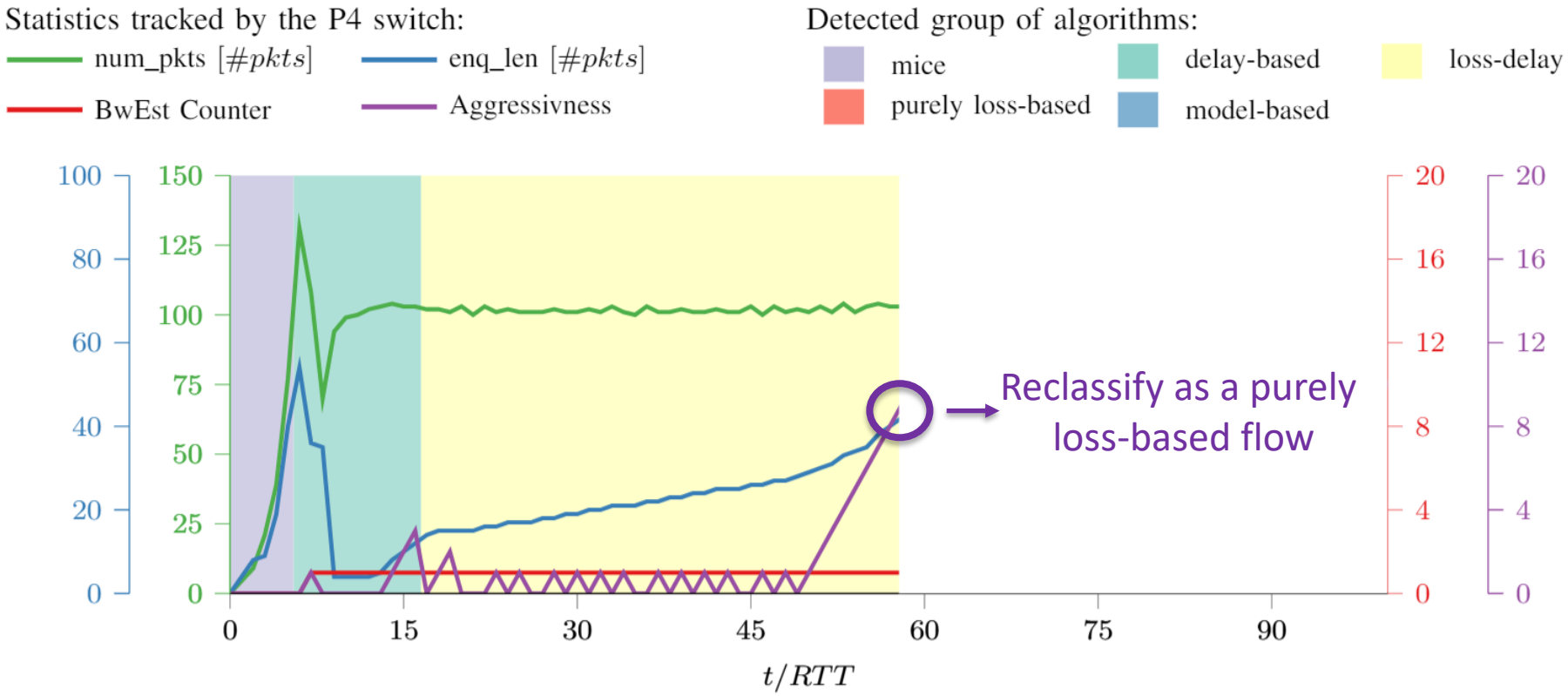
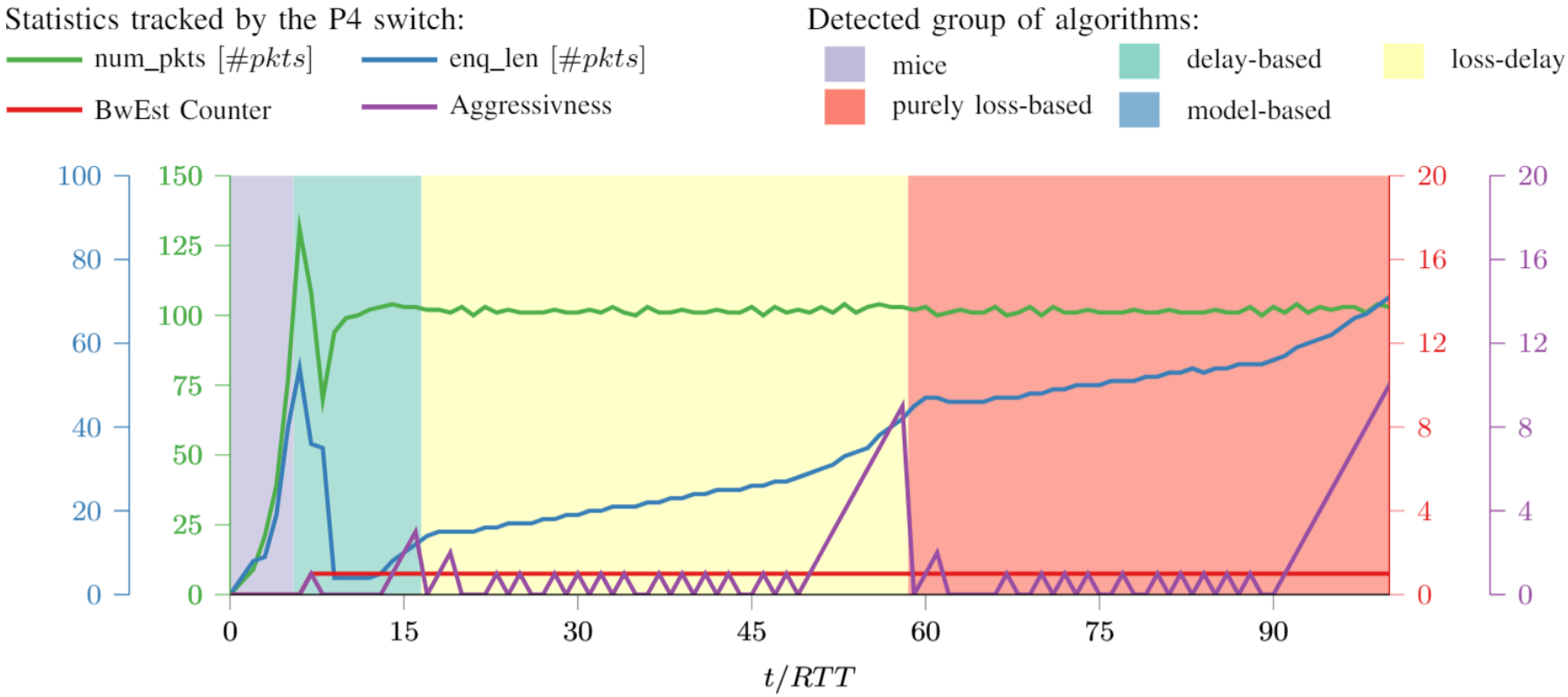


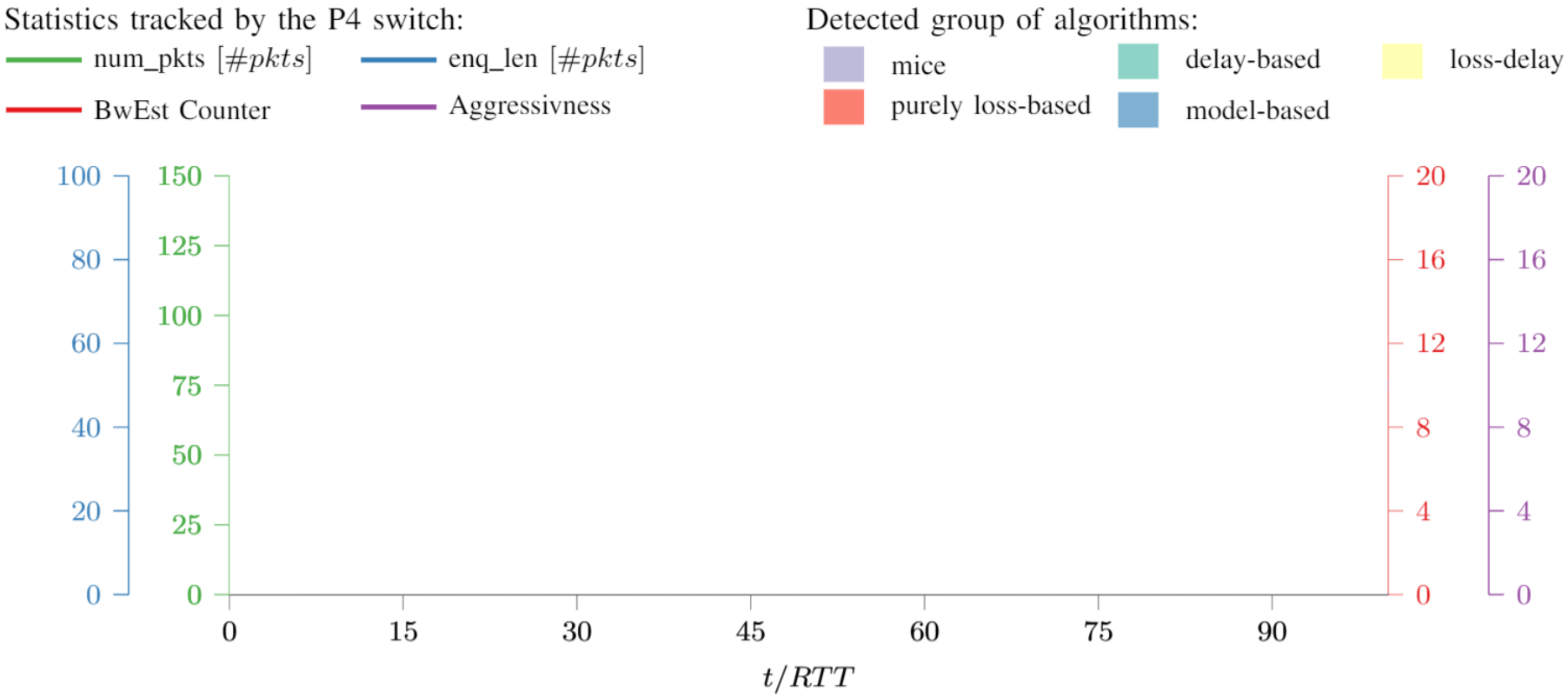
Fingerprinting - Cubic



Fingerprinting - Cubic



Fingerprinting - BBR



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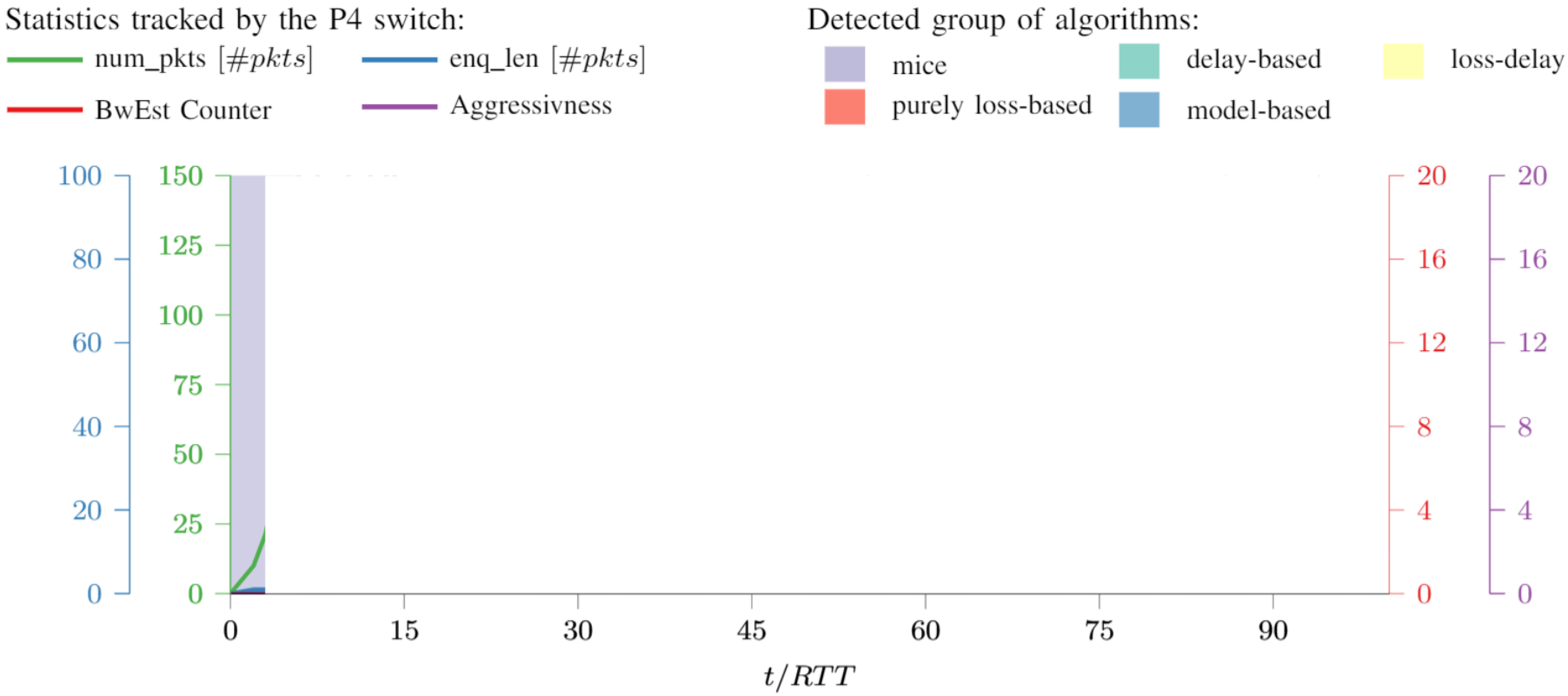

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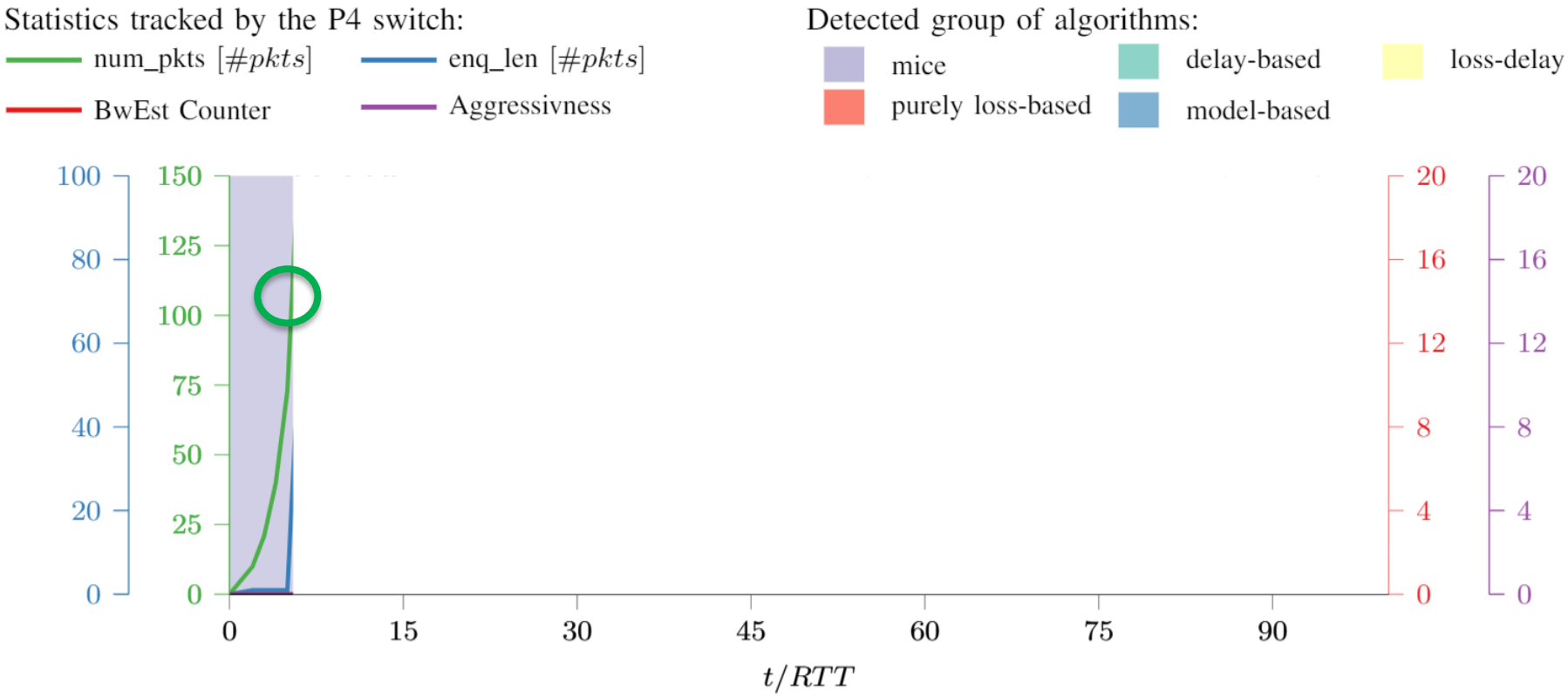

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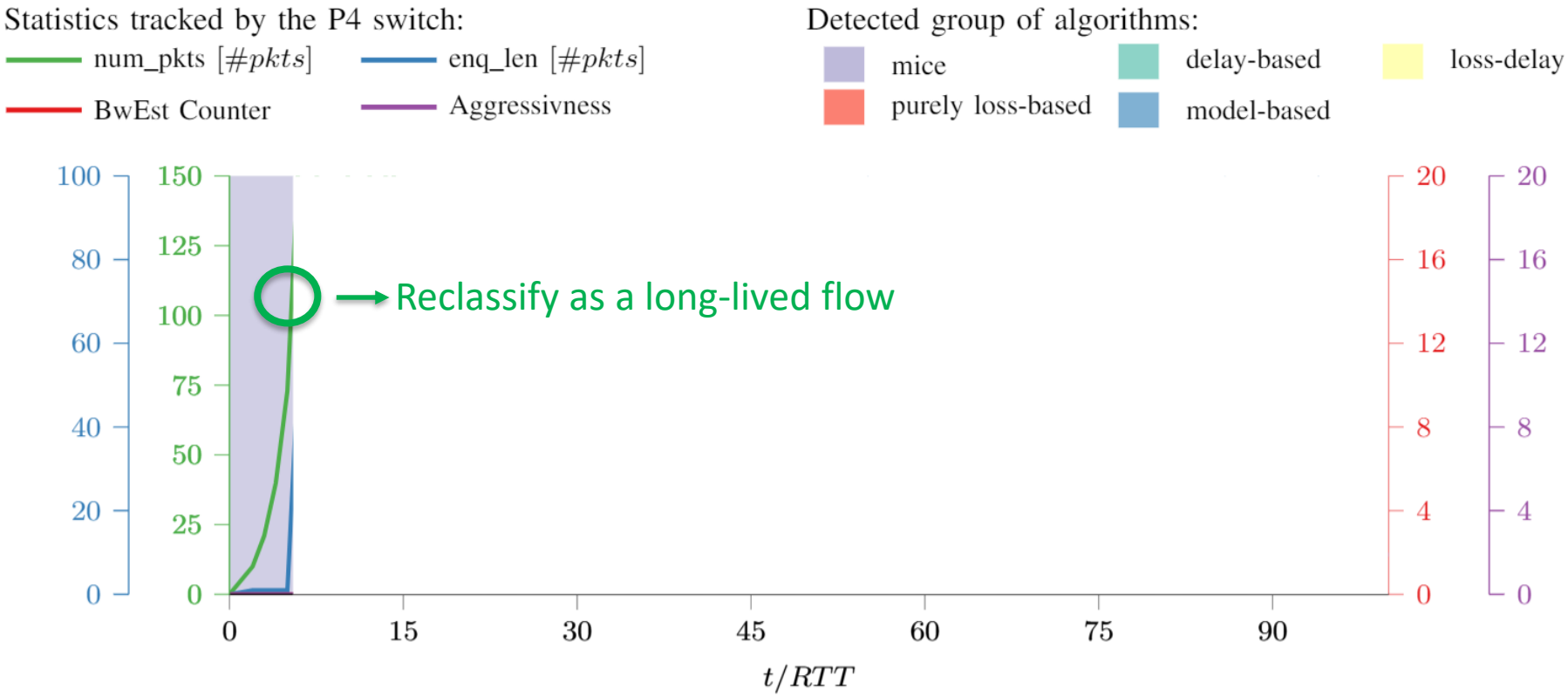

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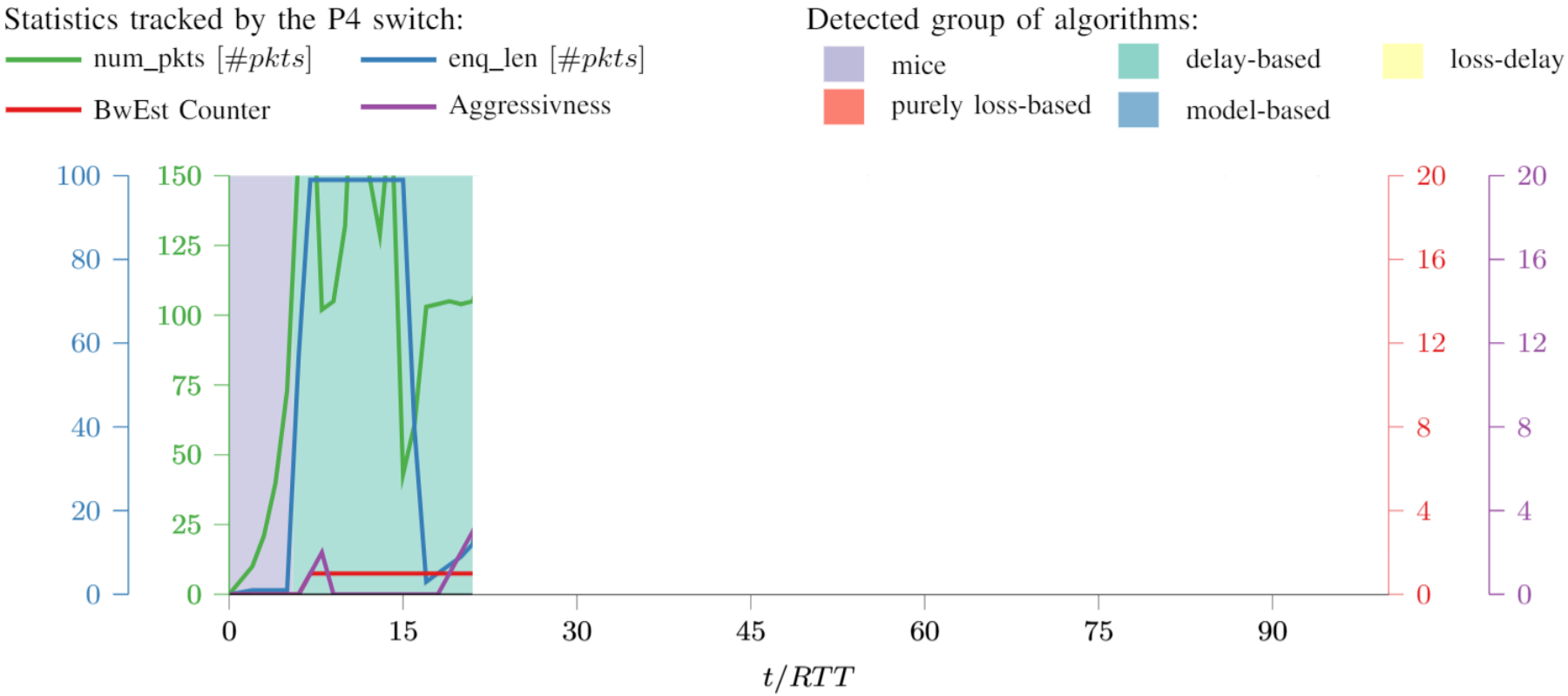

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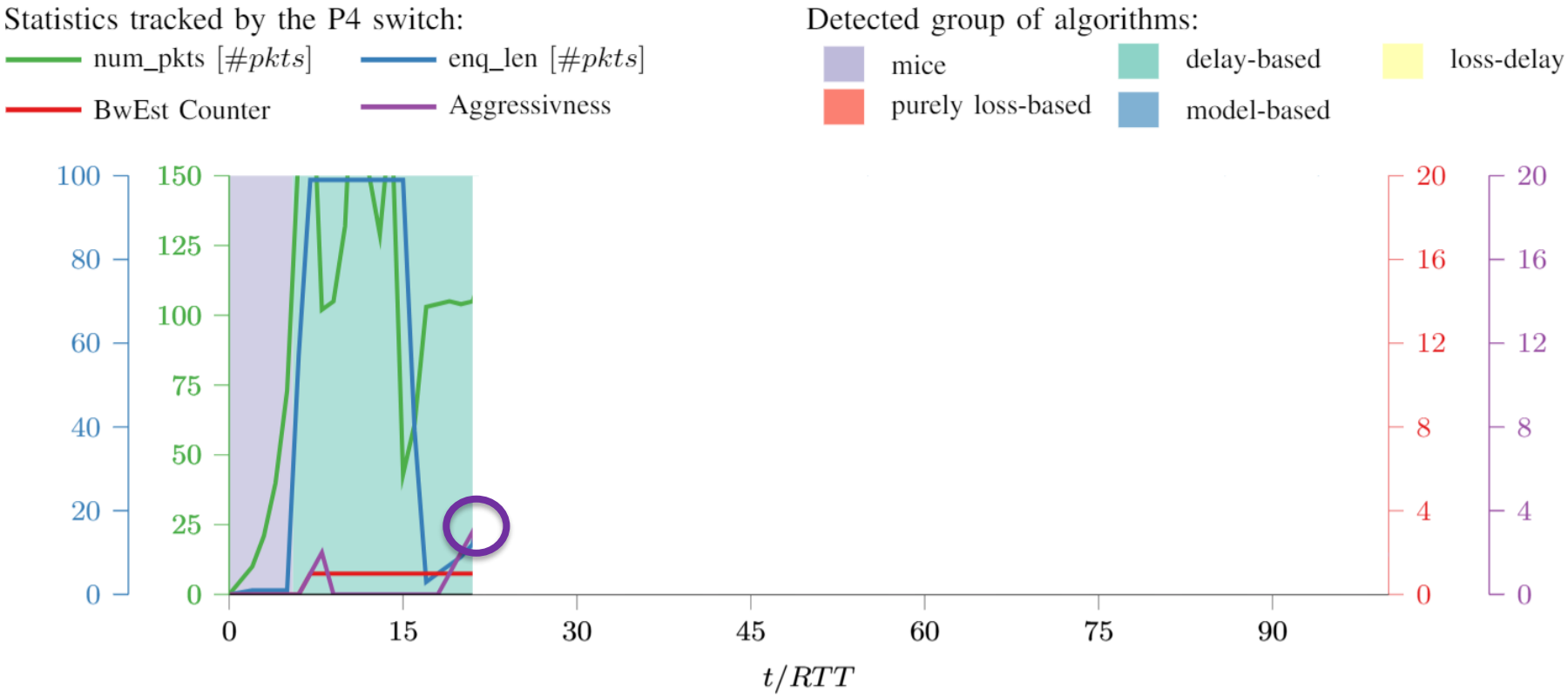

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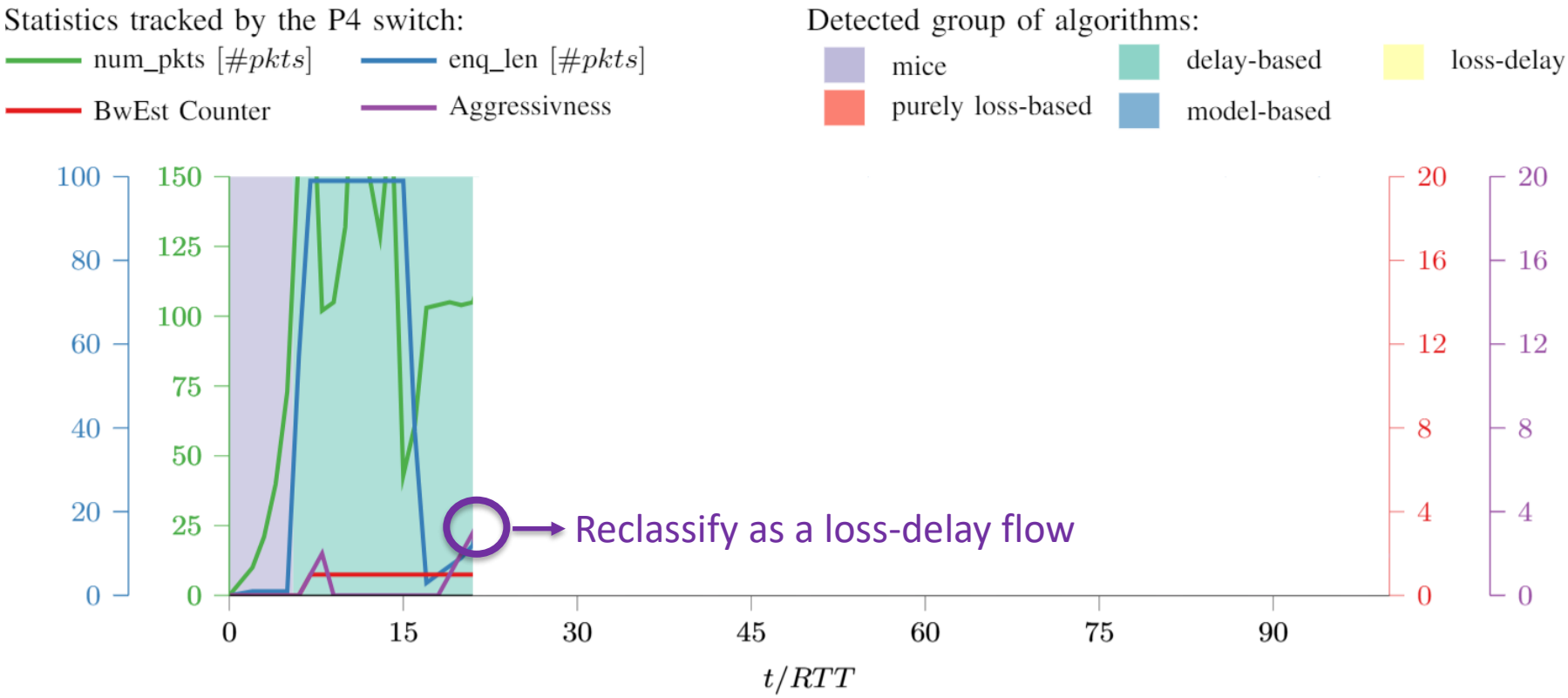

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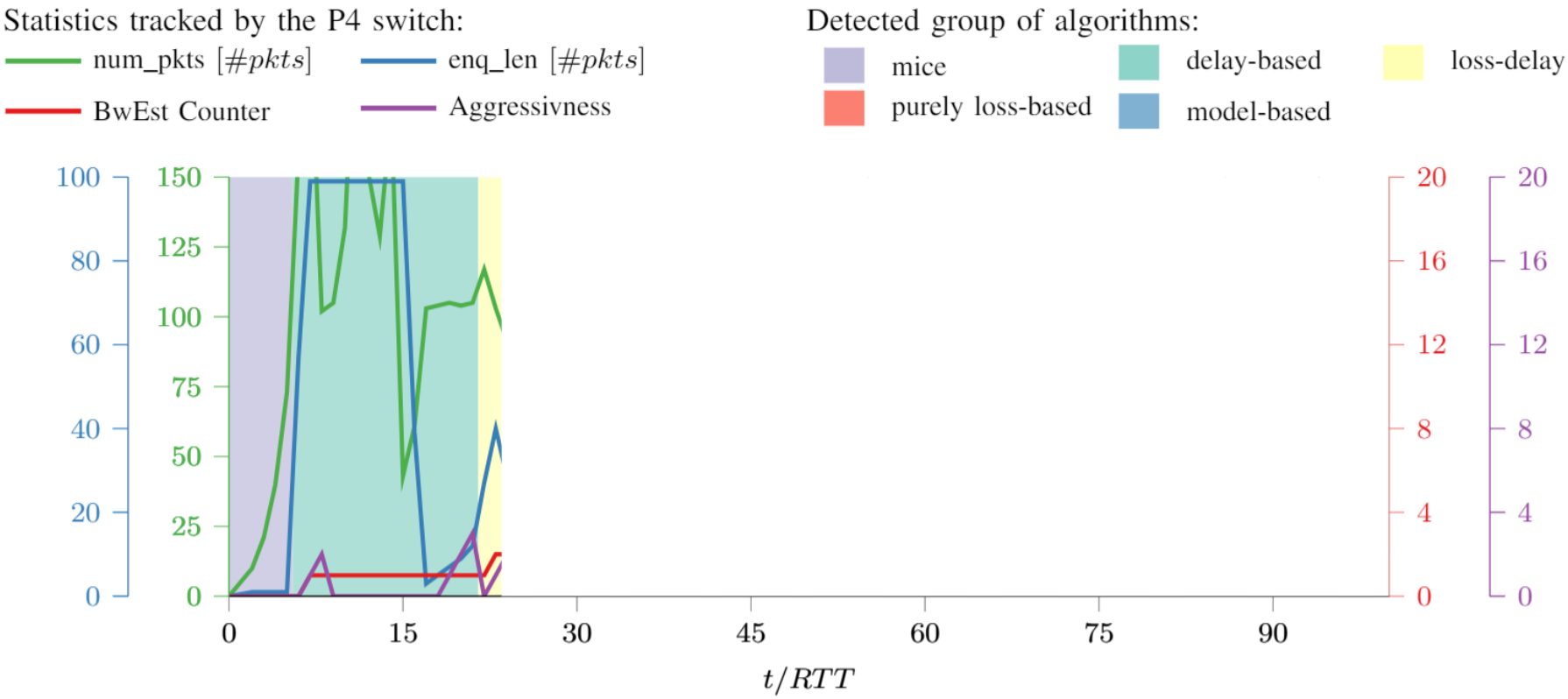

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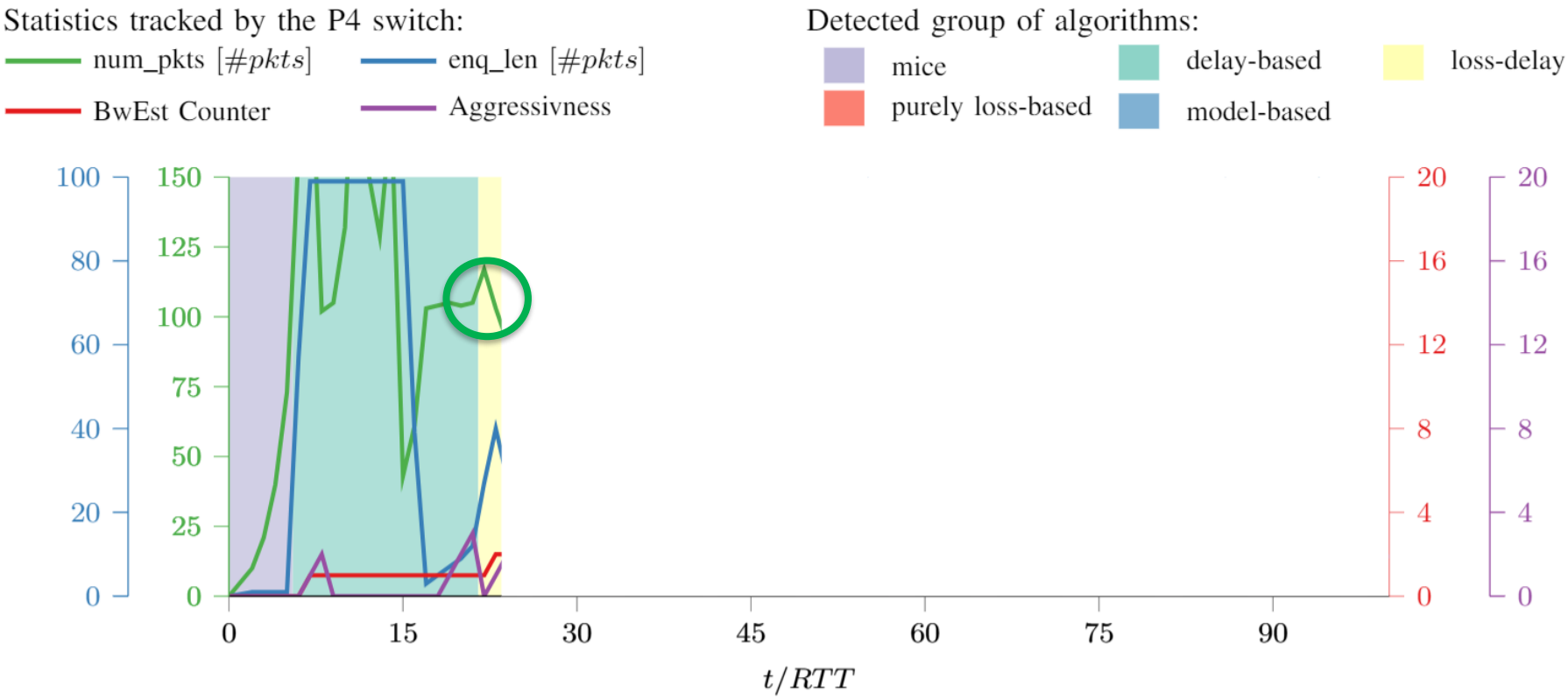

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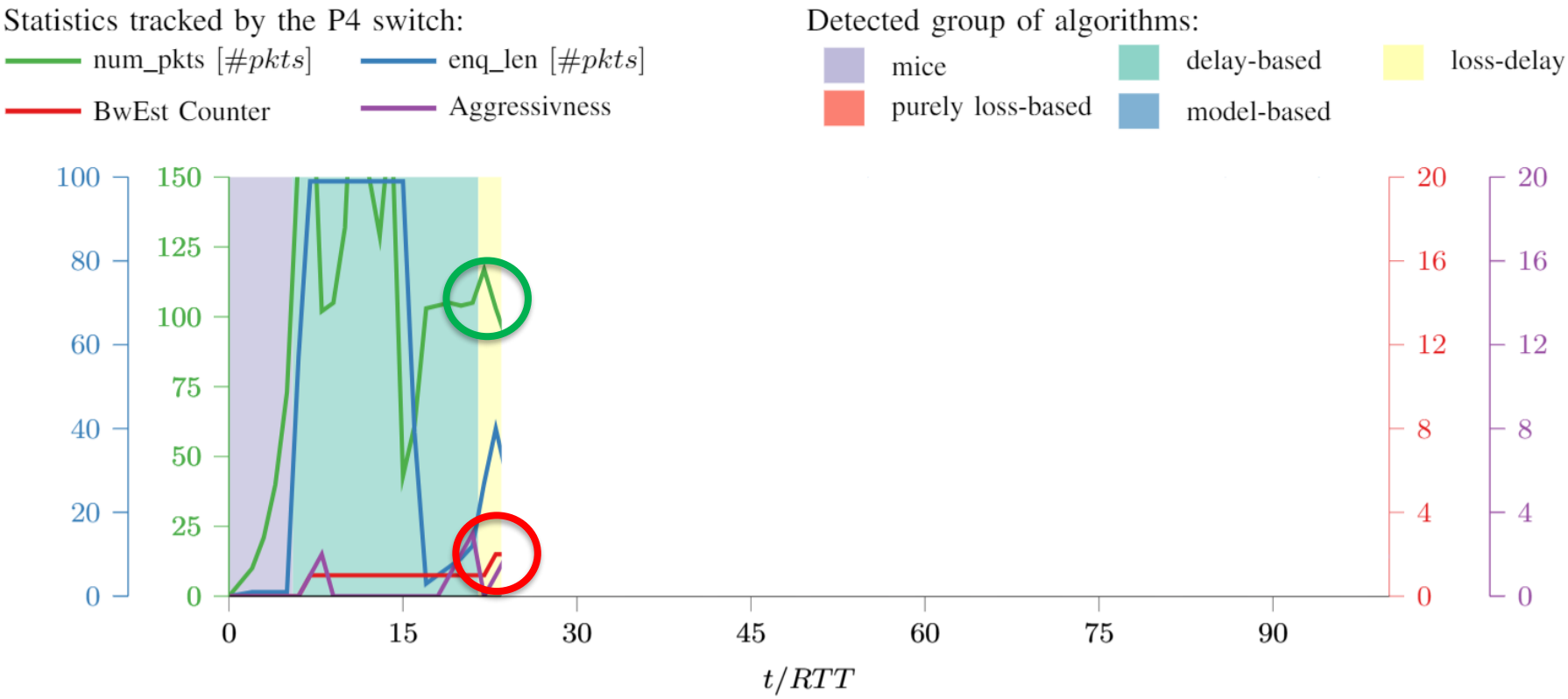

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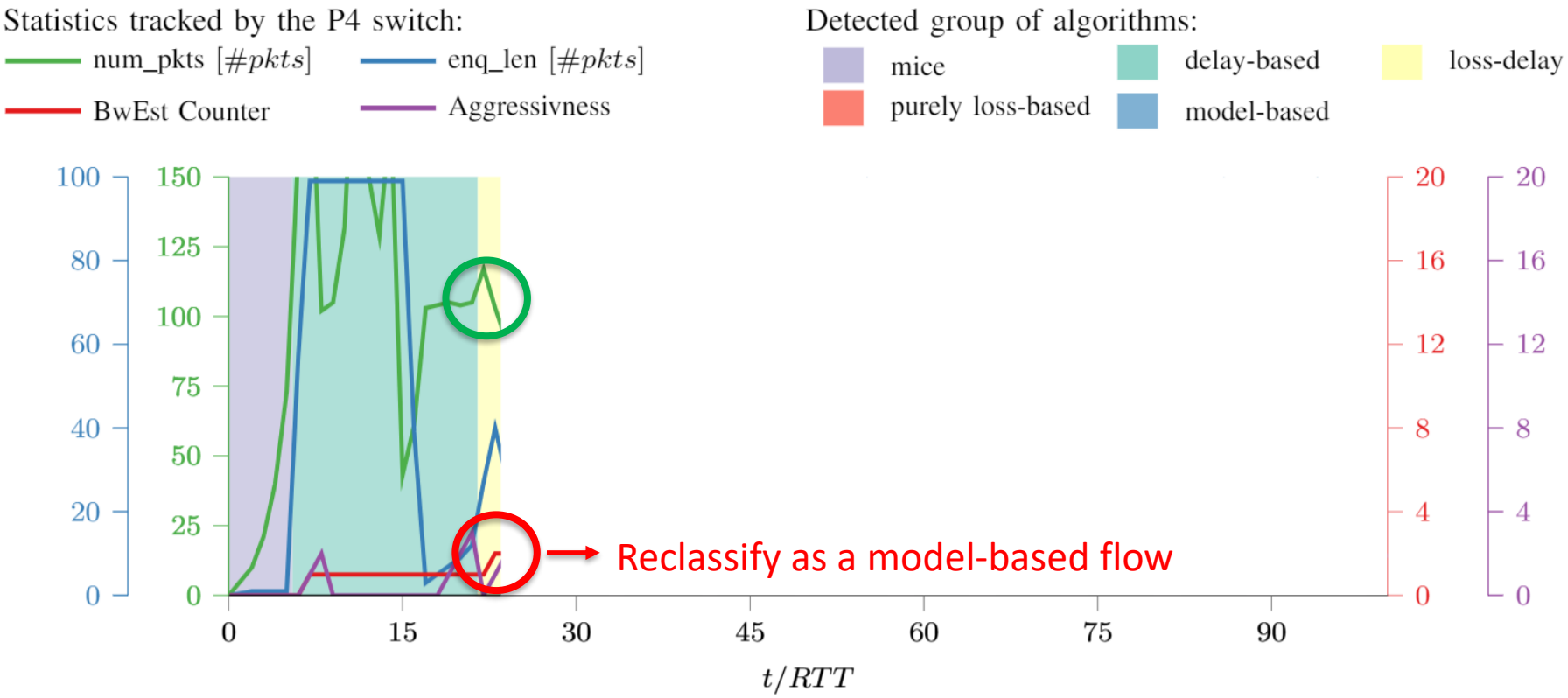

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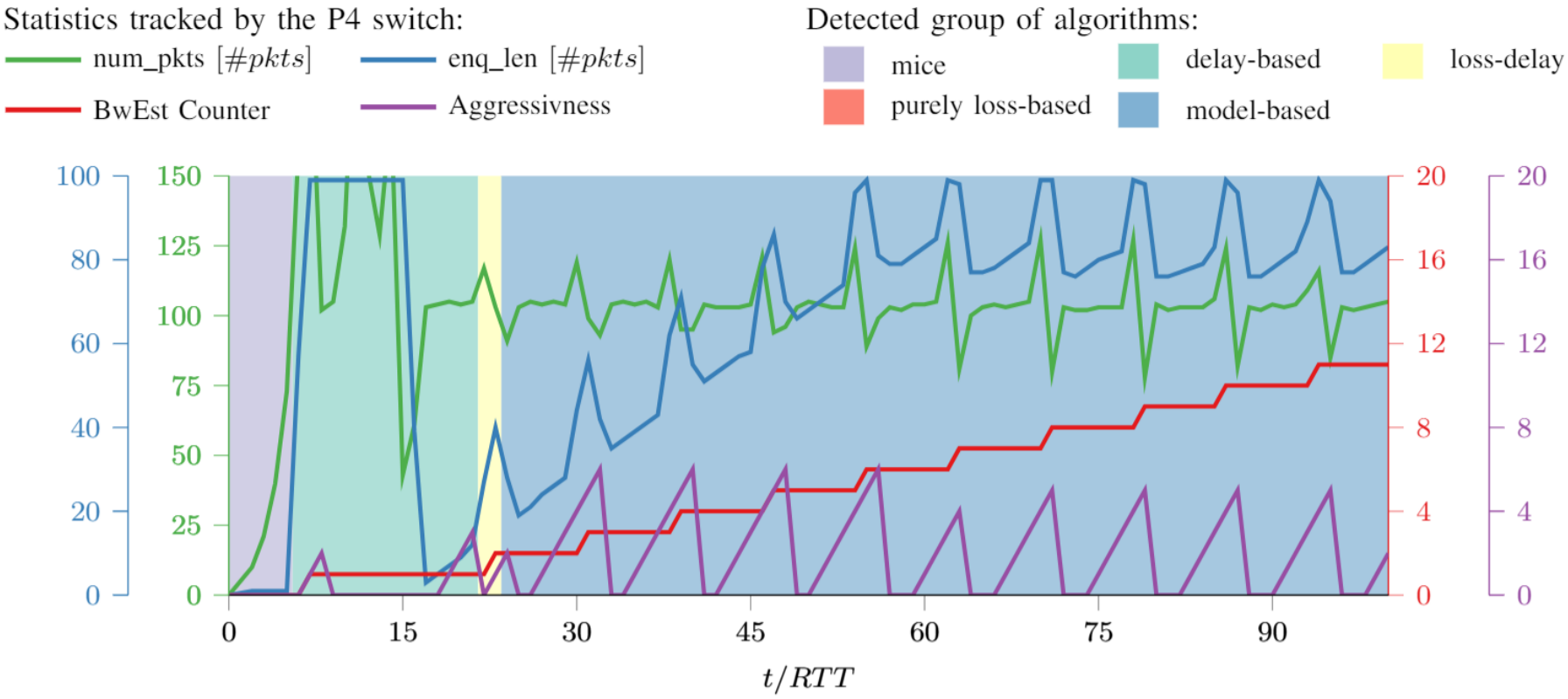

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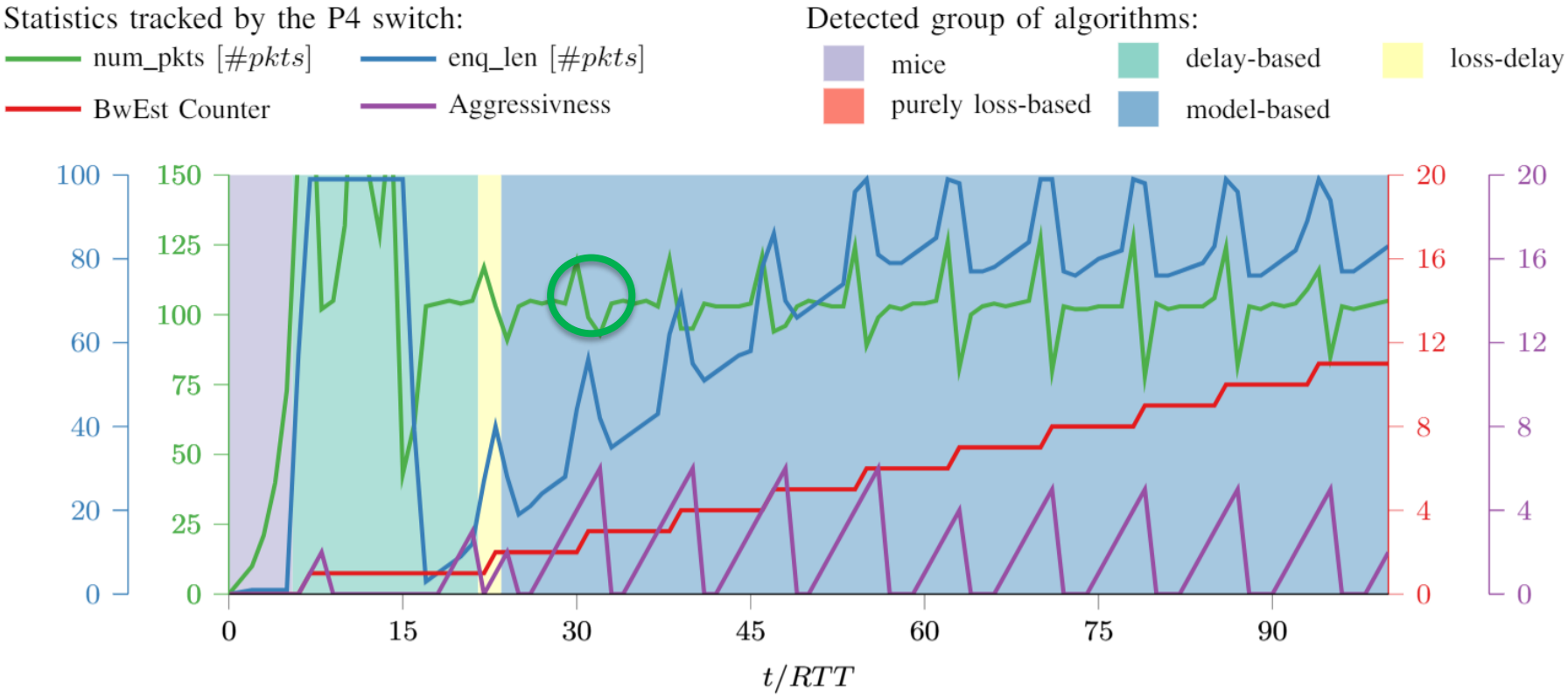

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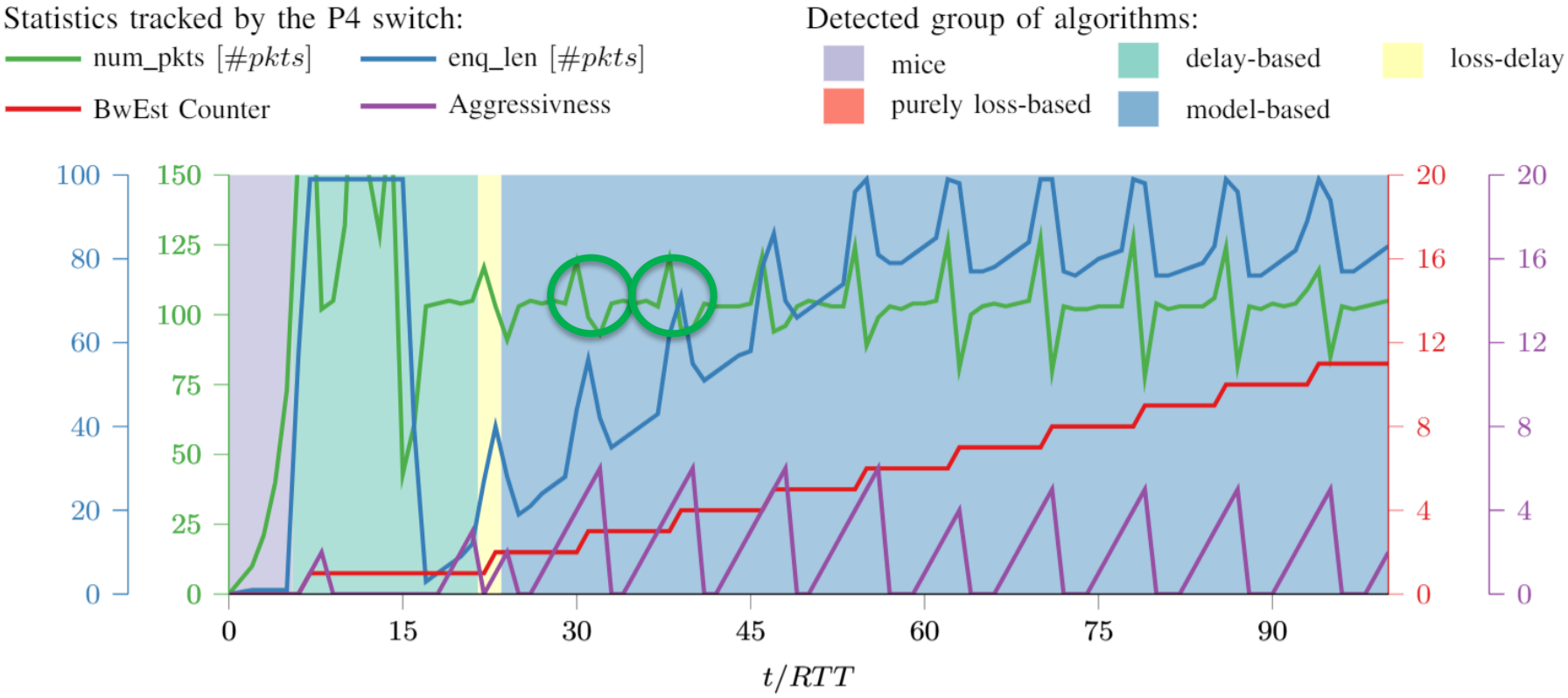

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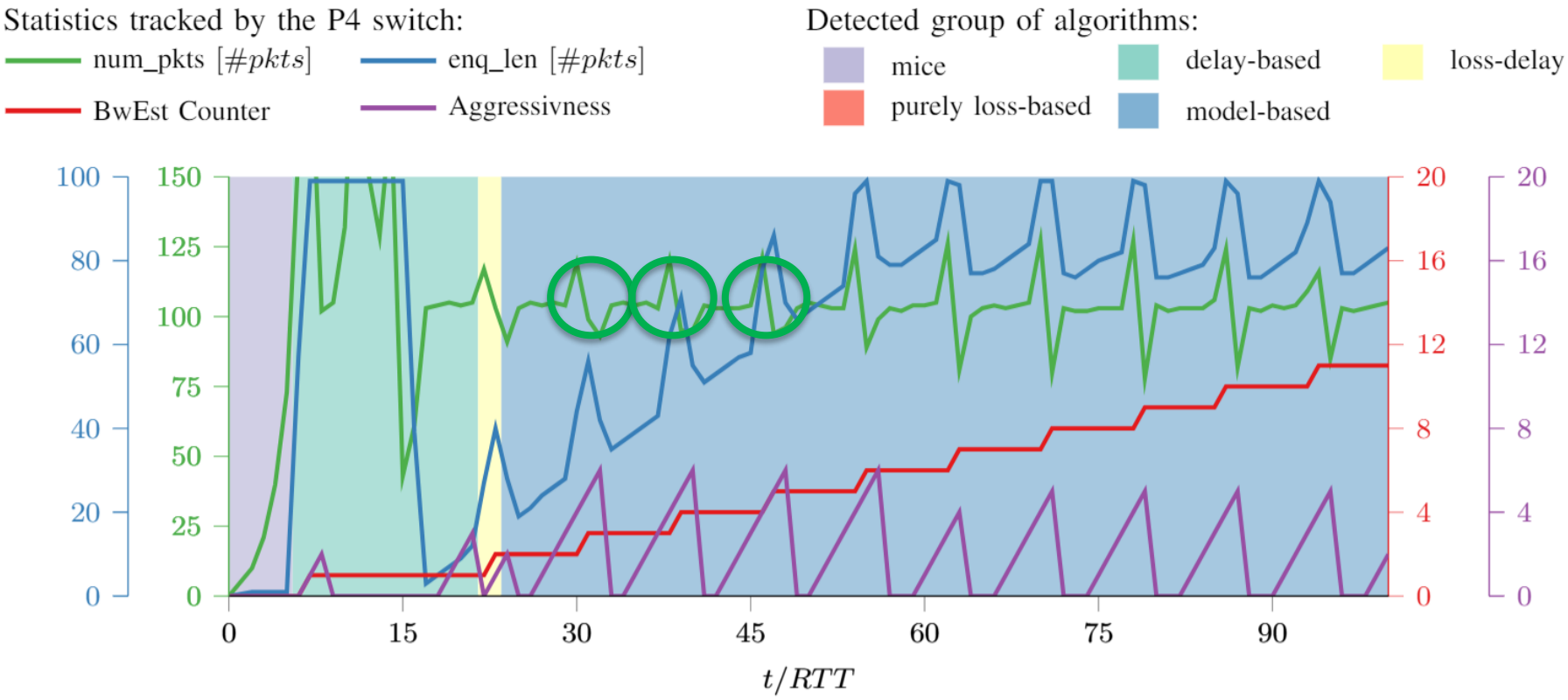
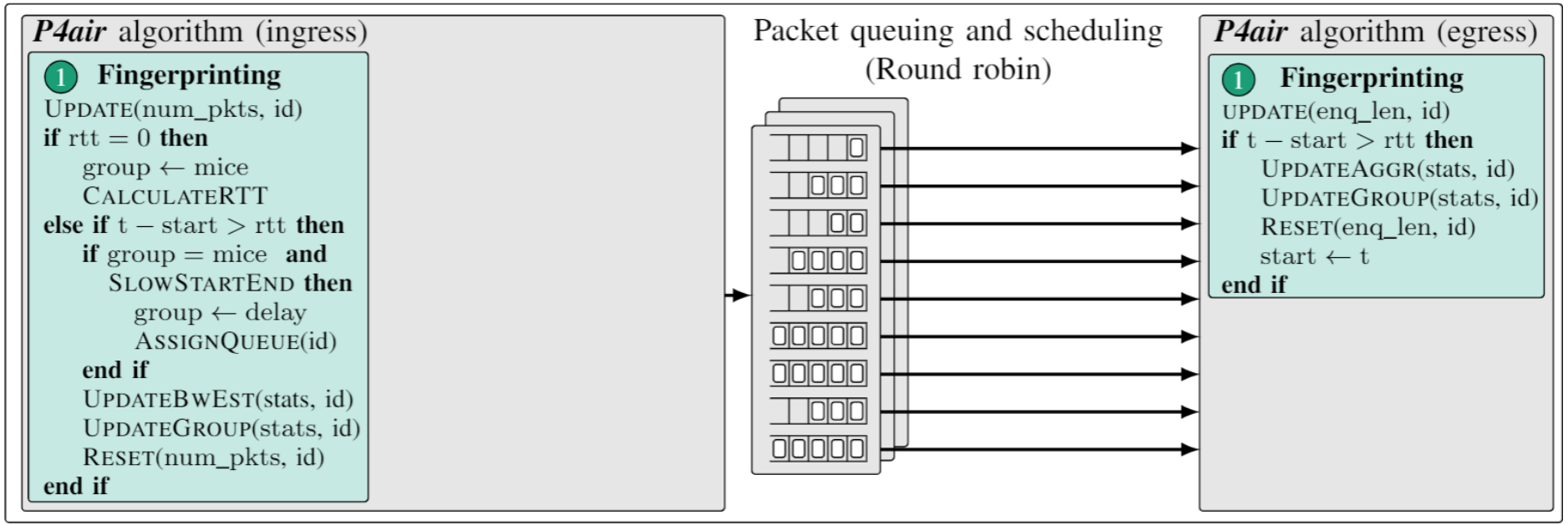


P4air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else if t − start > rtt then
if group = mice and
SLOWSTARTEND then
group ← delay
ASSIGNQUEUE(id)
end if
UPDATEBWEST(stats, id)
UPDATEGROUP(stats, id)
RESET(num_pkts, id)
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Packet queuing and scheduling
(Round robin)
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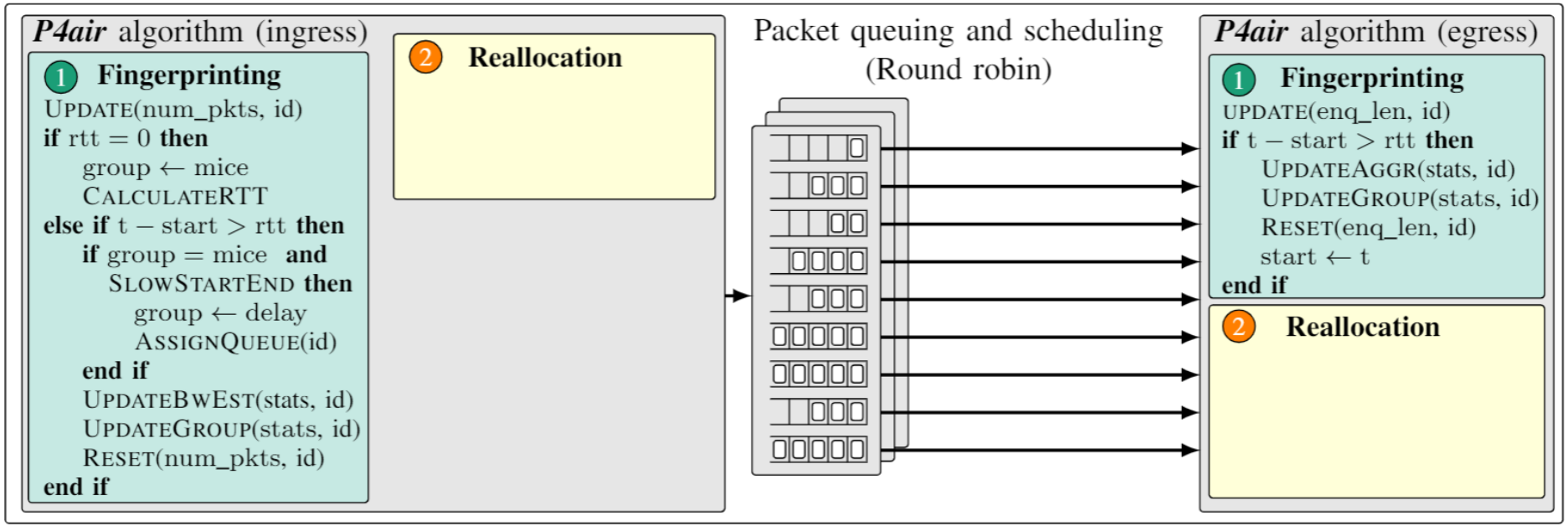
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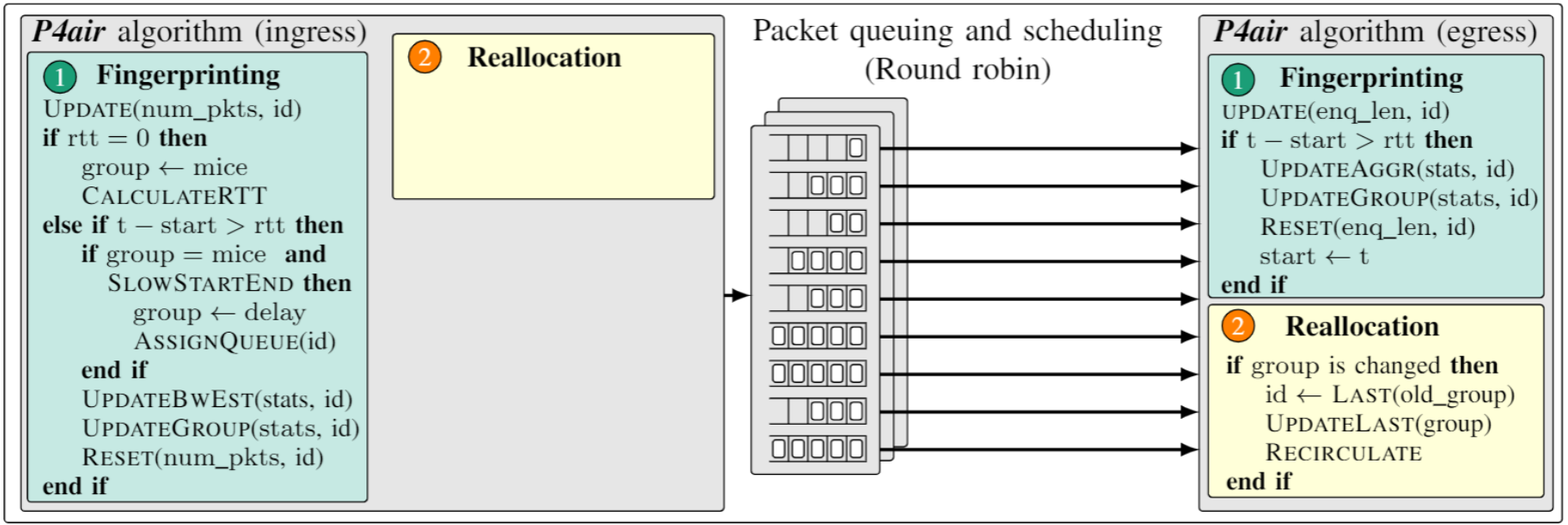
P4air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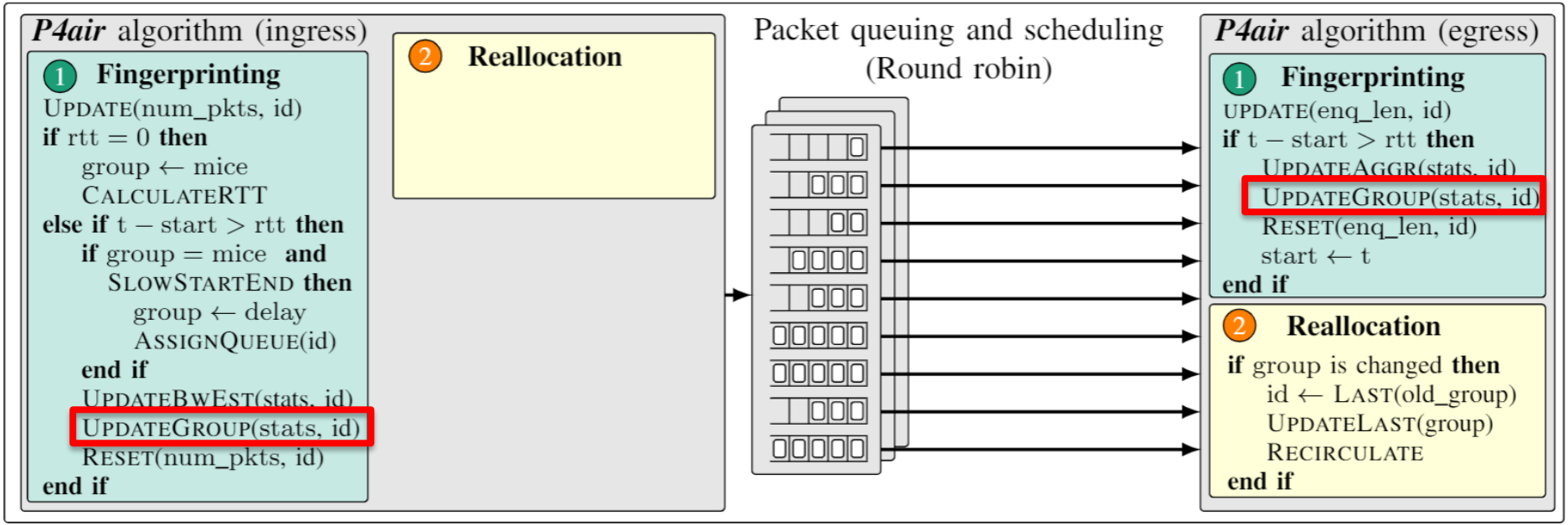
2 Reallocation
if group is changed then
id ← LAST(old_group)
UPDATELAST(group)
RECIRCULATE
end if

P4air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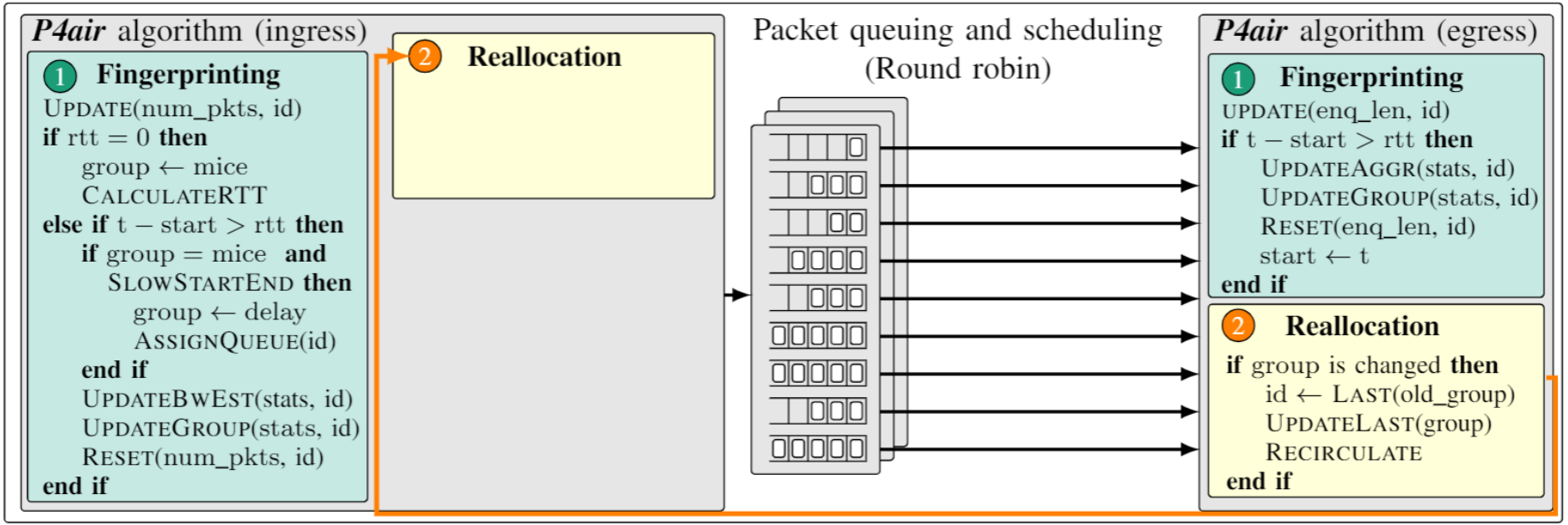
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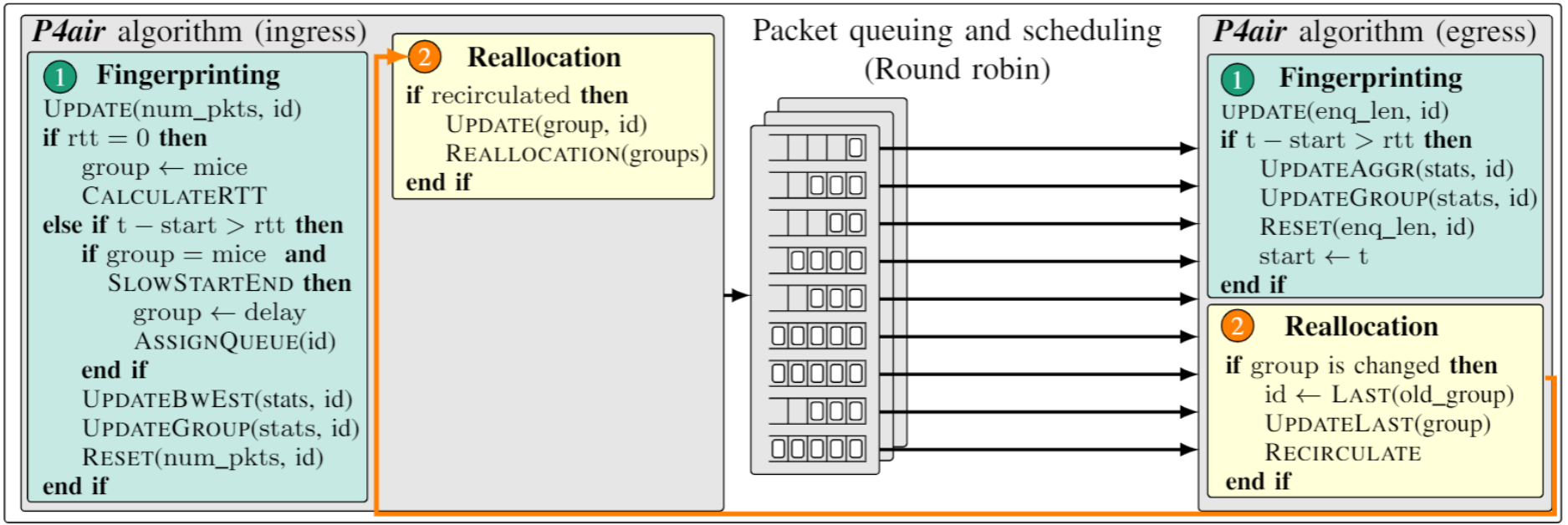
P4air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group ← delay
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end if
UPDATEBWEST(stats, id)
UPDATEGROUP(stats, id)
RESET(num_pkts, id)
end if
2 Reallocation
if recirculated then
UPDATE(group, id)
REALLOCATION(groups)
end if
Packet queuing and scheduling
(Round robin)
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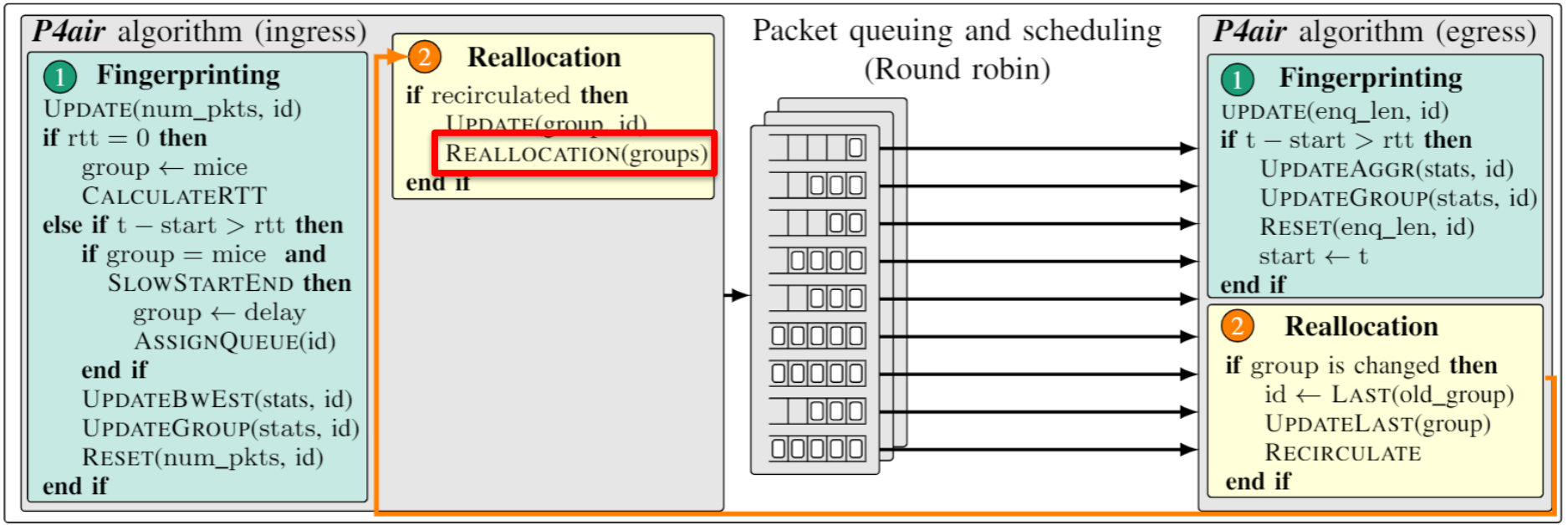
end if

P4air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2 Reallocation
if recirculated then
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REALLOCATION(groups)
end if
Packet queuing and scheduling
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UPDATEGROUP(stats, id)
RESET(enq_len, id)
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if group is changed then
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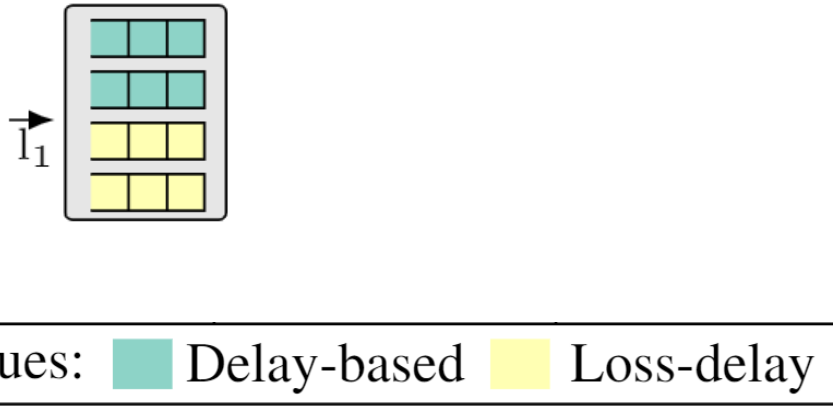
UPDATELAST(group)
RECIRCULATE
end if

Reallocation

Reallocation



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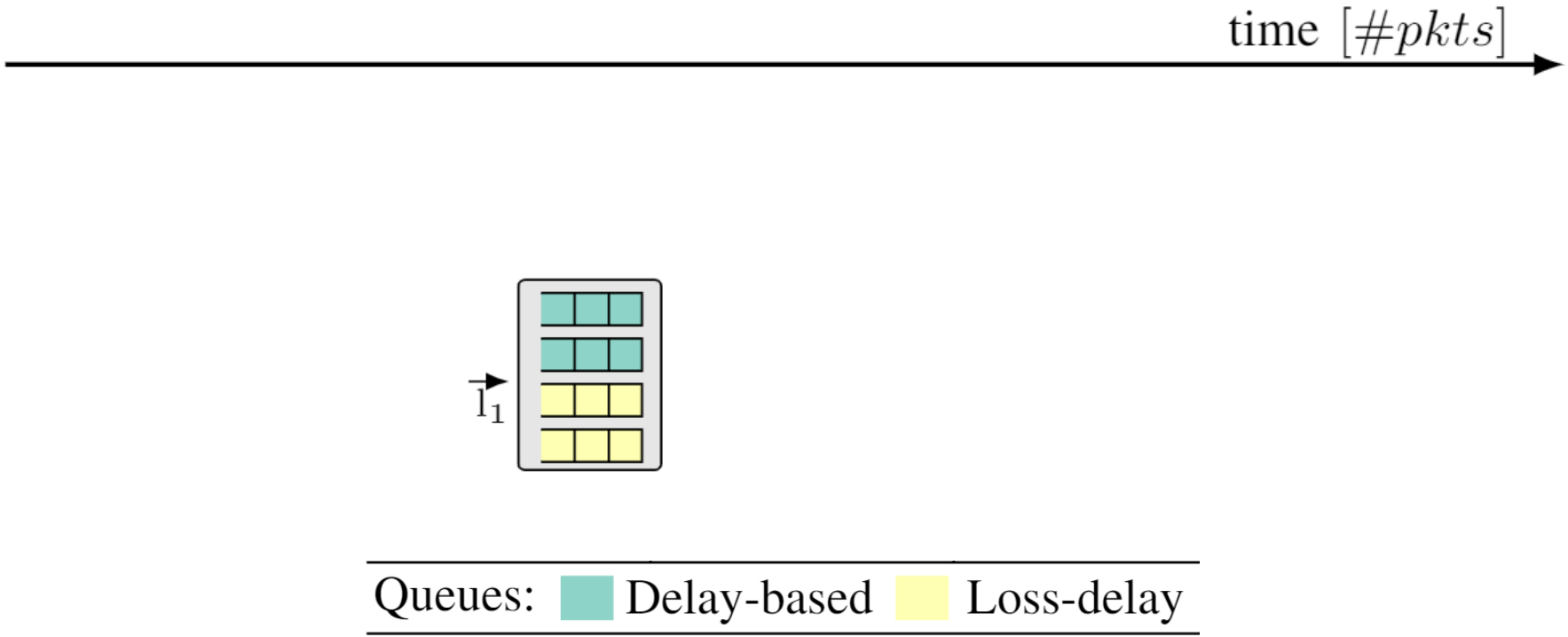

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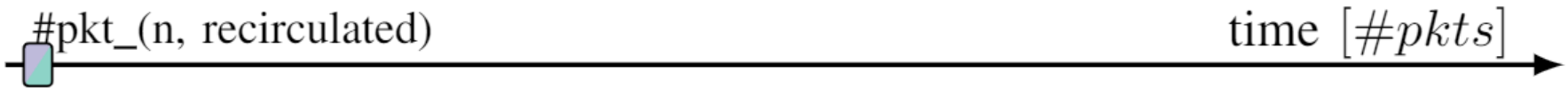
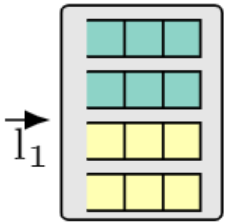
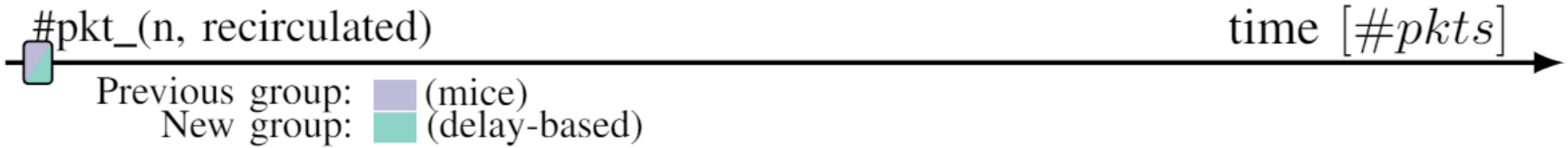
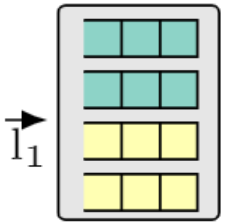


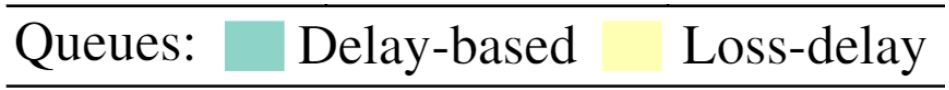


Queues: Delay-based Loss-delay

Reallocation







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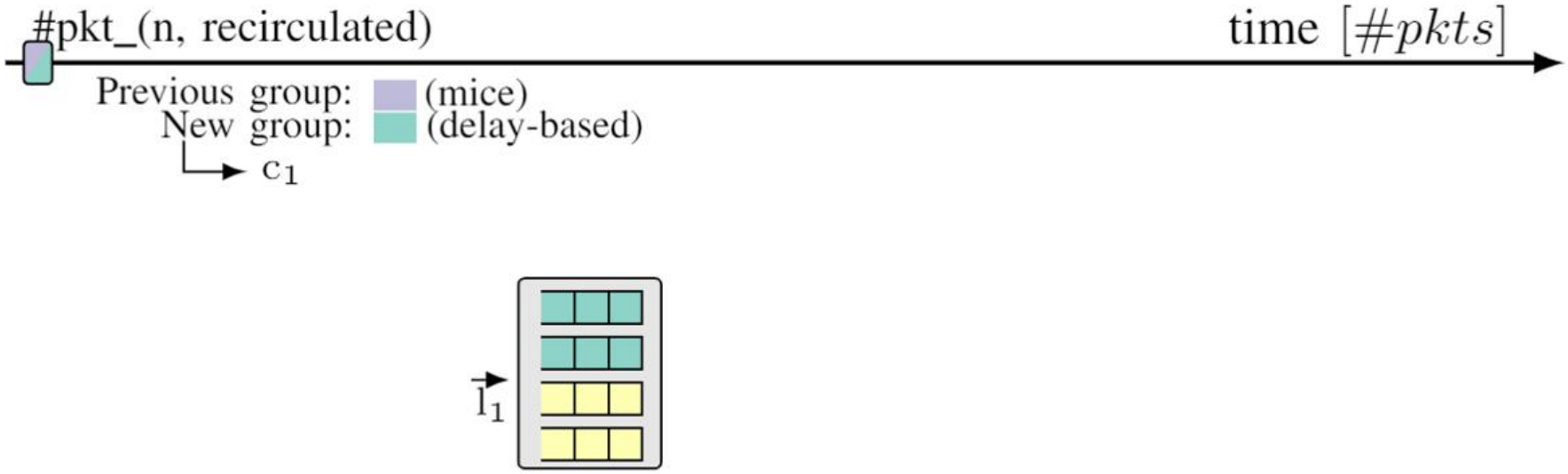

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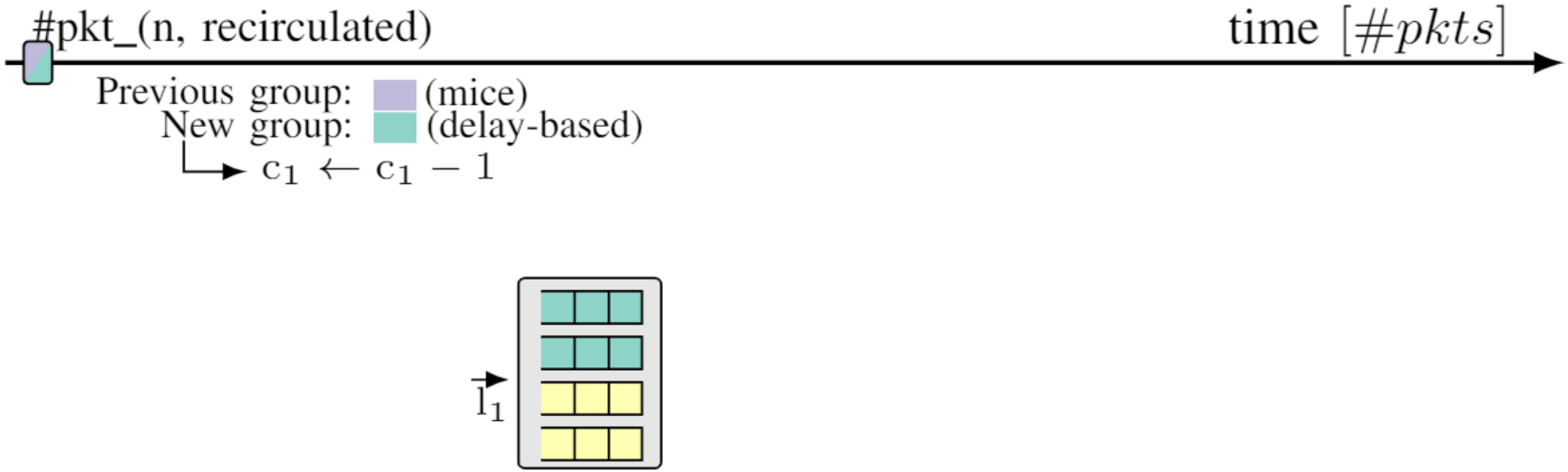

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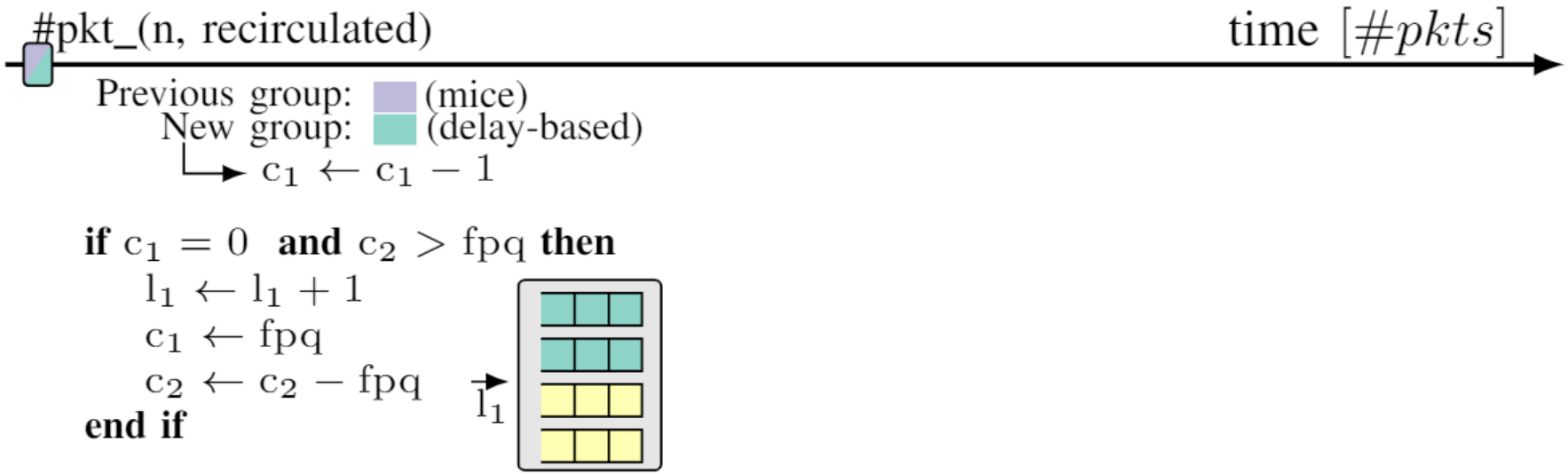

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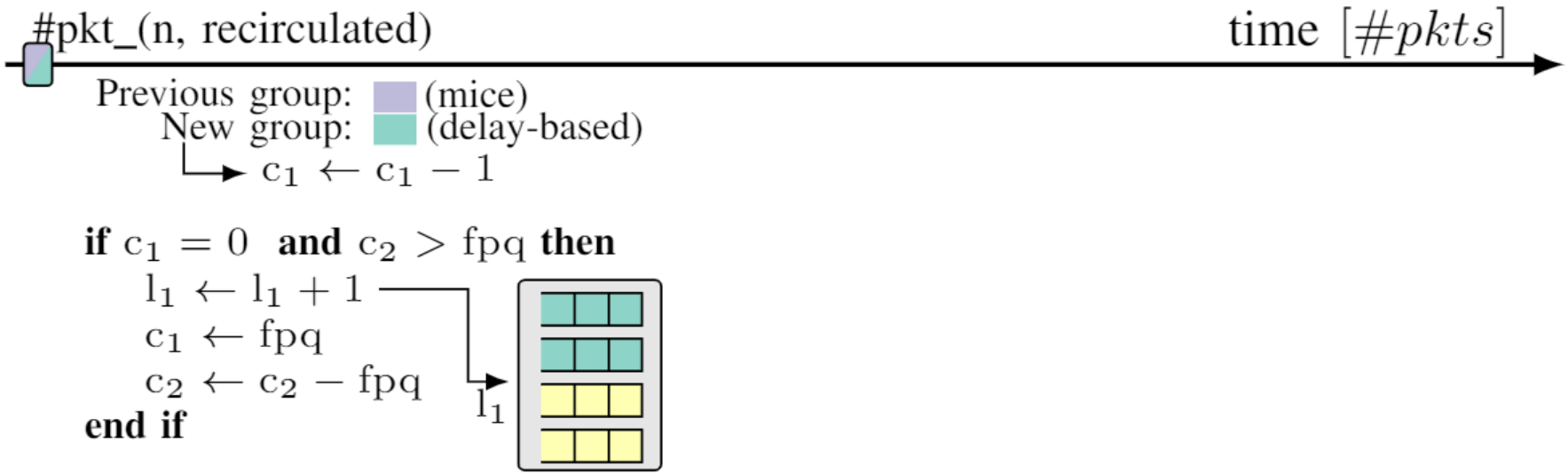

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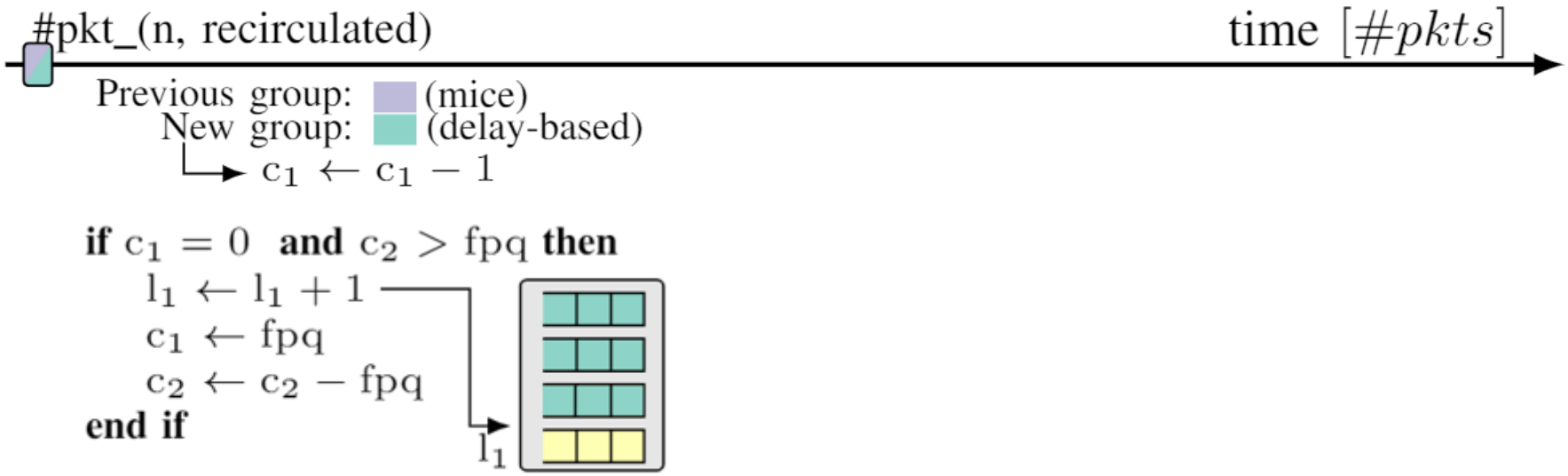

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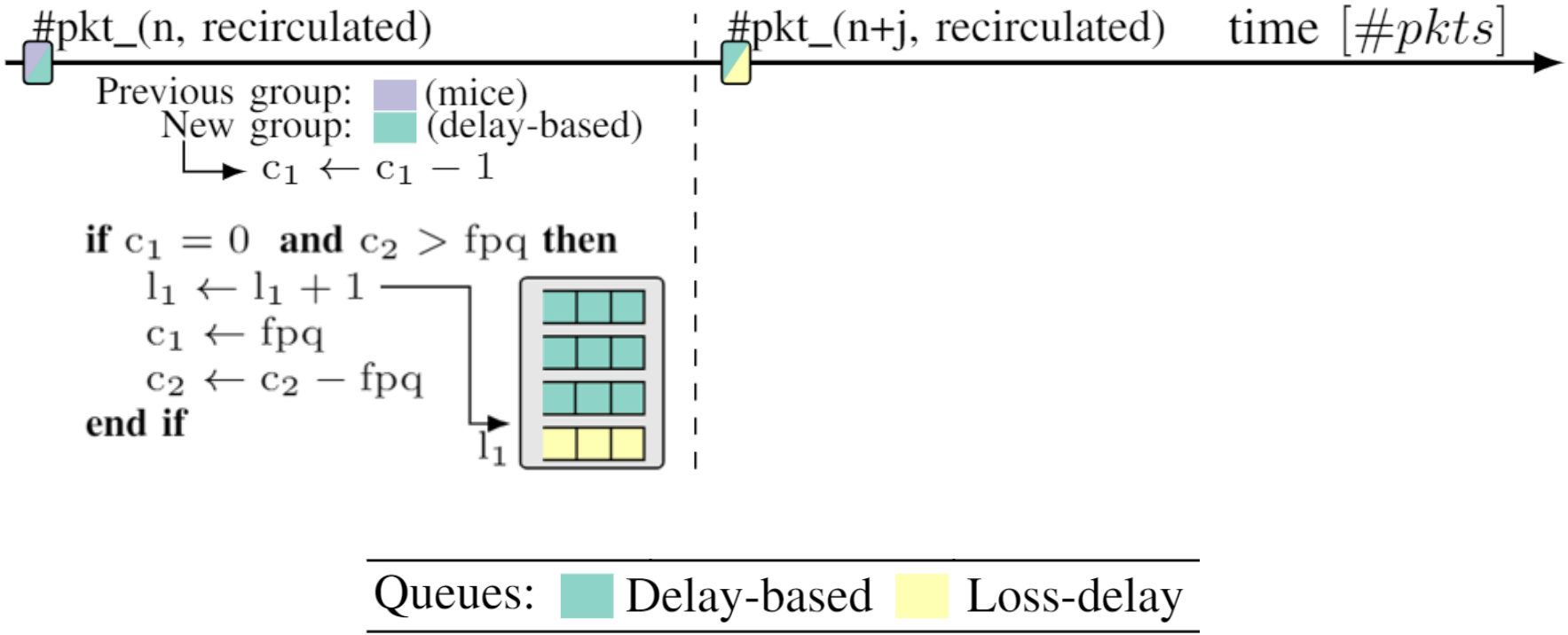

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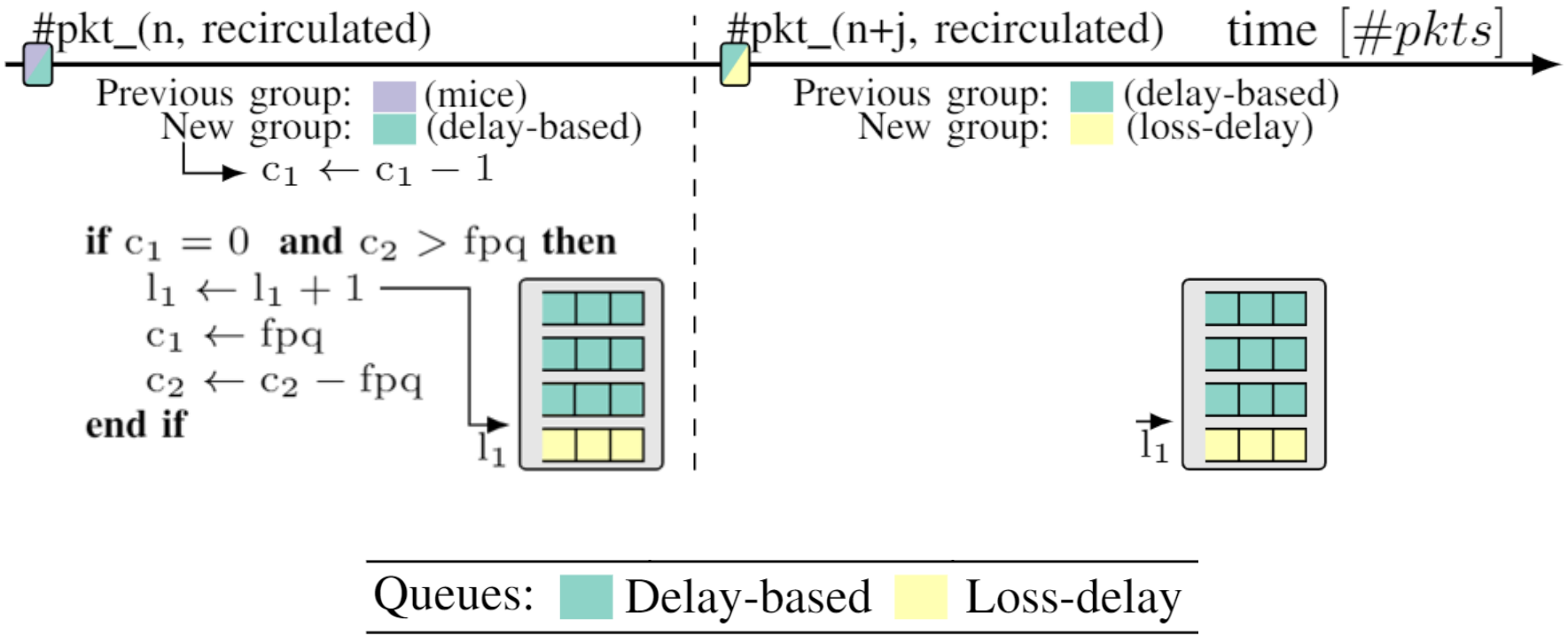

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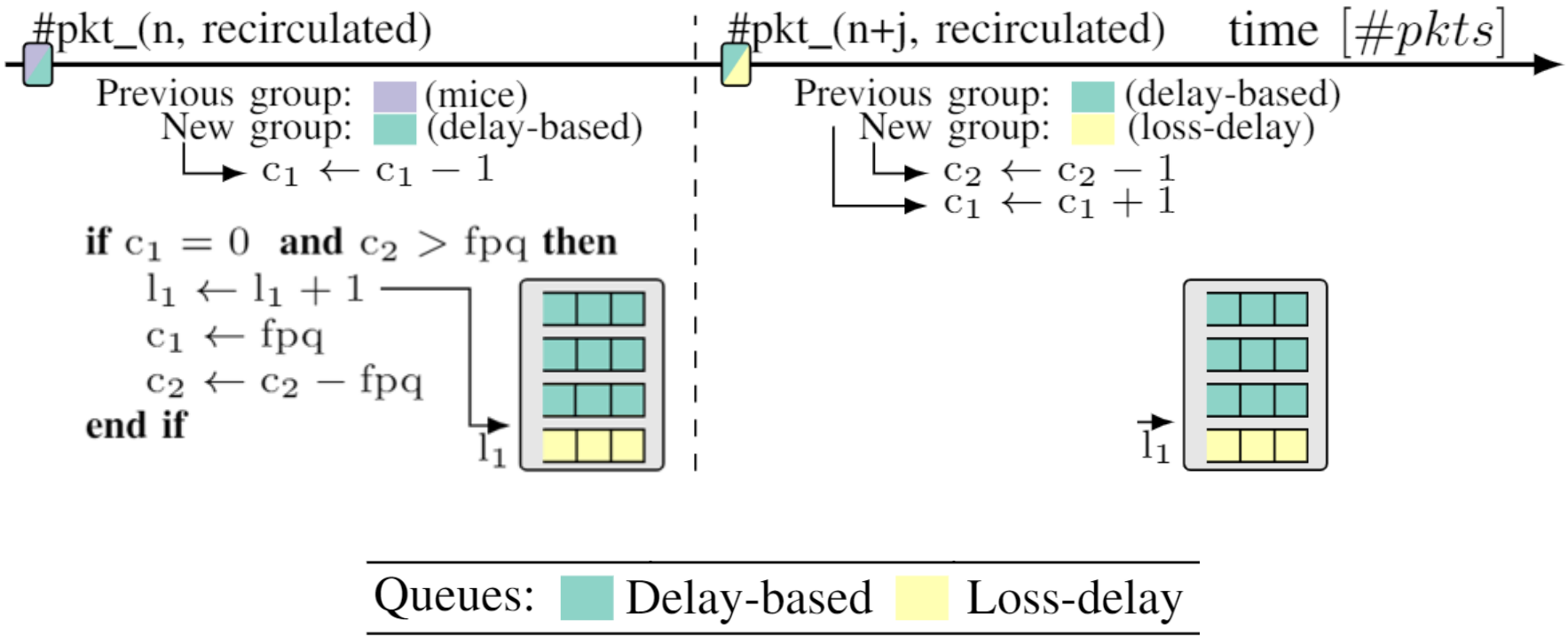

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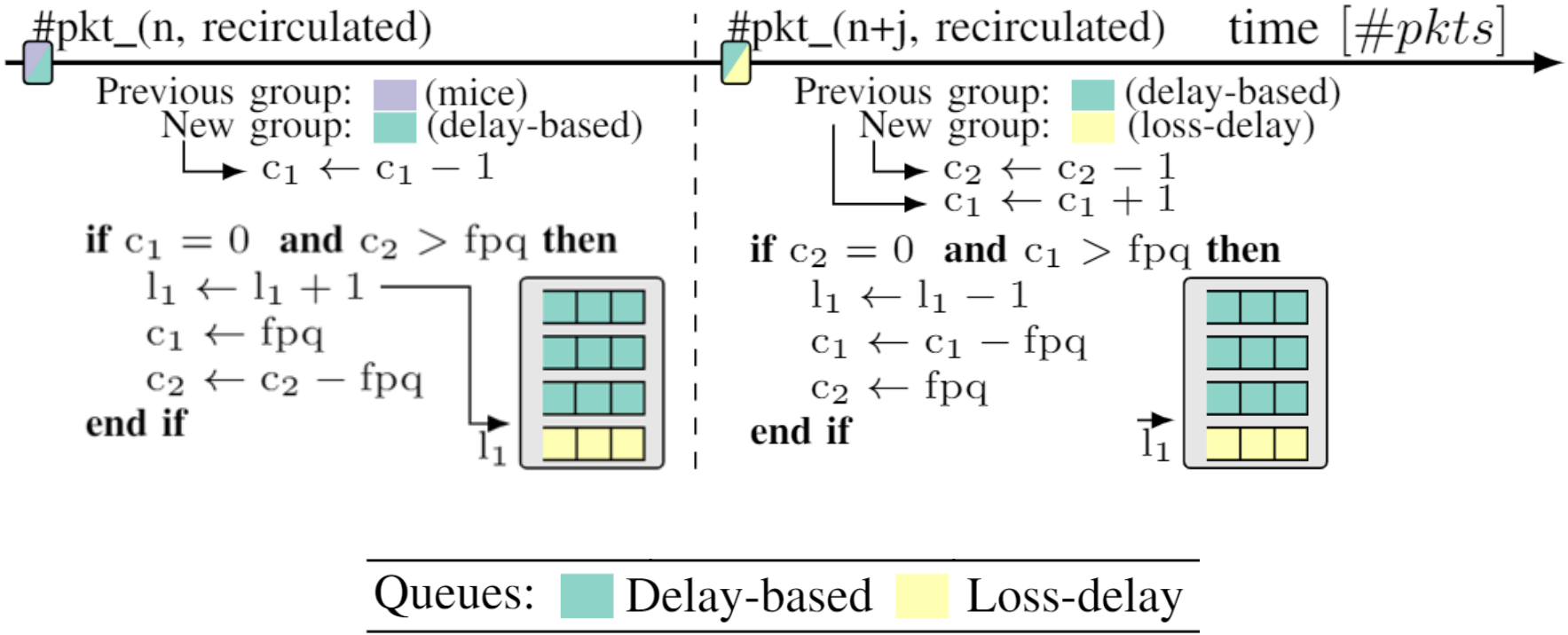

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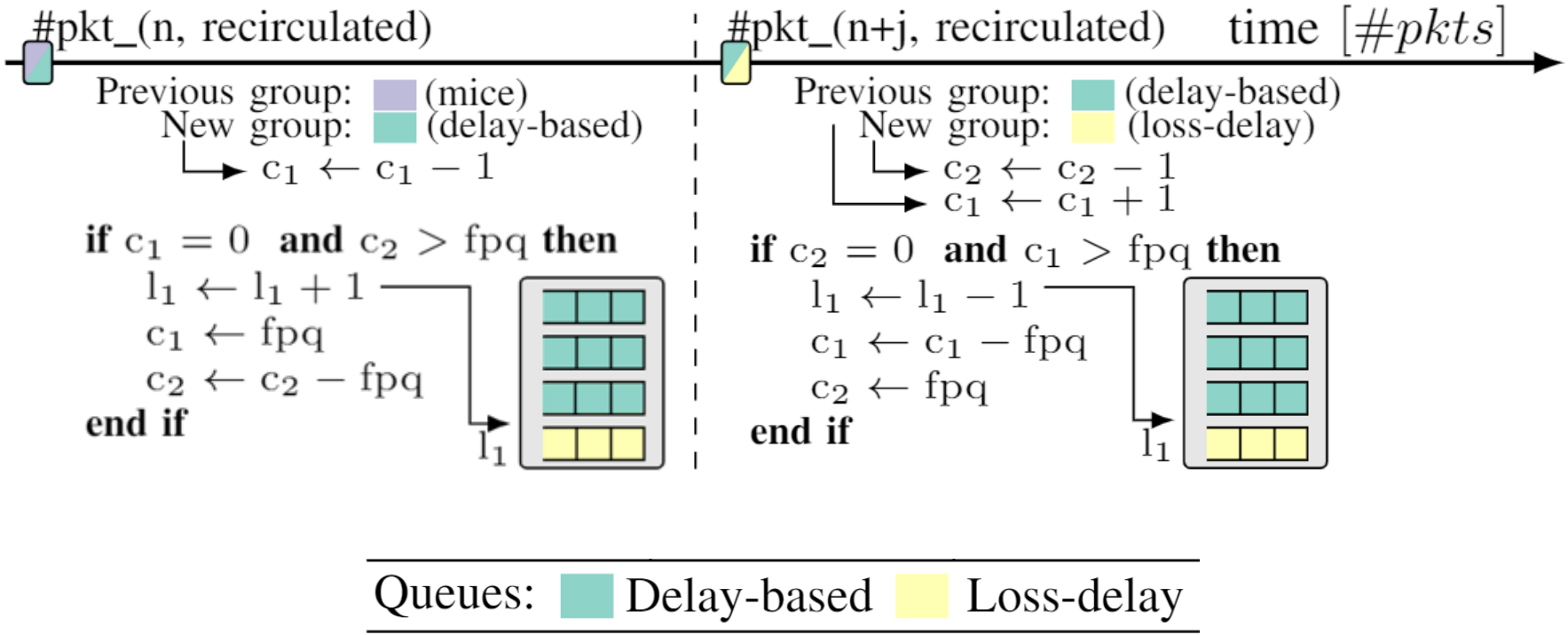

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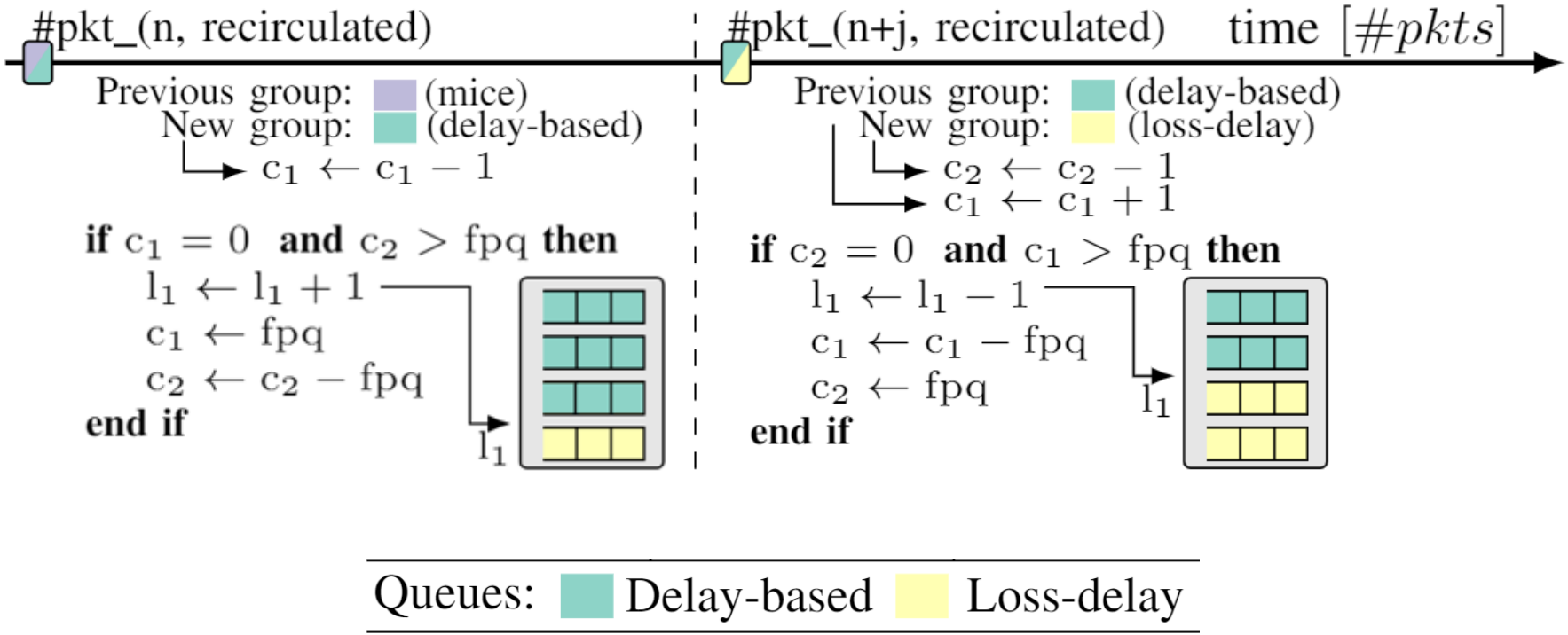
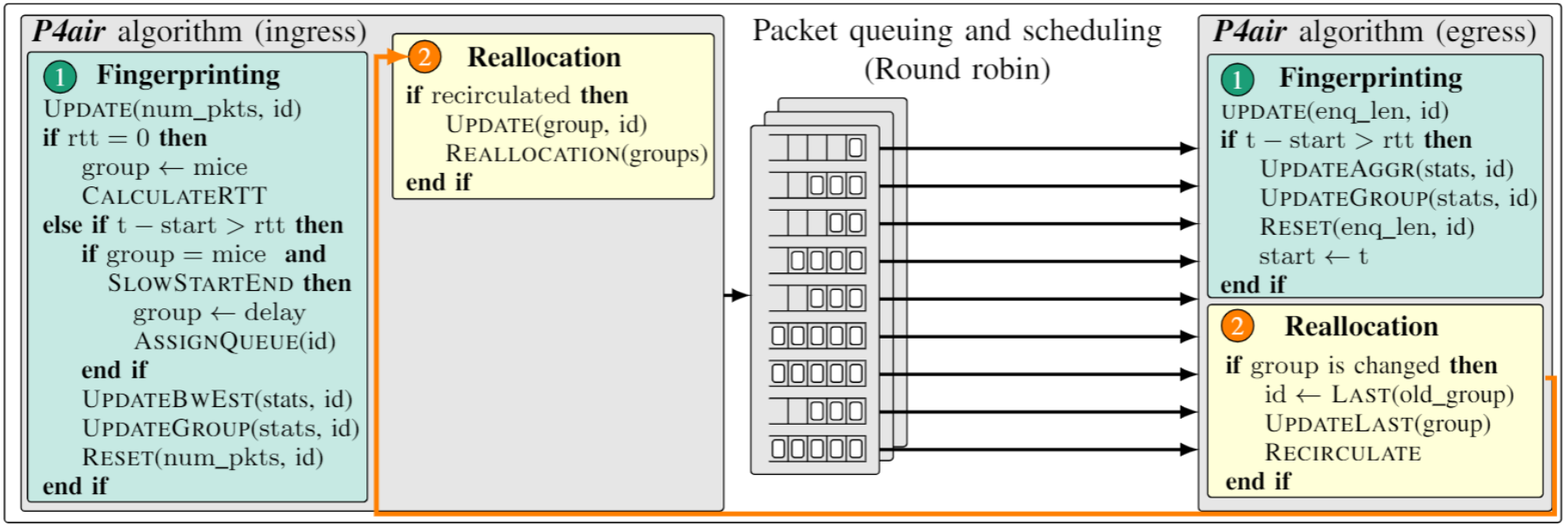


P4air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UPDATEBWEST(stats, id)
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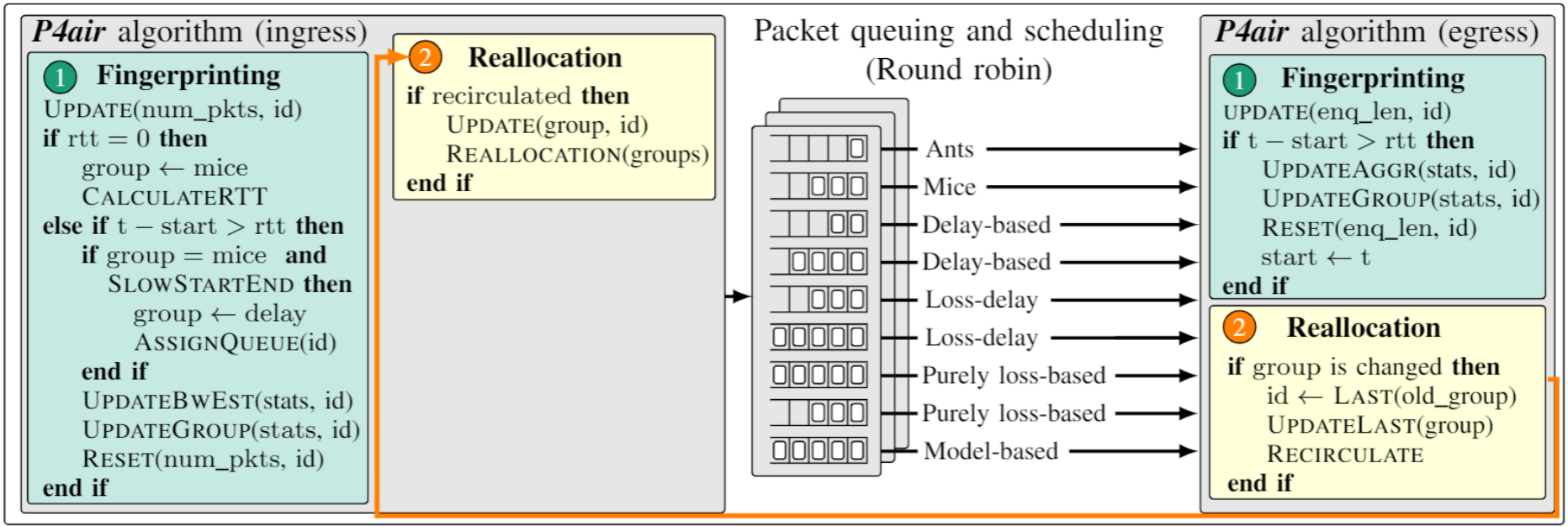
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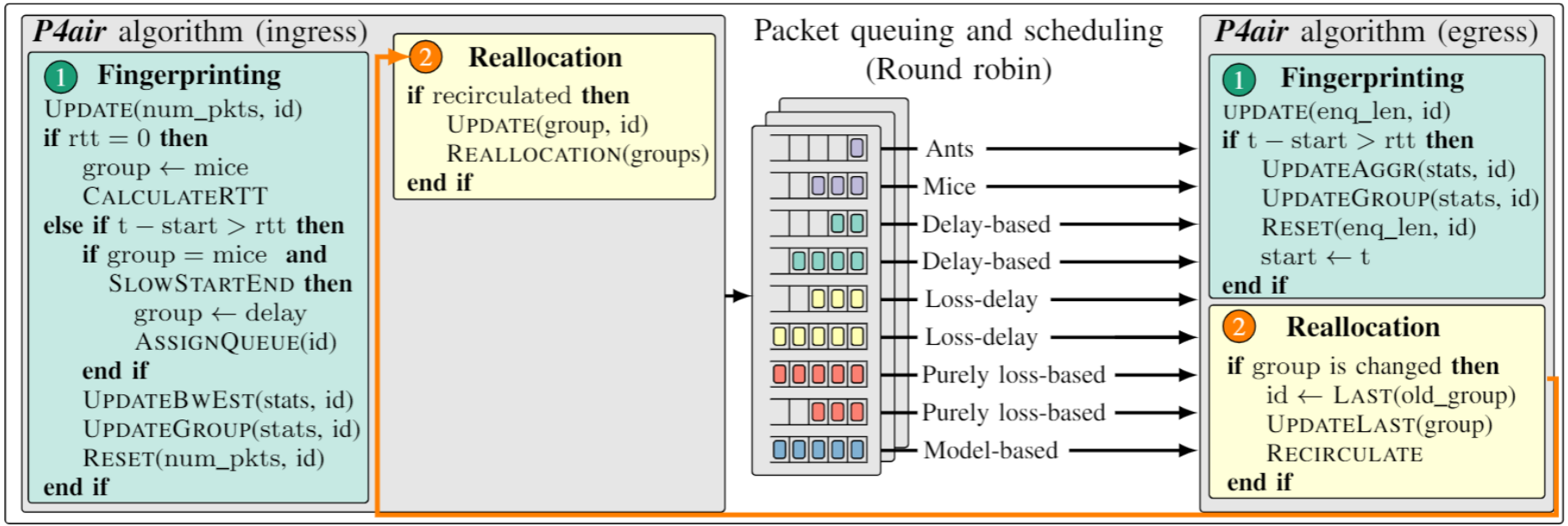
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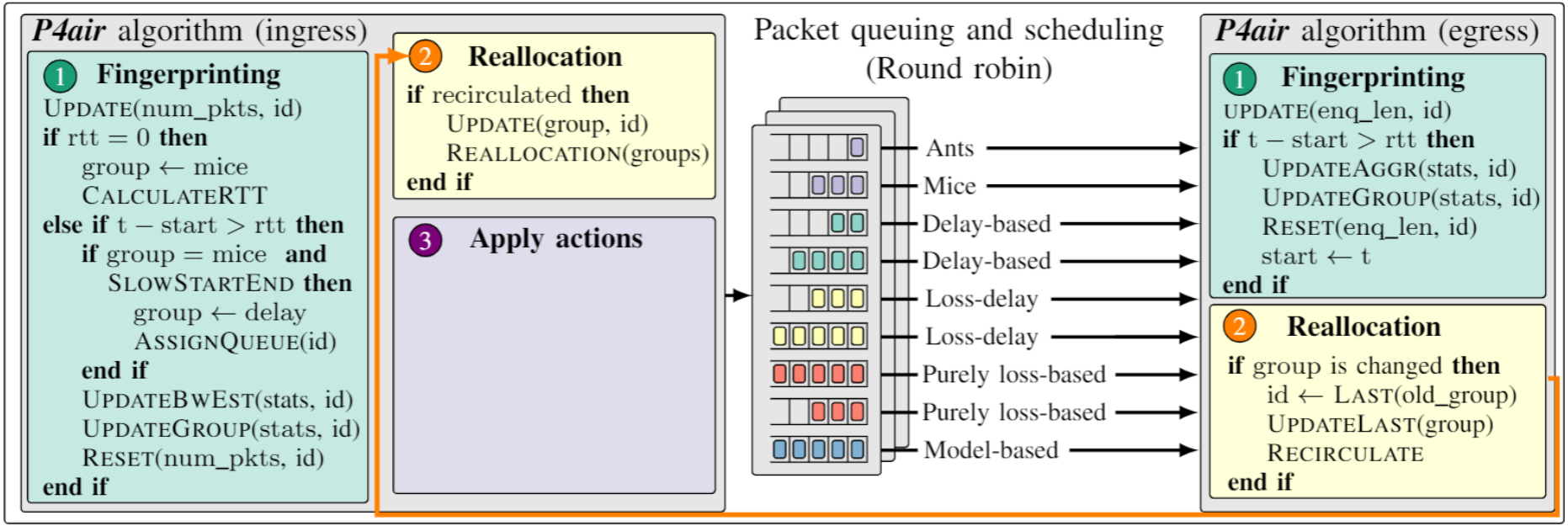
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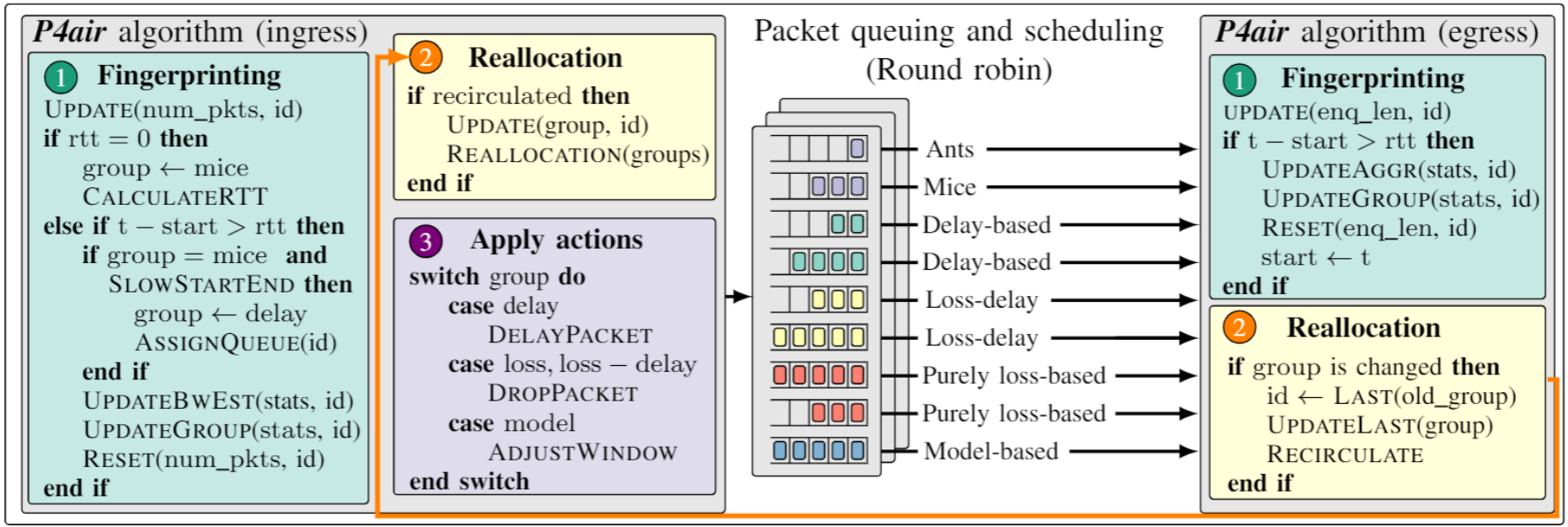
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end if
2 Reallocation
if recirculated then
UPDATE(group, id)
REALLOCATION(groups)
end if
3 Apply actions
switch group do
case delay
DELAYPACKET
case loss, loss − delay
DROPPACKET
case model
ADJUSTWINDOW
end switch
Packet queuing and scheduling
(Round robin)
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Mice
Delay-based
Delay-based
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Loss-delay
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Evaluation

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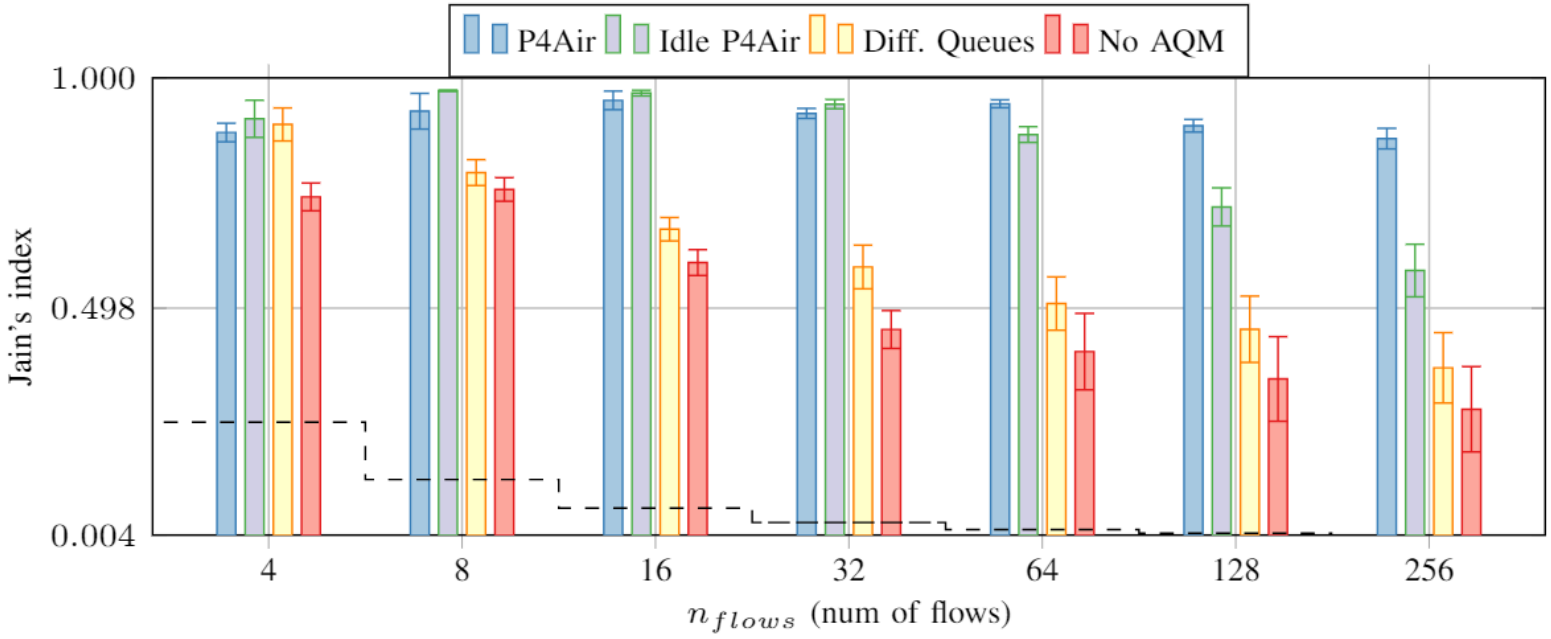
- Using Mininet
- Using a Barefoot switch

Evaluation

- Using Mininet
- Using a Barefoot switch

- Details on tuning in the paper!

Evaluation – inter- and intra-fairness



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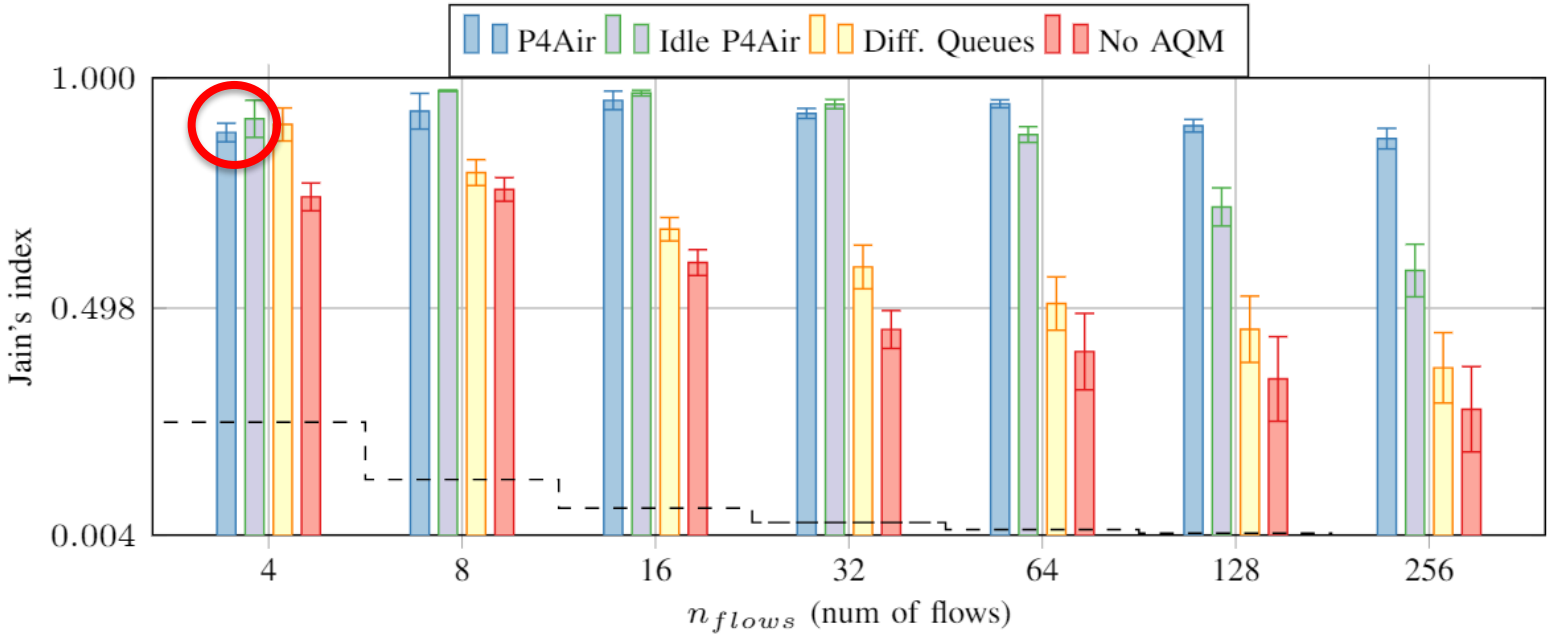

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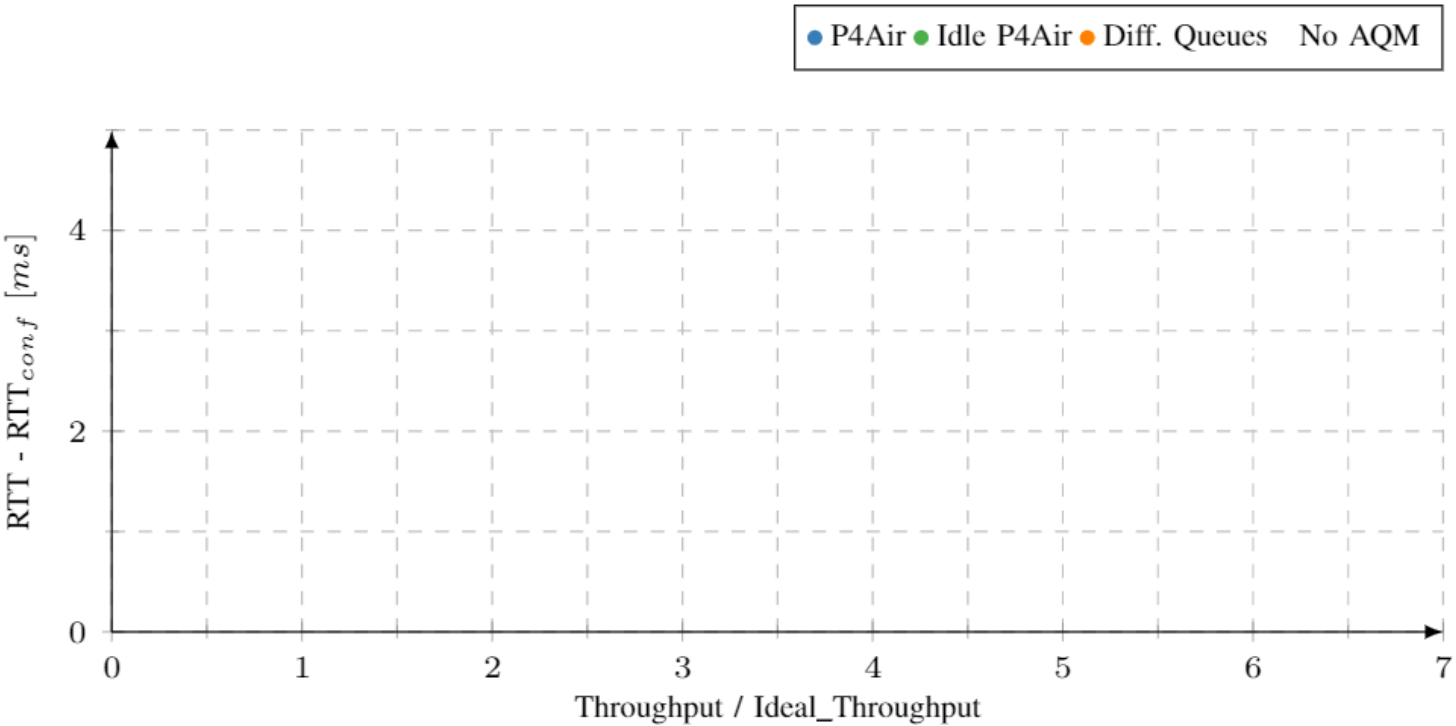

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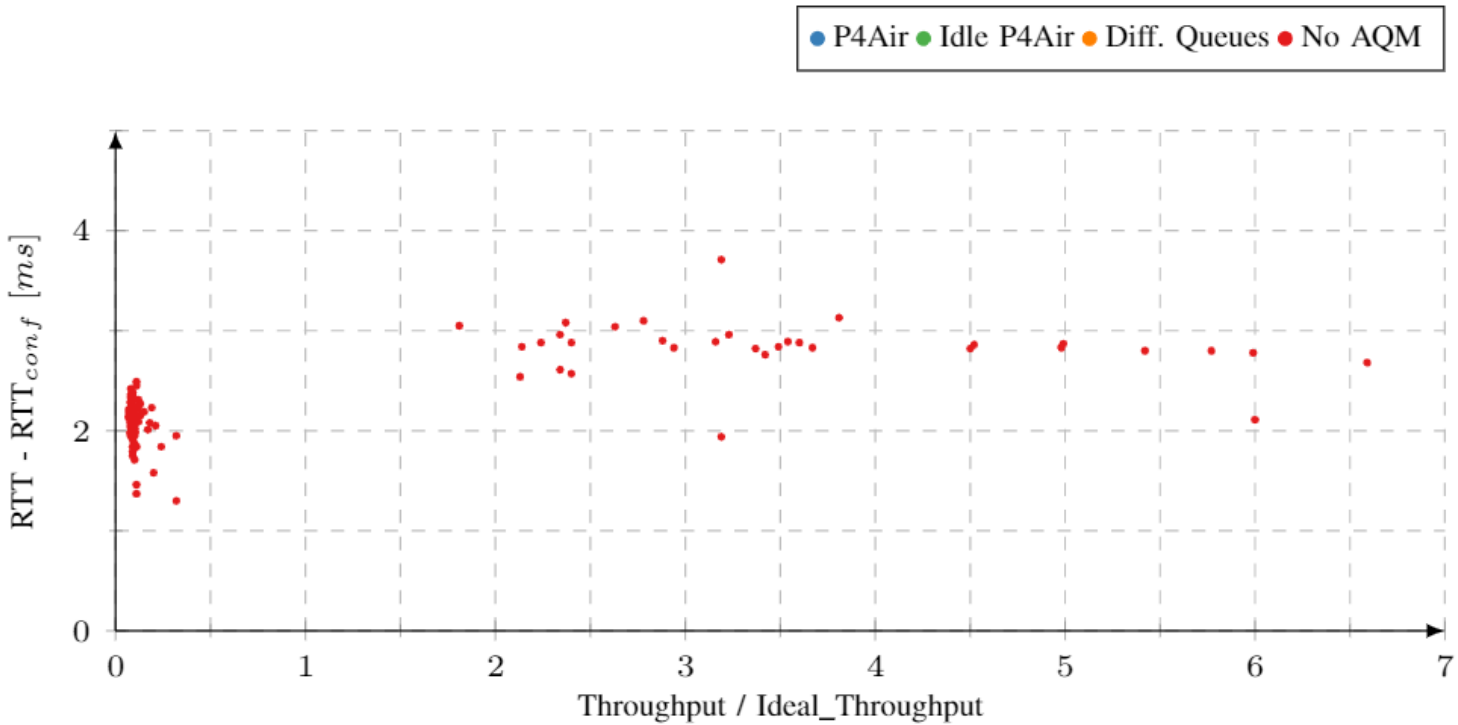

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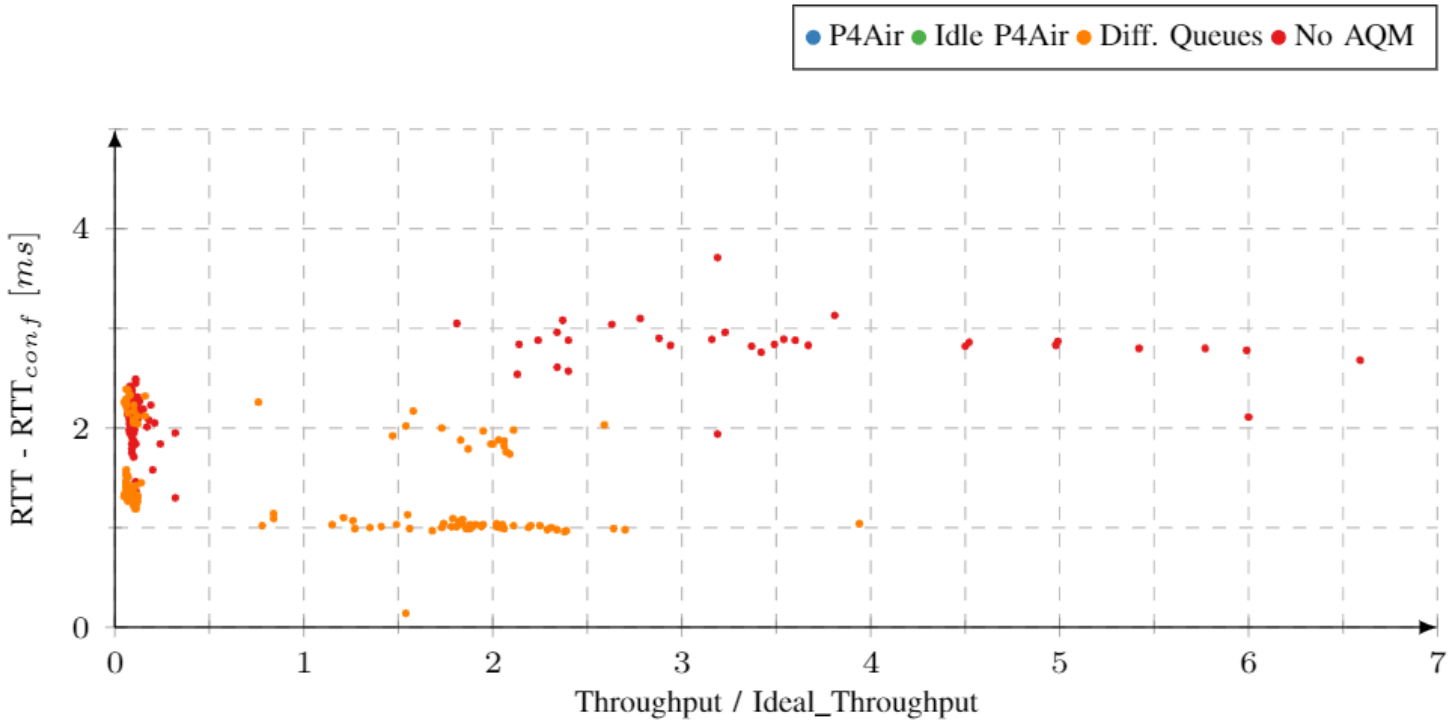

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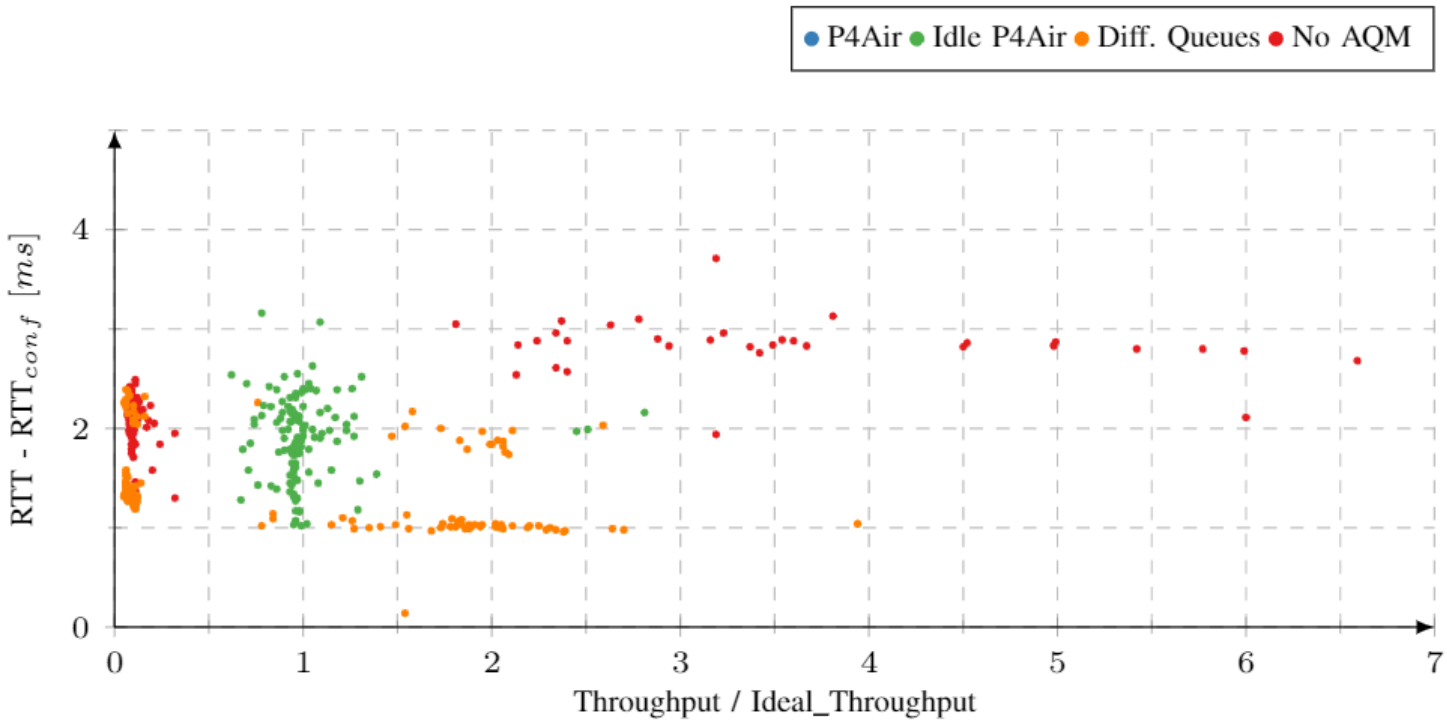

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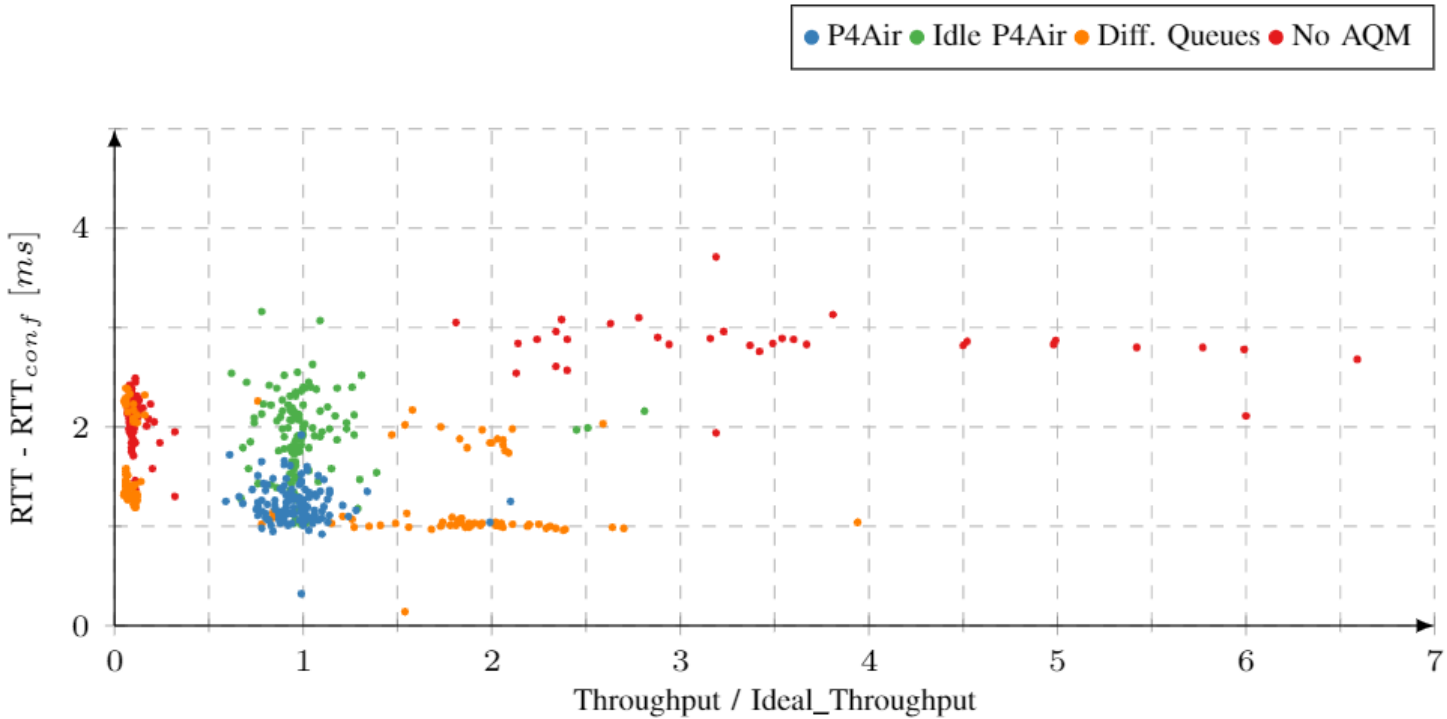
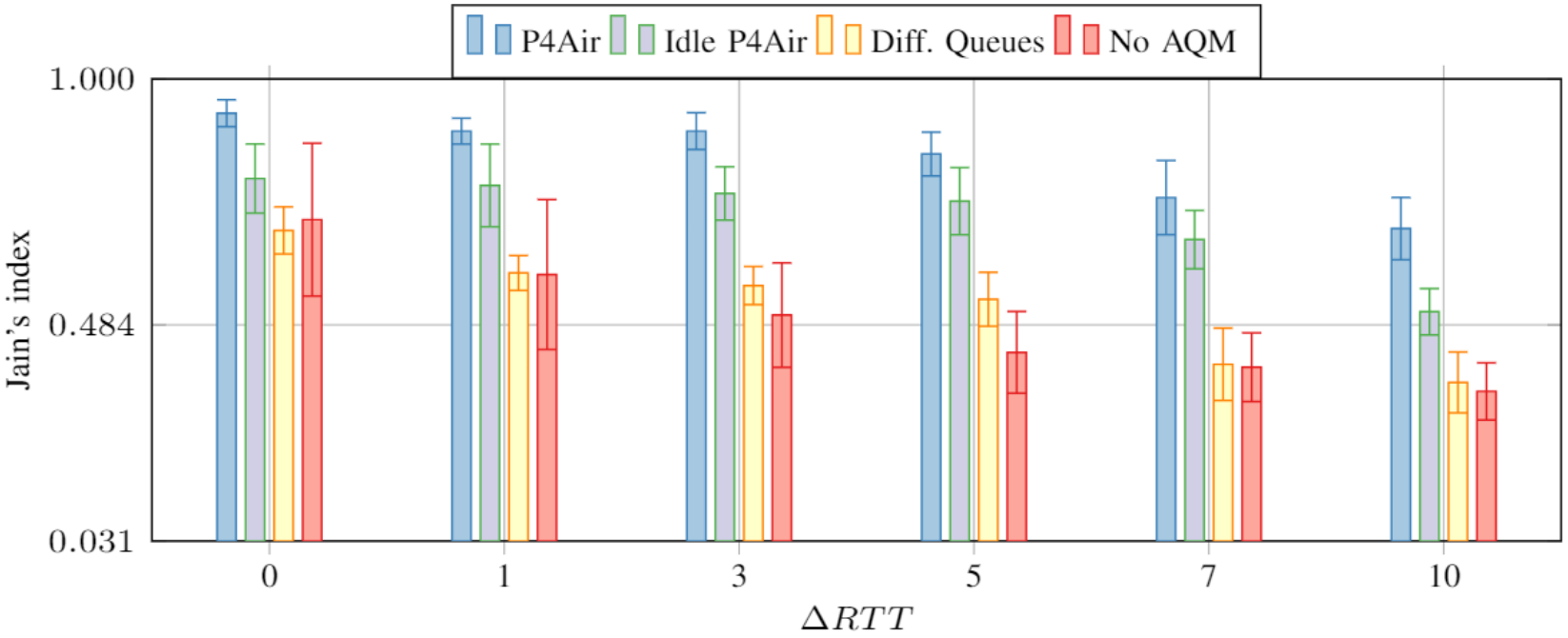


Evaluation – RTT-fairness



Conclusion

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- Distributing flows to queues based on their congestion control group can significantly improves fairness in network resource utilization