May 2025 – v02

802.1CB FRER Sequence Recovery – Issues with Resets & Timeouts and Potential Solutions

David McCall (Intel – david.mccall@intel.com)

References

[1] Venkat Arunarthi & Sunil Raj, “802.1CB-2017 Maintenance item #378 v2”, contribution to IEEE 802.1 Maintenance, March 2025

[2] Lisa Maile, “P802.1CBec Text Contribution”, April 2025

[3] Frank Dürr, Simon Egger, Lucas Haug, Joachim Sachs, János Farkas, “Control Plane Extensions for Wireless Aware Traffic Engineering v2”, contribution to 802.1 TSN, March 2025

Content

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  - Lost Packet
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    - “Simple” fix would generate Incorrectly Discarded Packets
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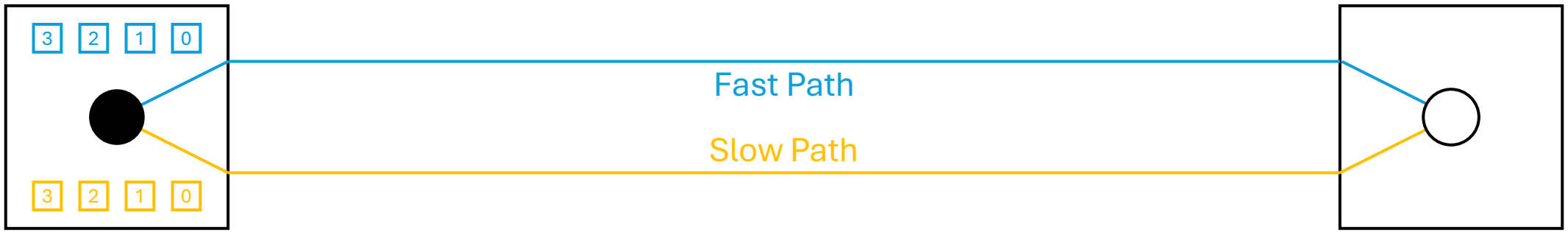
  - Issues with Aggressive Timeout (when packets are delayed)

Notes

- At intialisation with the current algorithm (SequenceRecoveryReset):
  - RecovSeqNum is initialised to 65,535, but the value is irrelevant because…
  - TakeAny is initialised to TRUE, meaning any sequence number will be accepted
    - This state is represented by showing RecovSeqNum as a dash, i.e. “-”
  - SequenceHistory is set to all 0s
- For simplicity, this presentation only deals with per-stream & per-port variables:
  - PassedPackets = frerCpsSeqRcvyPassedPackets
  - DiscardedPackets = frerCpsSeqRcvyDiscardedPackets

Simple 2-Path Model



VectorRecoveryAlgorithm – Basic Operation

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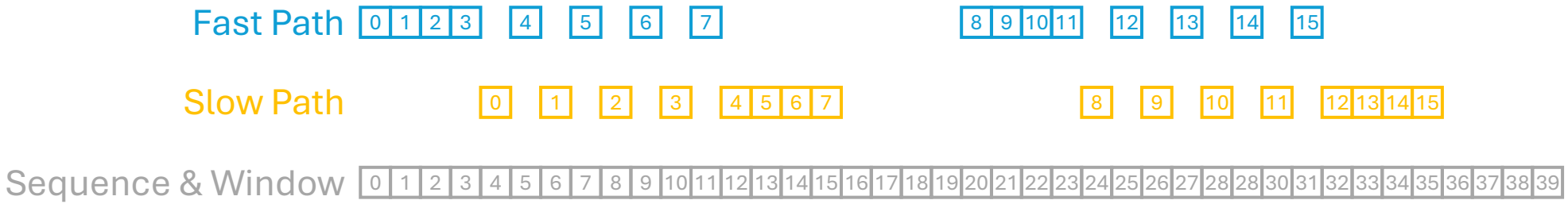
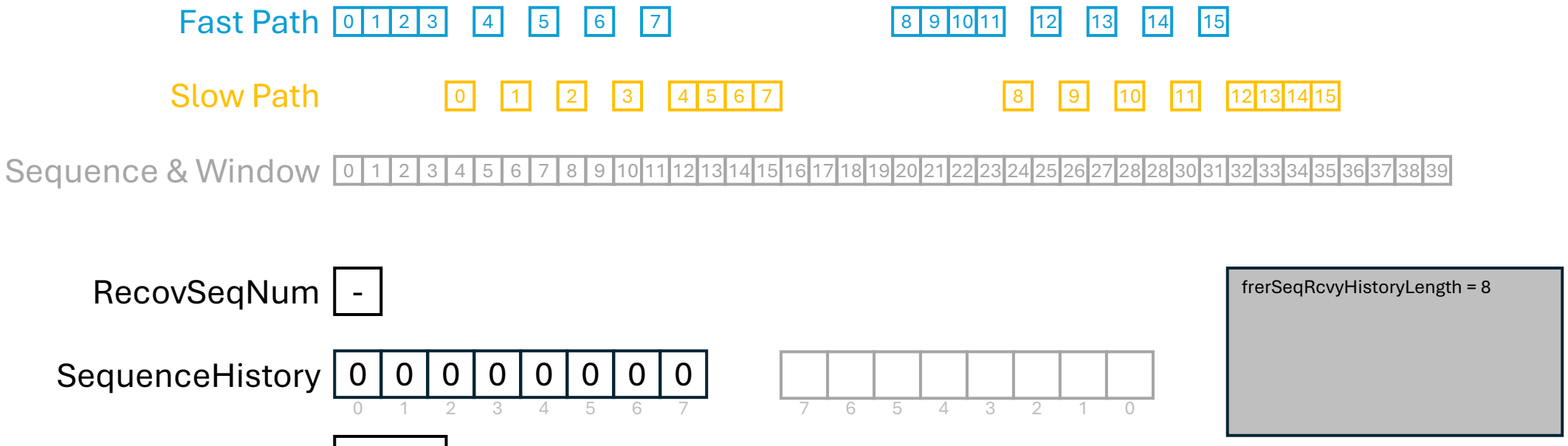
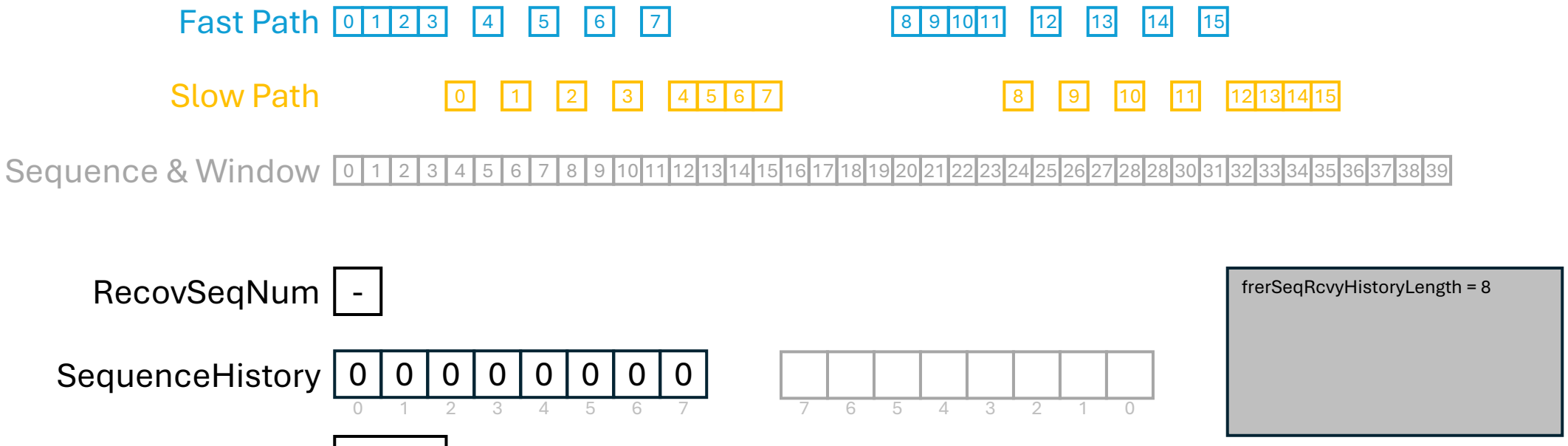


Normal Operation

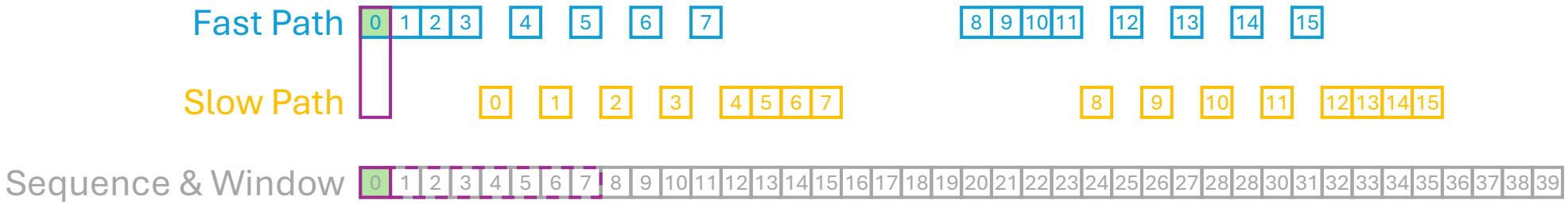


FRER Vector Recovery Algorithm Normal Operation

Normal Operation



Normal Operation



RecovSeqNum 0

SequenceHistory 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

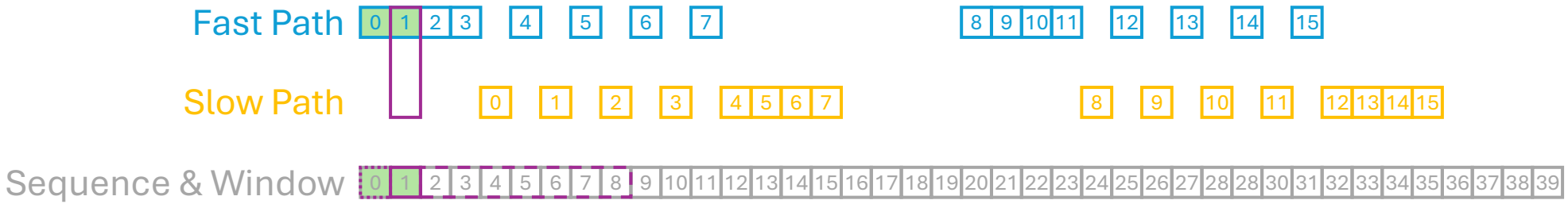
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Normal Operation



RecovSeqNum 1

SequenceHistory

1	1	0	0	0	0	0	0
0	1	2	3	4	5	6	7

7	6	5	4	3	2	1	0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 2

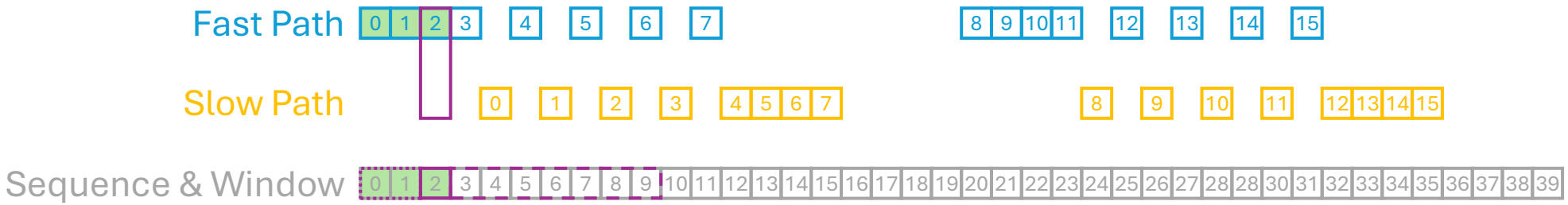
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Normal Operation



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

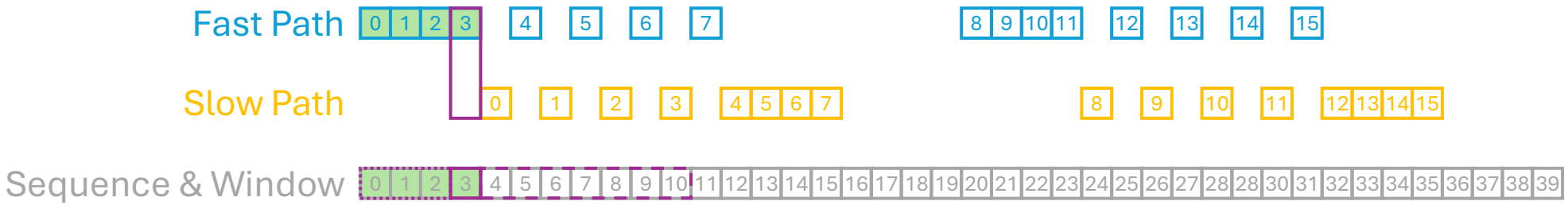
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

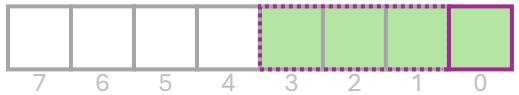
RoguePackets: 0

Normal Operation



RecovSeqNum: 3

SequenceHistory: 1 1 1 1 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

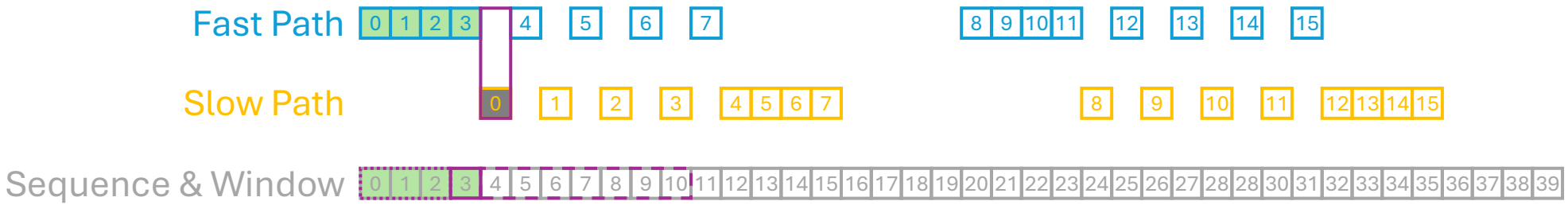
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

Normal Operation



RecovSeqNum 3

SequenceHistory

1	1	1	1	0	0	0	0
0	1	2	3	4	5	6	7

7	6	5	4	3	2	1	0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 4

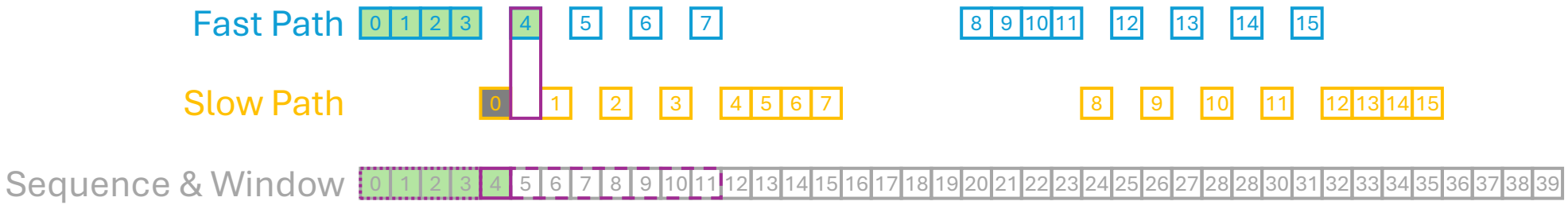
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 1

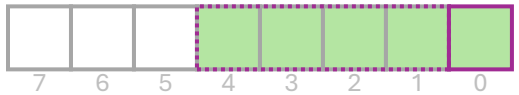
RoguePackets 0

Normal Operation



RecovSeqNum: 4

SequenceHistory: 1 1 1 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

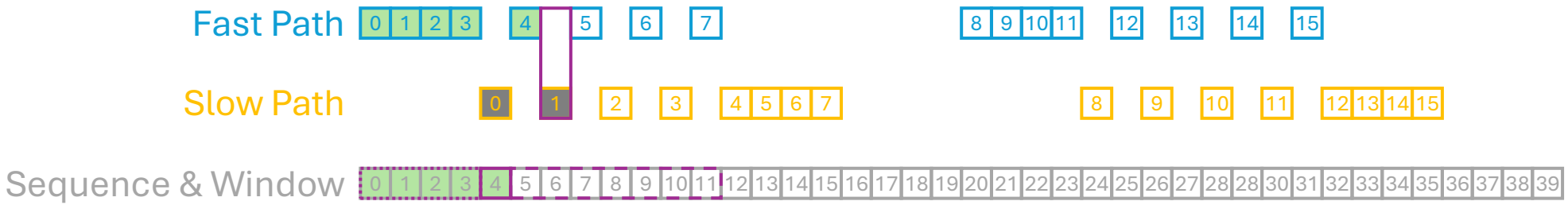
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 1

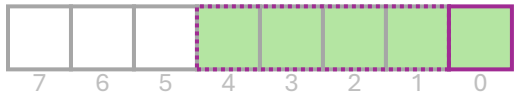
RoguePackets: 0

Normal Operation



RecovSeqNum: 4

SequenceHistory: 1 1 1 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

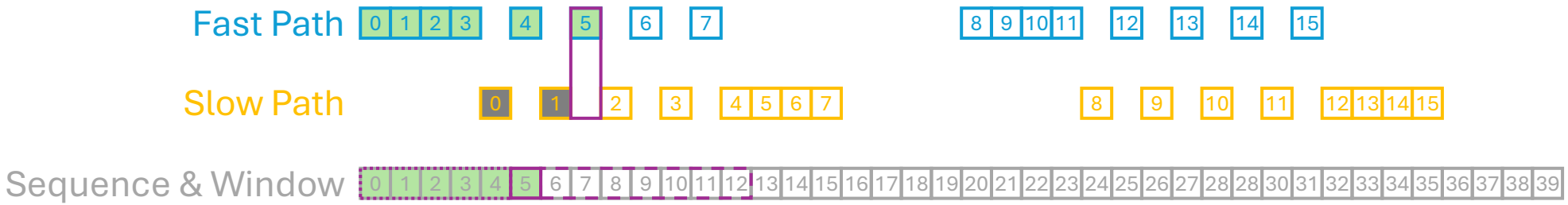
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 2

RoguePackets: 0

Normal Operation



RecovSeqNum 5

SequenceHistory 1 1 1 1 1 1 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 6

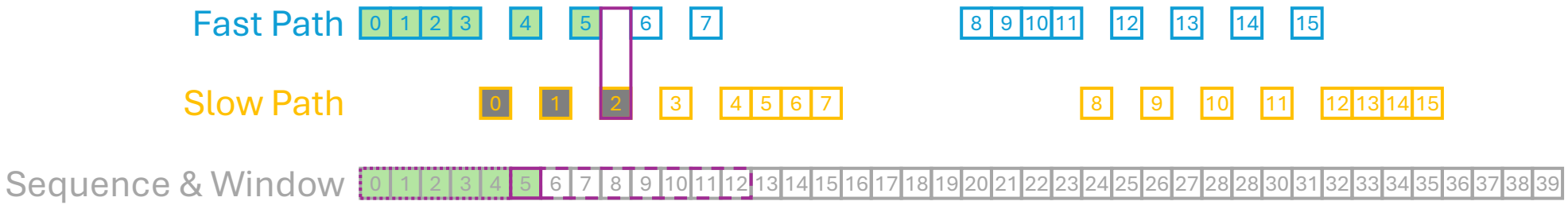
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 2

RoguePackets 0

Normal Operation



RecovSeqNum 5

SequenceHistory 1 1 1 1 1 1 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 6

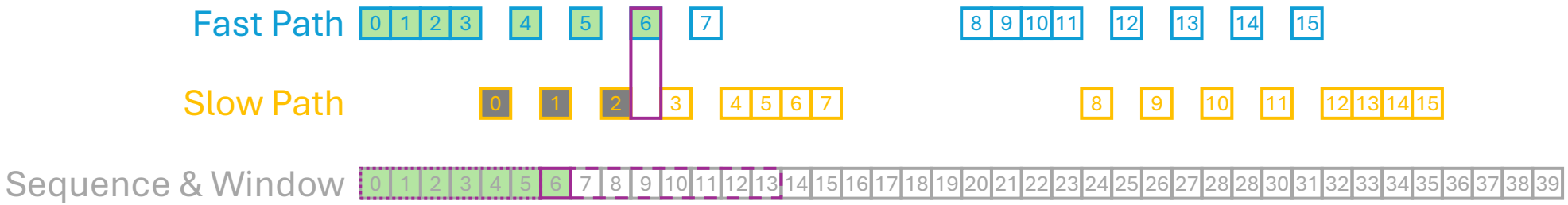
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

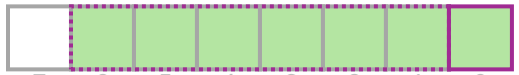
RoguePackets 0

Normal Operation



RecovSeqNum: 6

SequenceHistory: 1 1 1 1 1 1 1 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 7

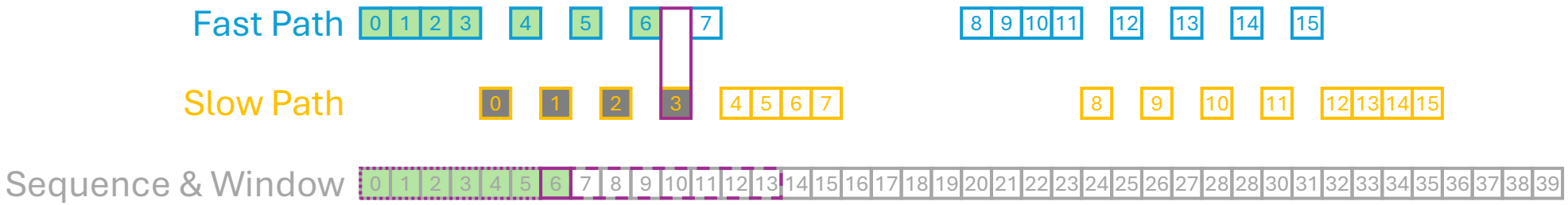
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 3

RoguePackets: 0

Normal Operation



RecovSeqNum 6

SequenceHistory 1 1 1 1 1 1 1 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

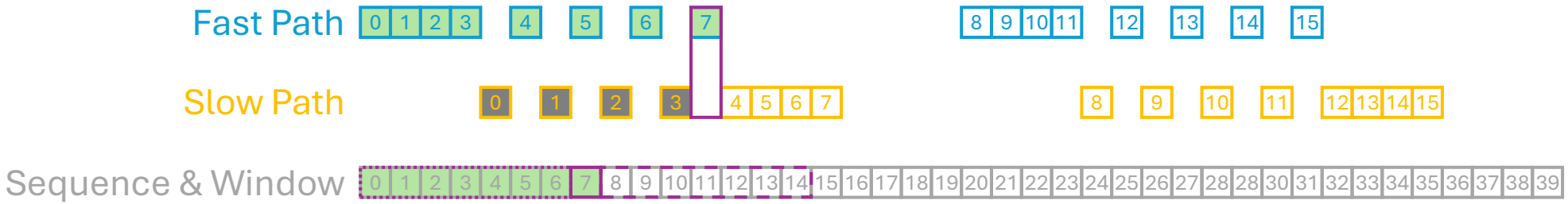
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 4

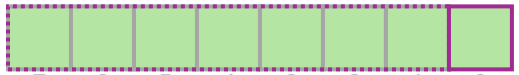
RoguePackets 0

Normal Operation



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 8

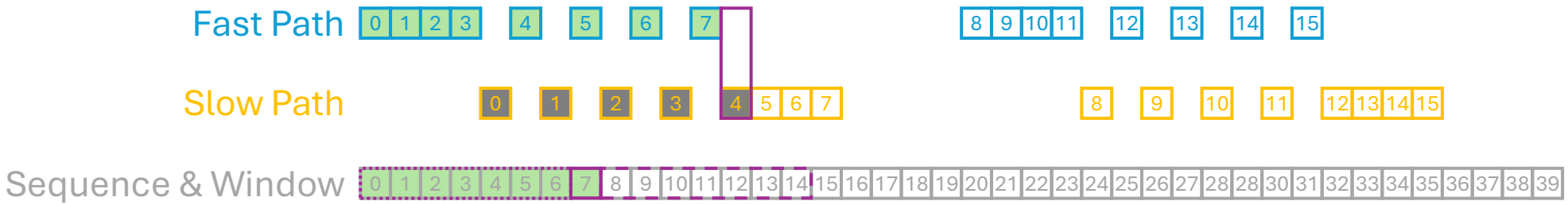
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 4

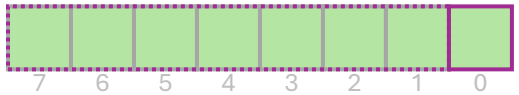
RoguePackets: 0

Normal Operation



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 8

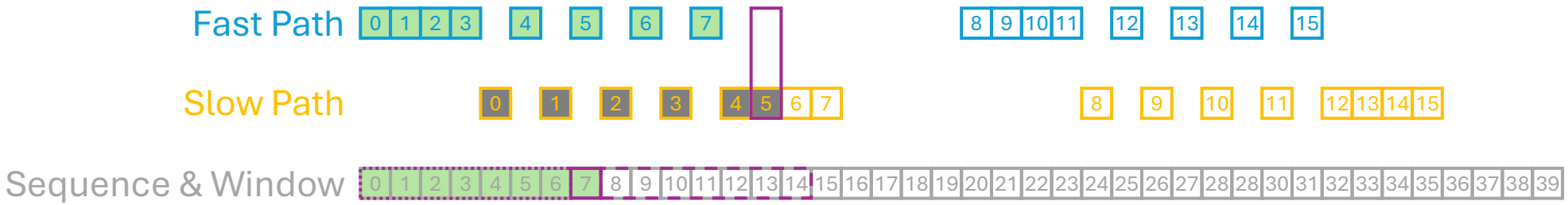
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 5

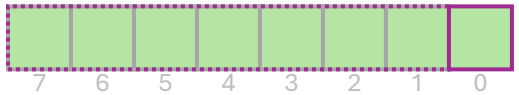
RoguePackets: 0

Normal Operation



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 8

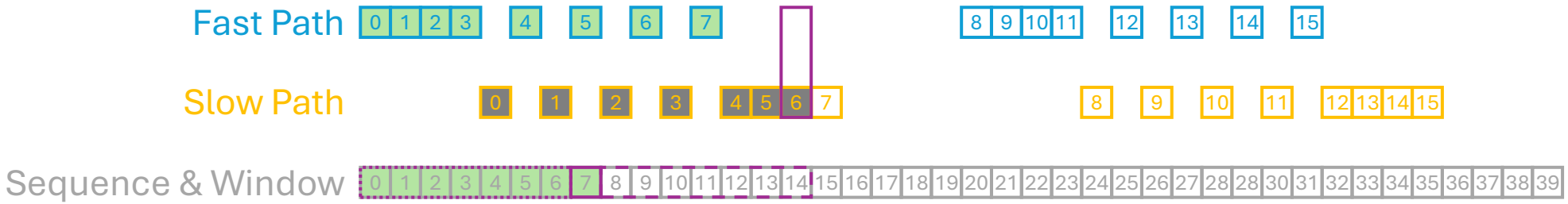
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 6

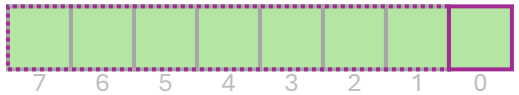
RoguePackets: 0

Normal Operation



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 8

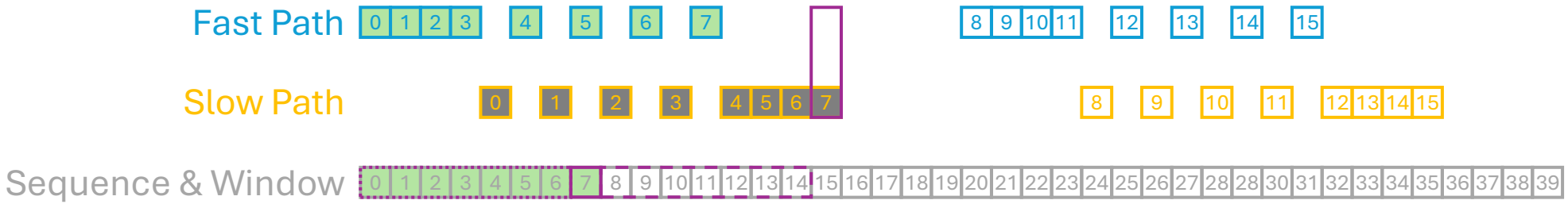
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 7

RoguePackets: 0

Normal Operation



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 8

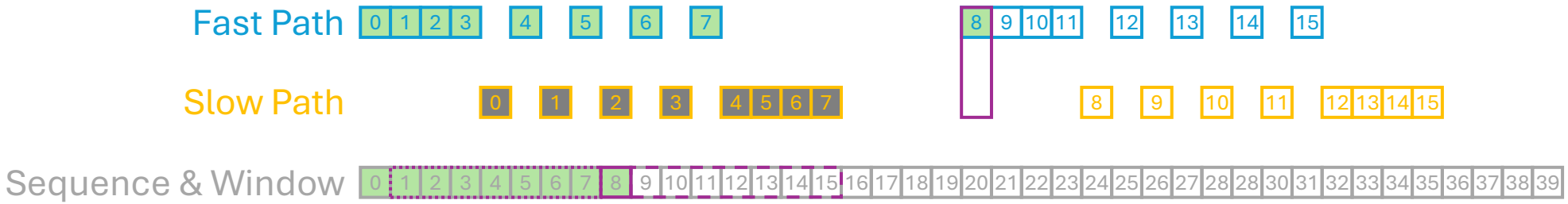
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 8

RoguePackets 0

Normal Operation



RecovSeqNum 8

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 9

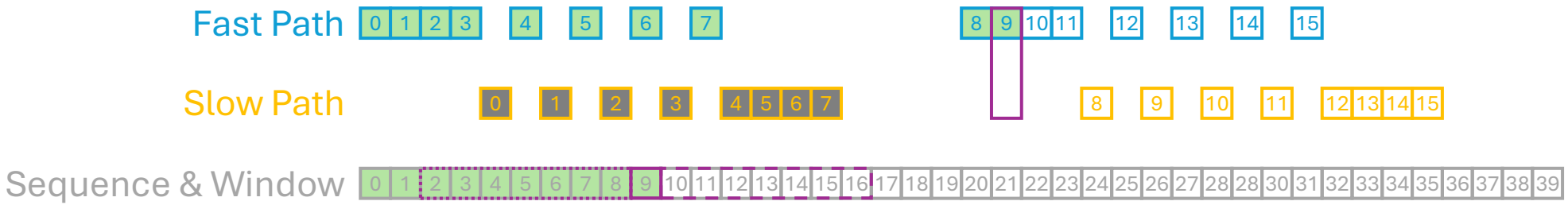
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 8

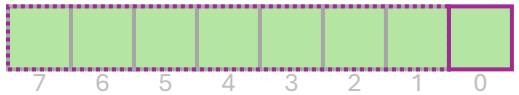
RoguePackets 0

Normal Operation



RecovSeqNum: 9

SequenceHistory: 1 1 1 1 1 1 1 1



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 10

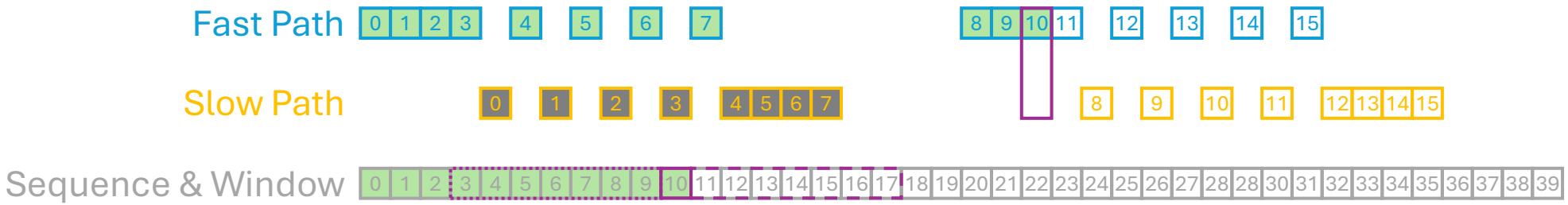
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 8

RoguePackets: 0

Normal Operation



RecovSeqNum 10

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 11

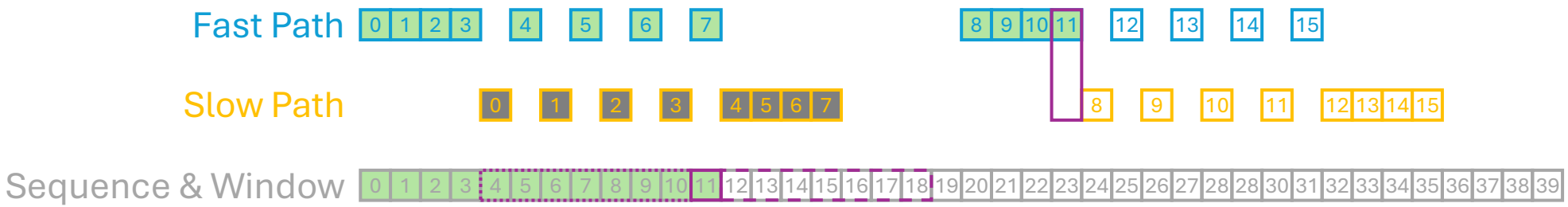
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 8

RoguePackets 0

Normal Operation



RecovSeqNum 11

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 12

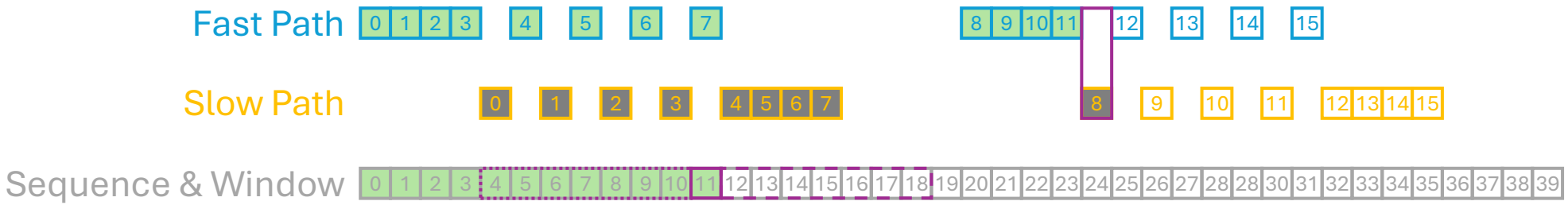
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 8

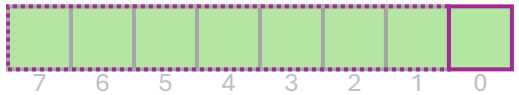
RoguePackets 0

Normal Operation



RecovSeqNum: 11

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 12

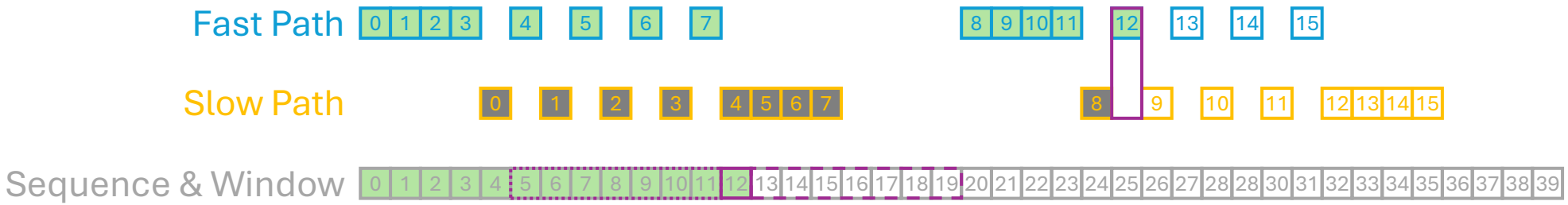
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 9

RoguePackets: 0

Normal Operation



RecovSeqNum 12

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 13

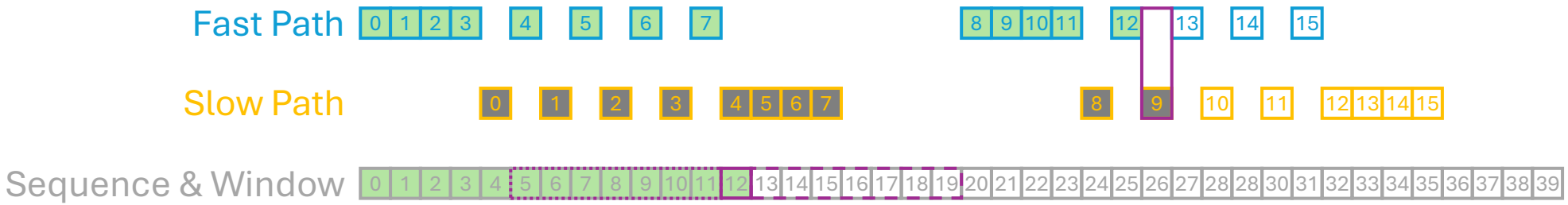
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 9

RoguePackets 0

Normal Operation



RecovSeqNum 12

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 13

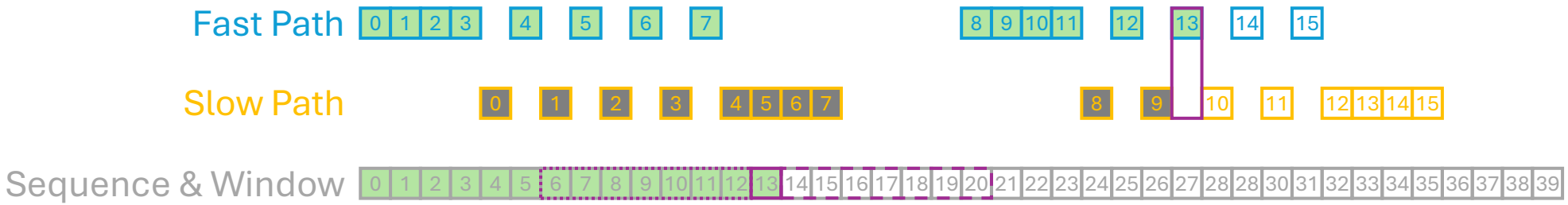
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 10

RoguePackets 0

Normal Operation



RecovSeqNum 13

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 14

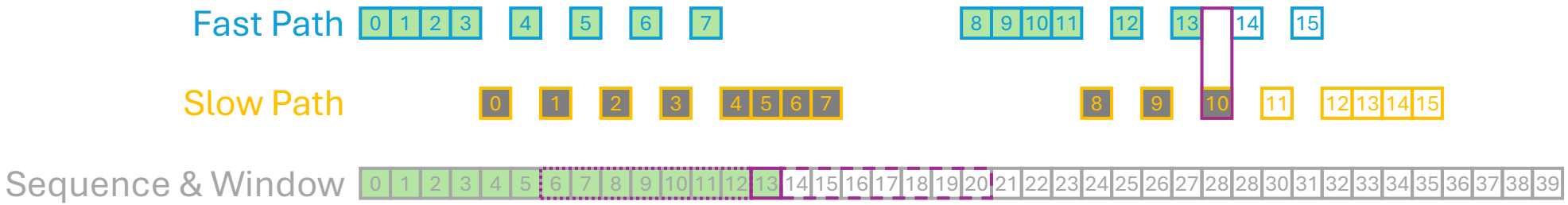
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 10

RoguePackets 0

Normal Operation



RecovSeqNum 13

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 14

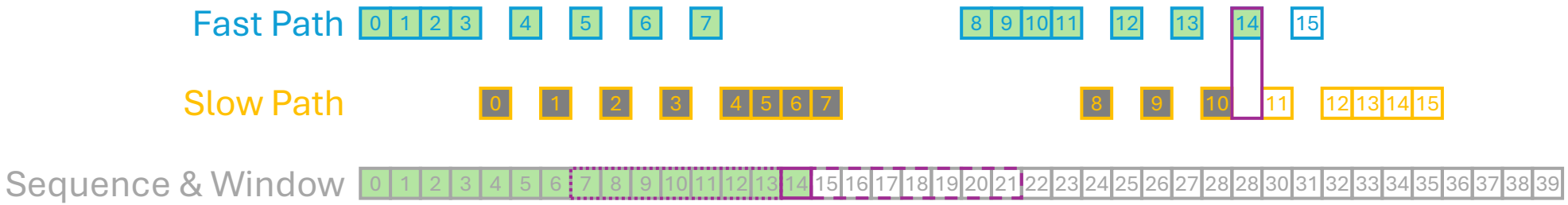
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 11

RoguePackets 0

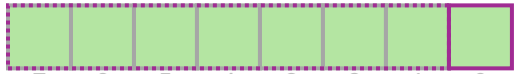
Normal Operation



RecovSeqNum 14

SequenceHistory

1	1	1	1	1	1	1	1
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 15

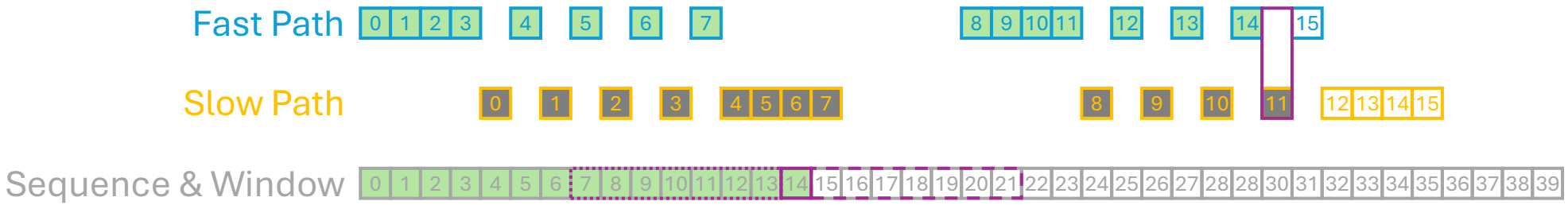
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 11

RoguePackets 0

Normal Operation



RecovSeqNum 14

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 15

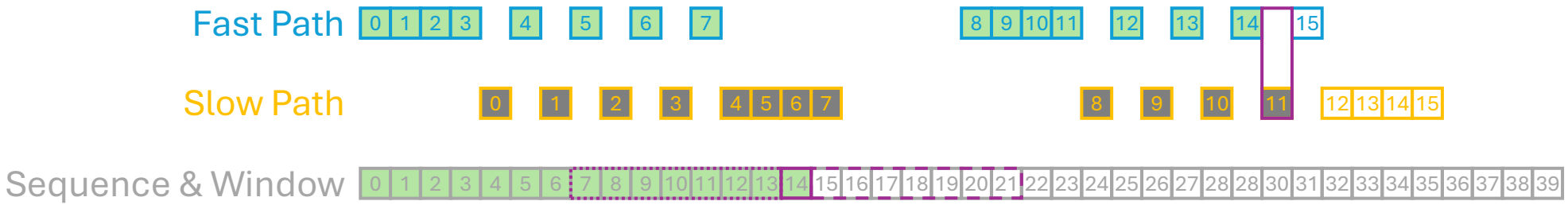
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 12

RoguePackets 0

Normal Operation



RecovSeqNum 14

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 15

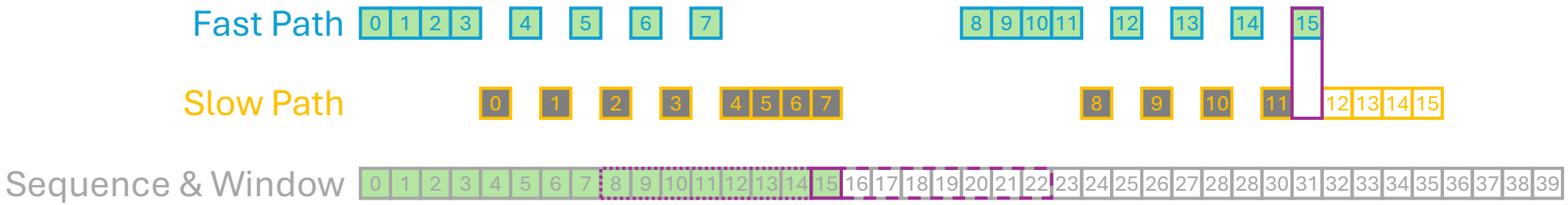
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 12

RoguePackets 0

Normal Operation



RecovSeqNum 15

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 16

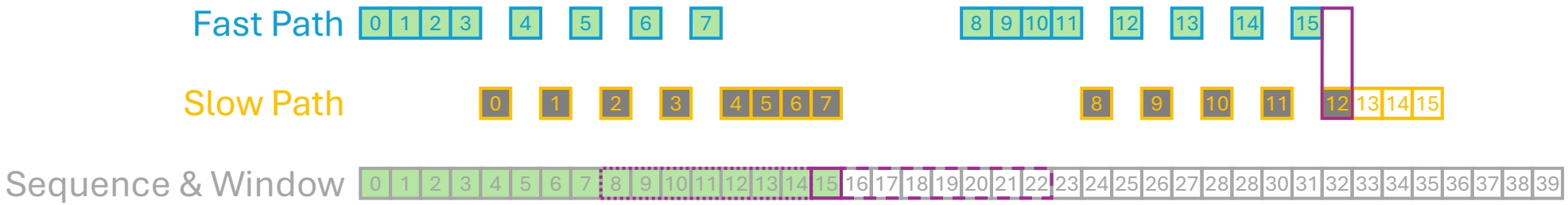
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 12

RoguePackets 0

Normal Operation



RecovSeqNum 15

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 16

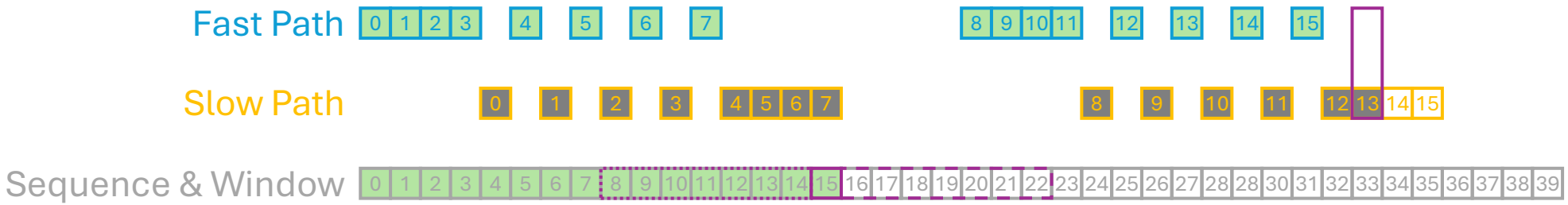
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 13

RoguePackets 0

Normal Operation



RecovSeqNum 15

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 16

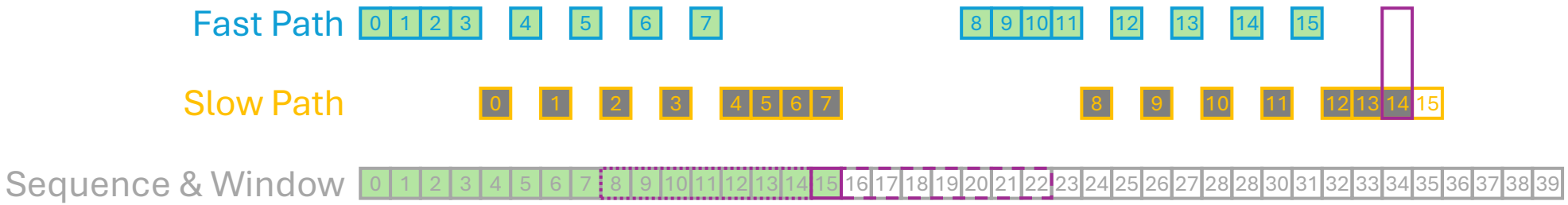
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 14

RoguePackets 0

Normal Operation



RecovSeqNum 15

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 16

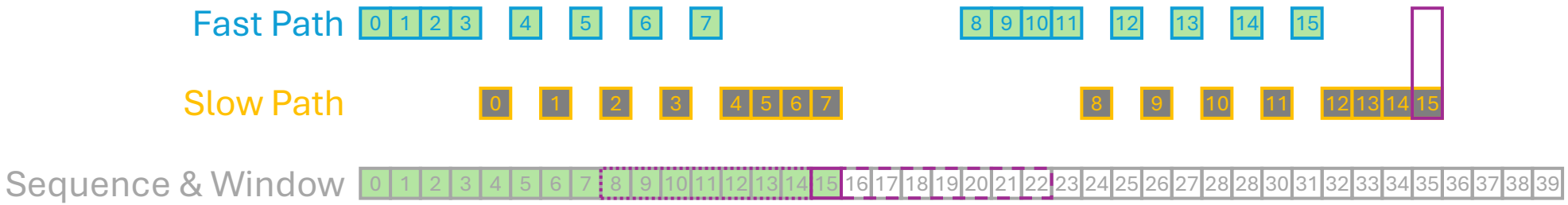
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 15

RoguePackets 0

Normal Operation



RecovSeqNum 15

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 16

OutOfOrderPackets 0

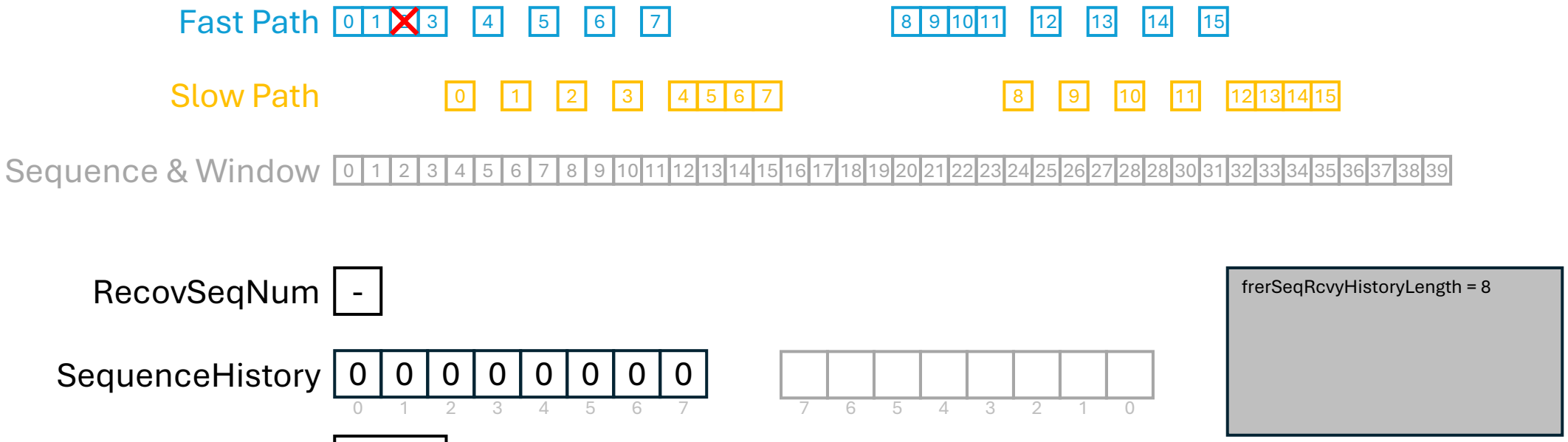
LostPackets 0

DiscardedPackets 16

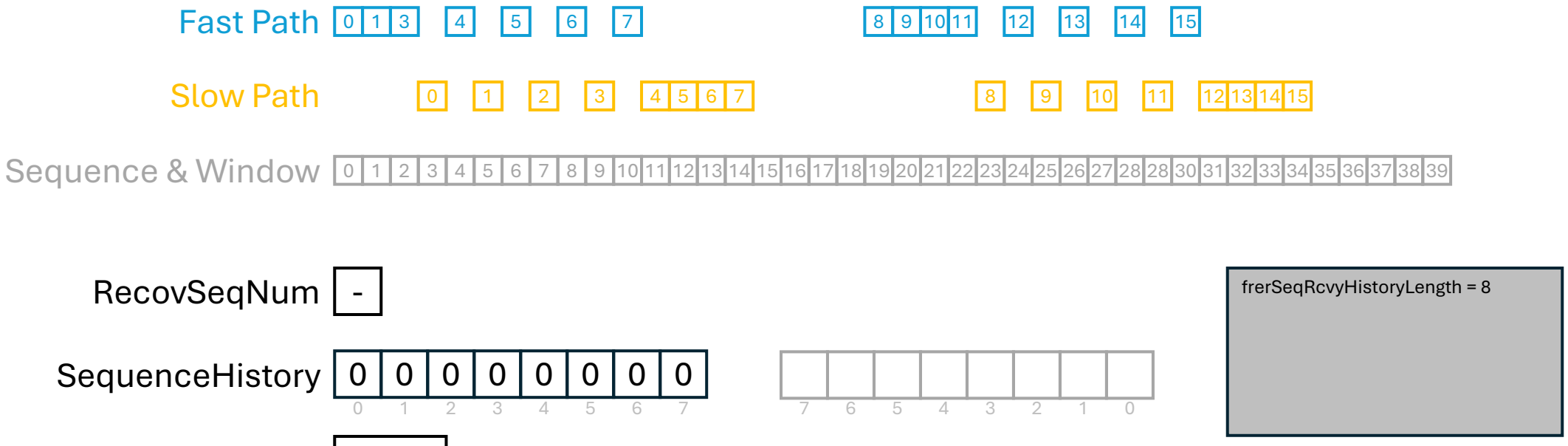
RoguePackets 0

FRER Vector Recovery Algorithm One Missing Packet

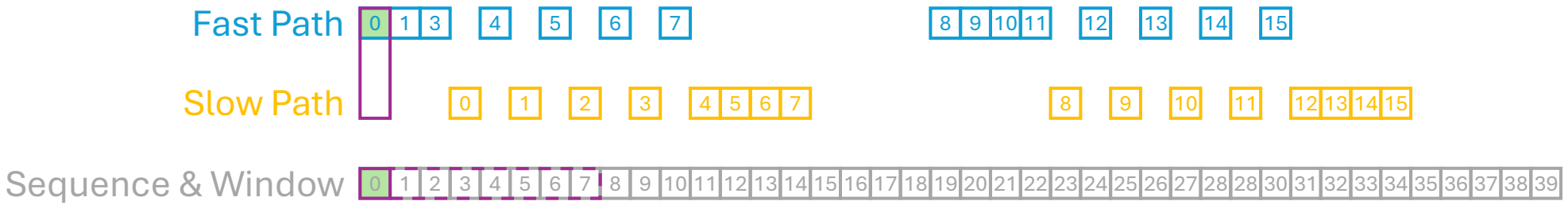
One Missing Packet



One Missing Packet



One Missing Packet



RecovSeqNum 0

SequenceHistory 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

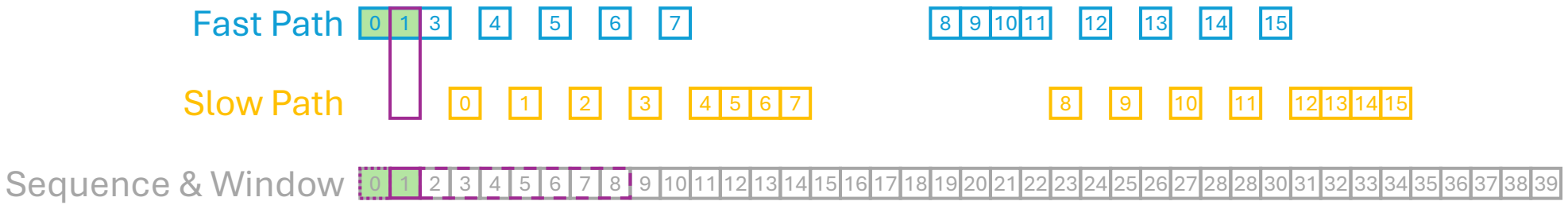
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

One Missing Packet



RecovSeqNum 1

SequenceHistory 1 1 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 2

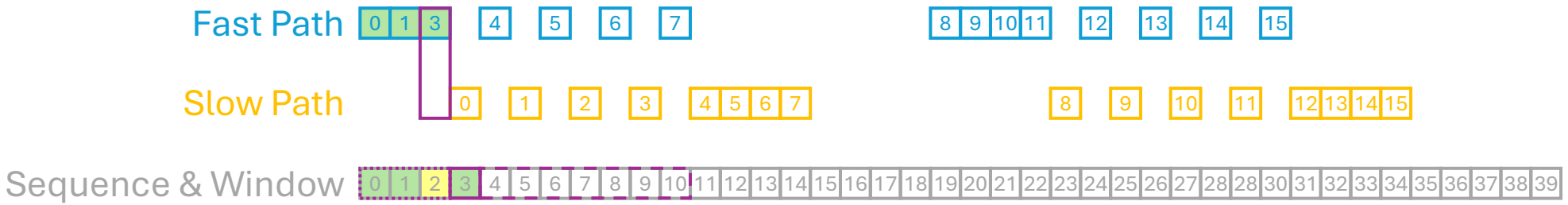
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

One Missing Packet



RecovSeqNum 3

SequenceHistory

1	0	1	1	0	0	0	0
0	1	2	3	4	5	6	7

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

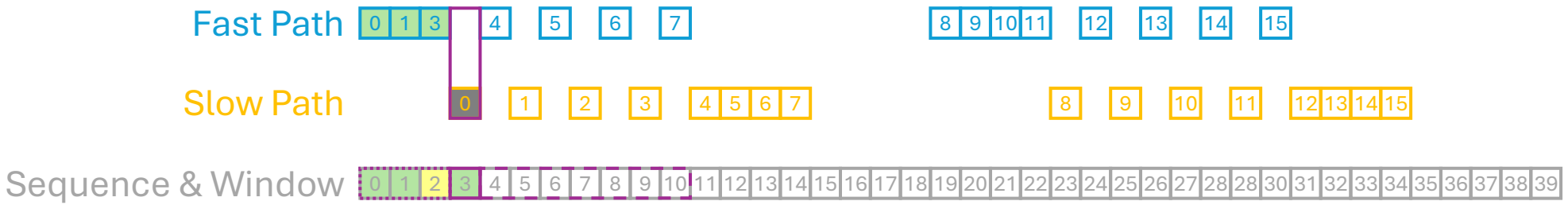
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 0

RoguePackets 0

One Missing Packet



RecovSeqNum 3

SequenceHistory 1 0 1 1 0 0 0 0

0 1 2 3 4 5 6 7

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

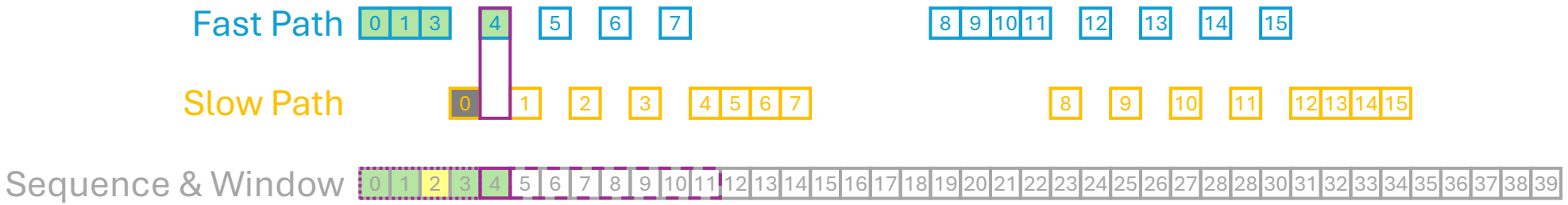
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 1

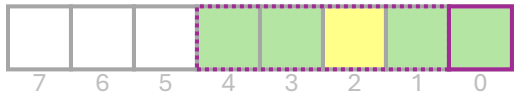
RoguePackets 0

One Missing Packet



RecovSeqNum: 4

SequenceHistory: 1 1 0 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

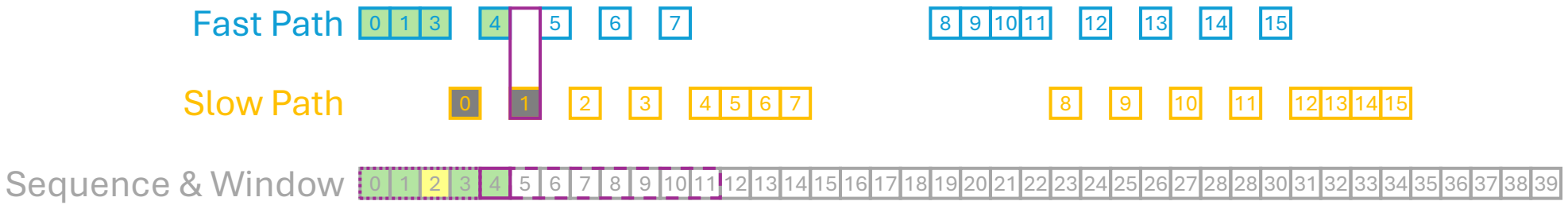
OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 1

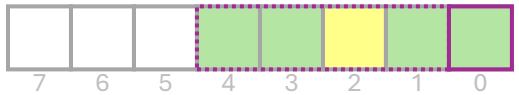
RoguePackets: 0

One Missing Packet



RecovSeqNum: 4

SequenceHistory: 1 1 0 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

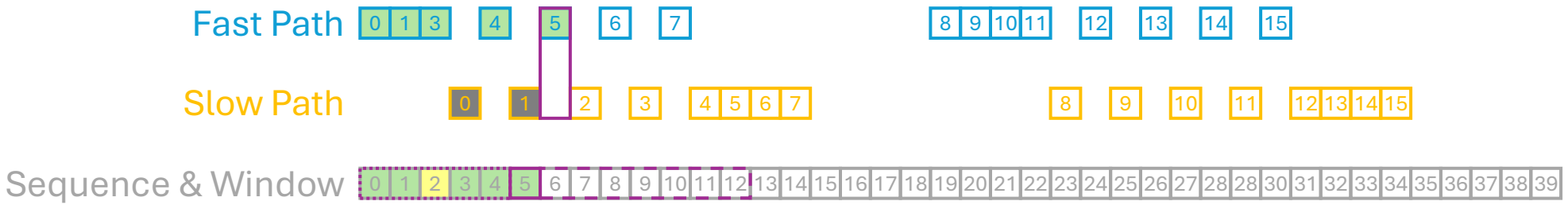
OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 2

RoguePackets: 0

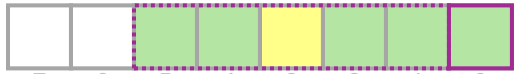
One Missing Packet



RecovSeqNum 5

SequenceHistory 1 1 1 0 1 1 0 0

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 5

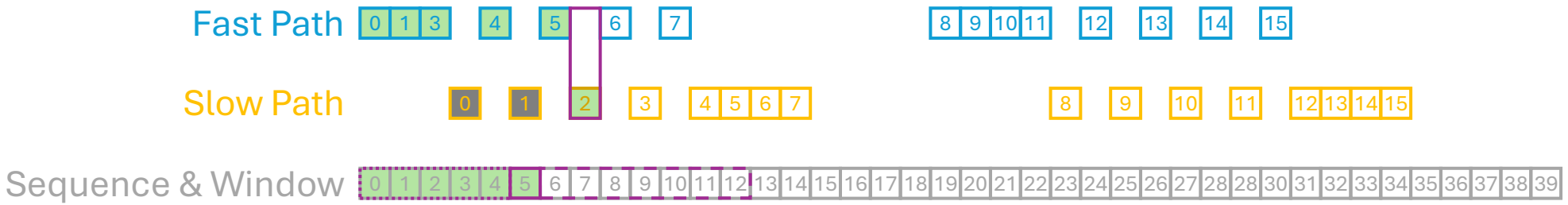
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 2

RoguePackets 0

One Missing Packet



RecovSeqNum 5

SequenceHistory 1 1 1 1 1 1 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 6

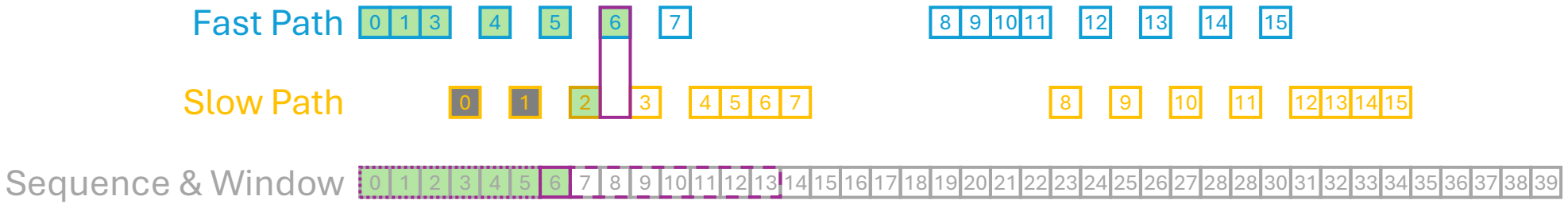
OutOfOrderPackets 2

LostPackets 0

DiscardedPackets 2

RoguePackets 0

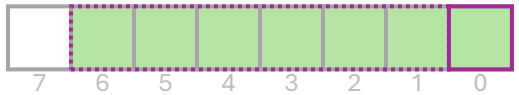
One Missing Packet



RecovSeqNum 6

SequenceHistory 1 1 1 1 1 1 1 0

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

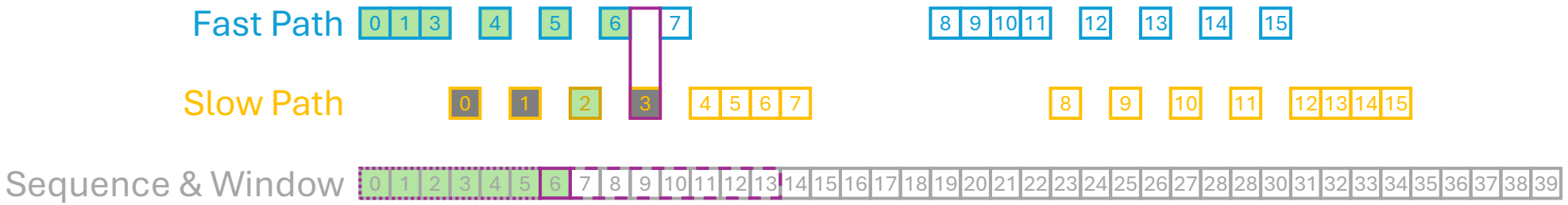
OutOfOrderPackets 2

LostPackets 0

DiscardedPackets 2

RoguePackets 0

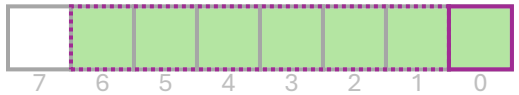
One Missing Packet



RecovSeqNum 6

SequenceHistory 1 1 1 1 1 1 1 0

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

OutOfOrderPackets 2

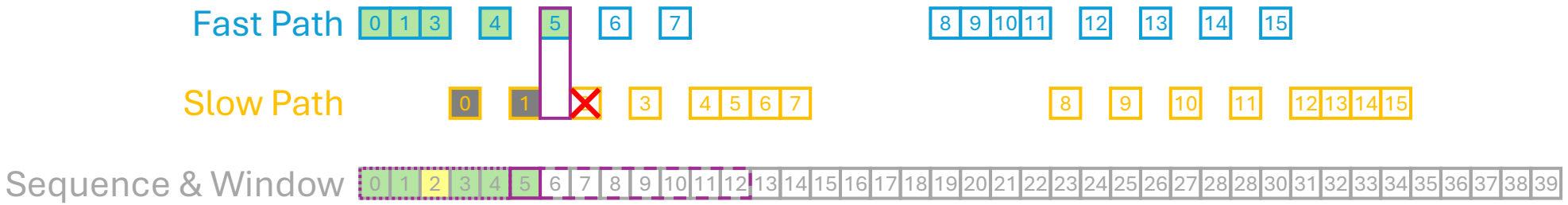
LostPackets 0

DiscardedPackets 3

RoguePackets 0

FRER Vector Recovery Algorithm Lost Packet

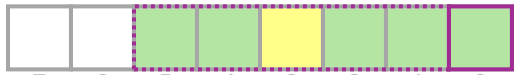
Lost Packet



RecovSeqNum 5

SequenceHistory 1 1 1 0 1 1 0 0

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 5

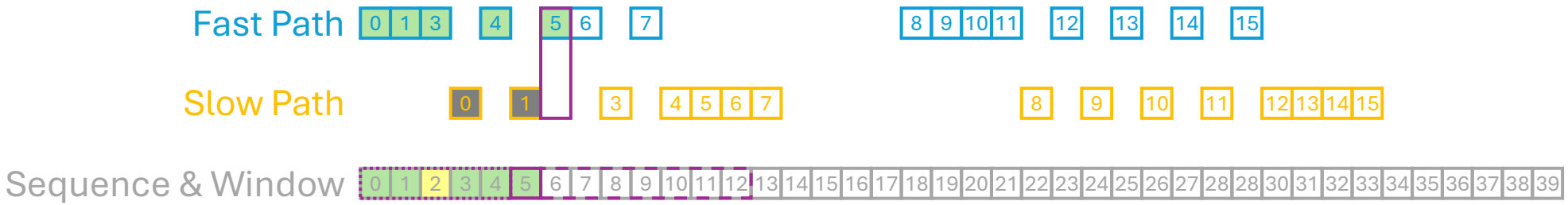
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 2

RoguePackets 0

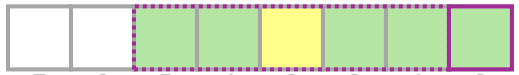
Lost Packet



RecovSeqNum 5

SequenceHistory 1 1 1 0 1 1 0 0

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 5

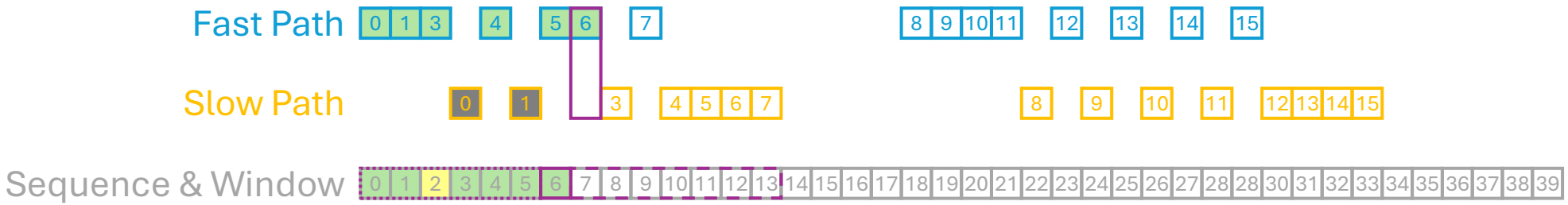
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 2

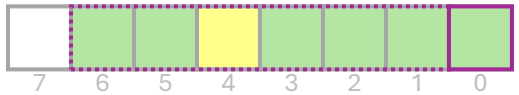
RoguePackets 0

Lost Packet



RecovSeqNum 6

SequenceHistory 1 1 1 1 0 1 1 0



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 6

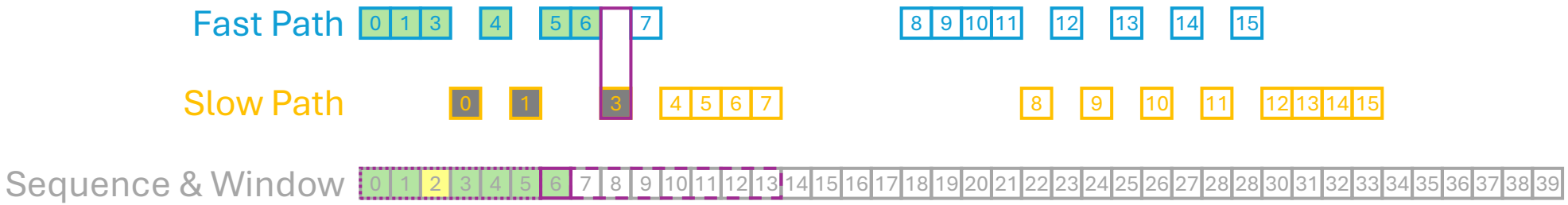
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 2

RoguePackets 0

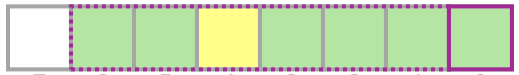
Lost Packet



RecovSeqNum 6

SequenceHistory 1 1 1 1 0 1 1 0

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 6

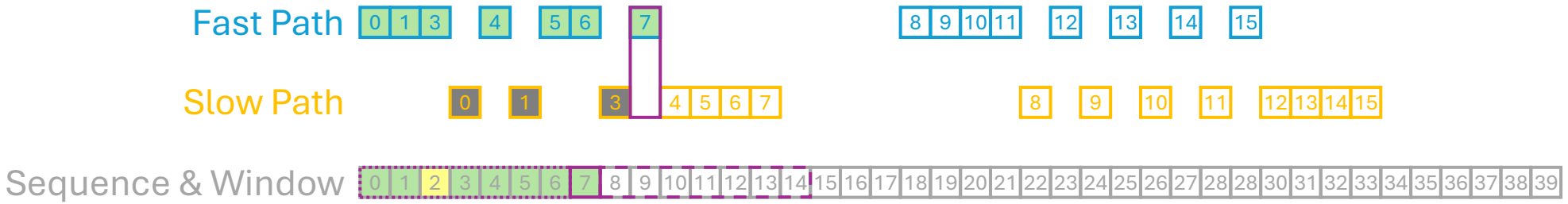
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 3

RoguePackets 0

Lost Packet



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 0 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

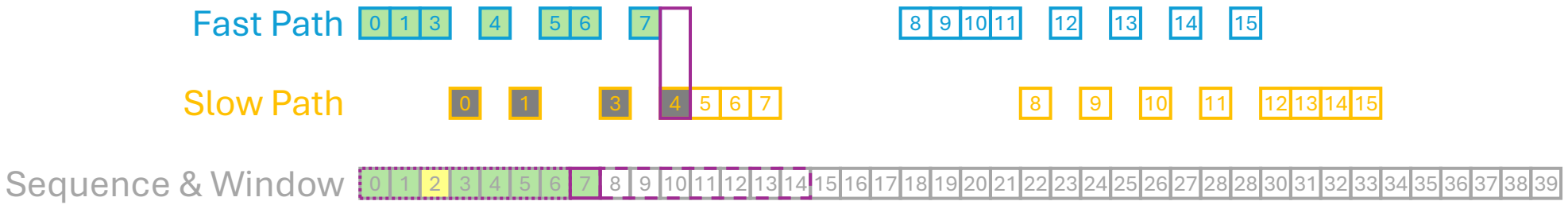
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 3

RoguePackets 0

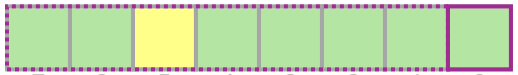
Lost Packet



RecovSeqNum 7

SequenceHistory

1	1	1	1	1	0	1	1
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

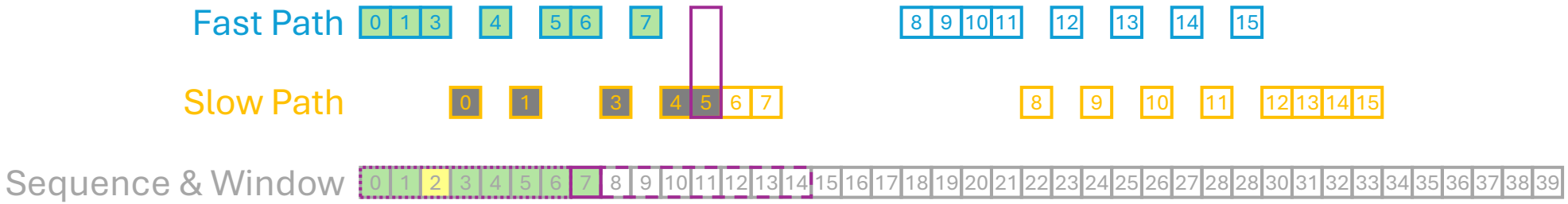
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 4

RoguePackets 0

Lost Packet



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 0 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

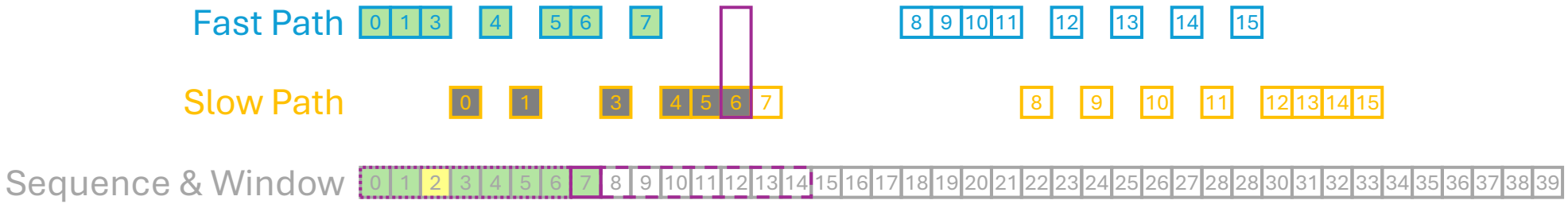
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 5

RoguePackets 0

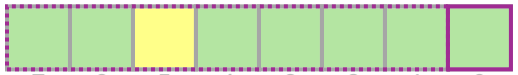
Lost Packet



RecovSeqNum 7

SequenceHistory

1	1	1	1	1	0	1	1
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

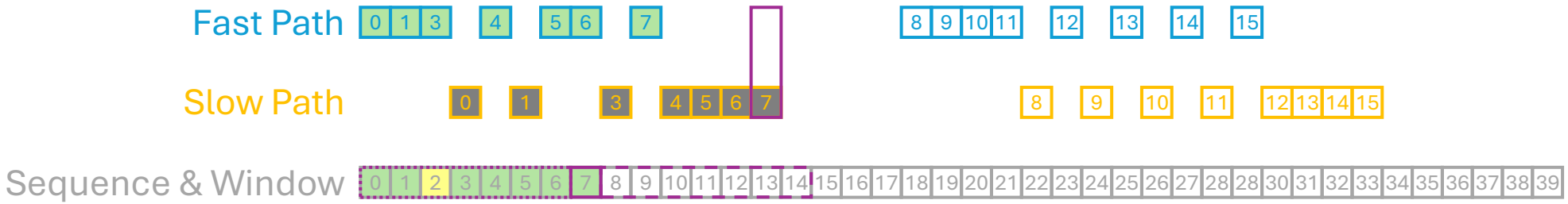
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 6

RoguePackets 0

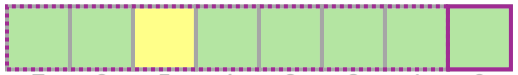
Lost Packet



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 0 1 1

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

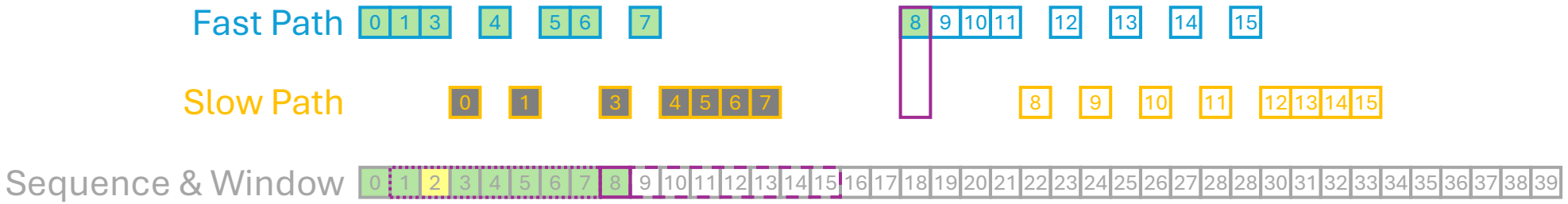
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 7

RoguePackets 0

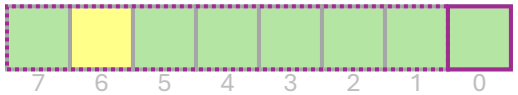
Lost Packet



RecovSeqNum 8

SequenceHistory

1	1	1	1	1	1	0	1
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 8

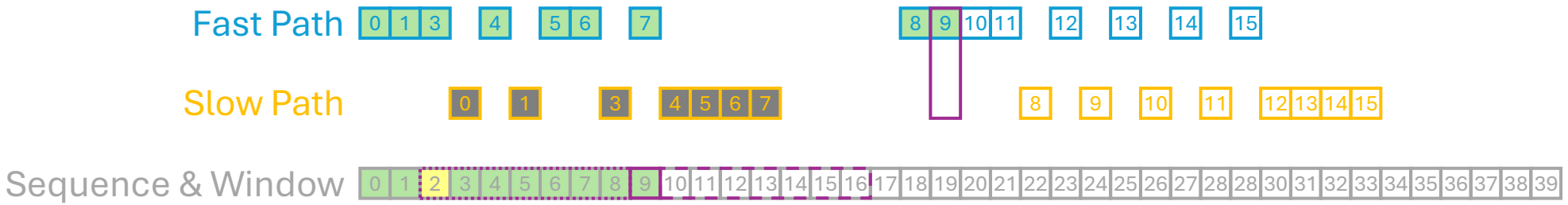
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 7

RoguePackets 0

Lost Packet



RecovSeqNum 9

SequenceHistory 1 1 1 1 1 1 1 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 9

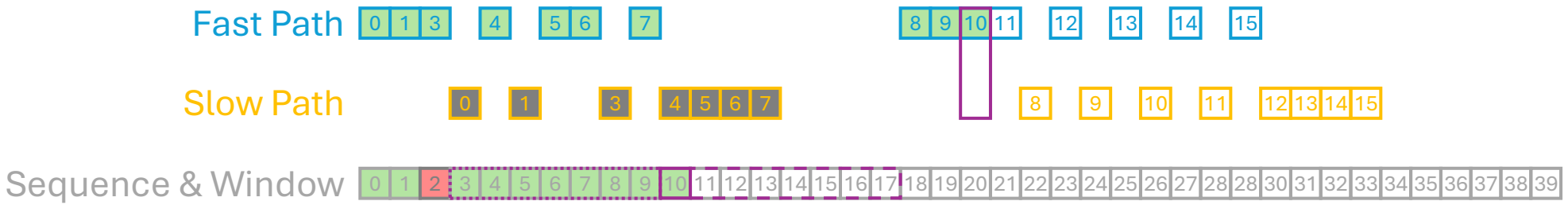
OutOfOrderPackets 1

LostPackets 0

DiscardedPackets 7

RoguePackets 0

Lost Packet



RecovSeqNum 9

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 9

OutOfOrderPackets 1

LostPackets 1

DiscardedPackets 7

RoguePackets 0

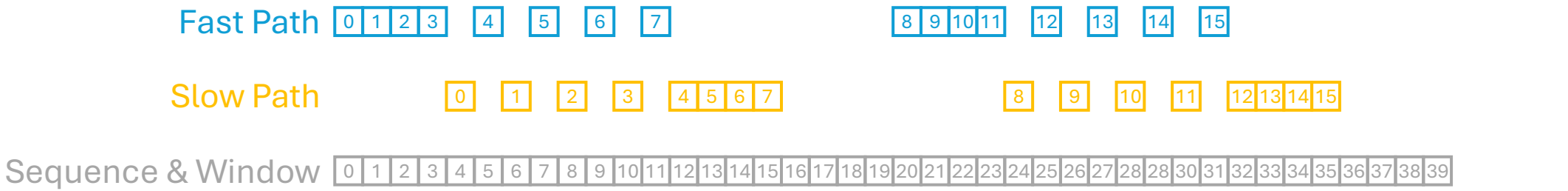
FRER Vector Recovery Algorithm Erroneous Lost Packets

After SequenceRecoveryReset

Cause of Erroneous Lost Packets

- After SequenceRecoveryReset, SequenceHistory is all 0s
- On arrival of first packet (TakeAny = TRUE)
  - SequenceHistory[0] set to 1
  - Other positions remain 0
- As other positions are shifted out SequenceHistory, any 0s are counted as Lost Packets

Erroneous Lost Packets



RecovSeqNum -

SequenceHistory 0 0 0 0 0 0 0 0 (0 1 2 3 4 5 6 7) (7 6 5 4 3 2 1 0)

frerSeqRcvyHistoryLength = 8

TakeAny TRUE

PassedPackets 0

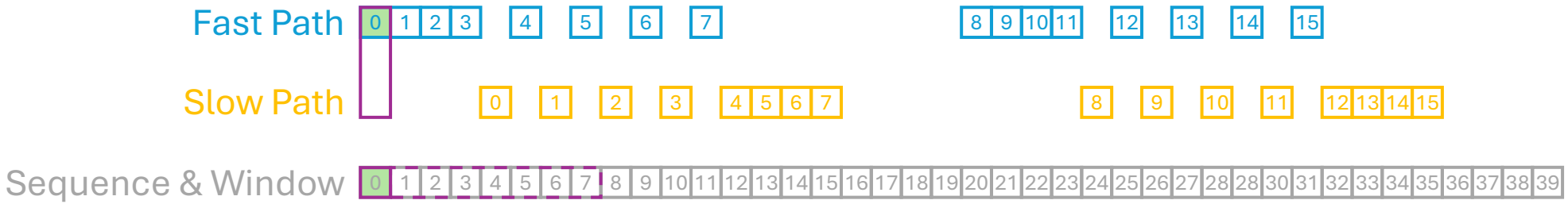
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 0

SequenceHistory 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

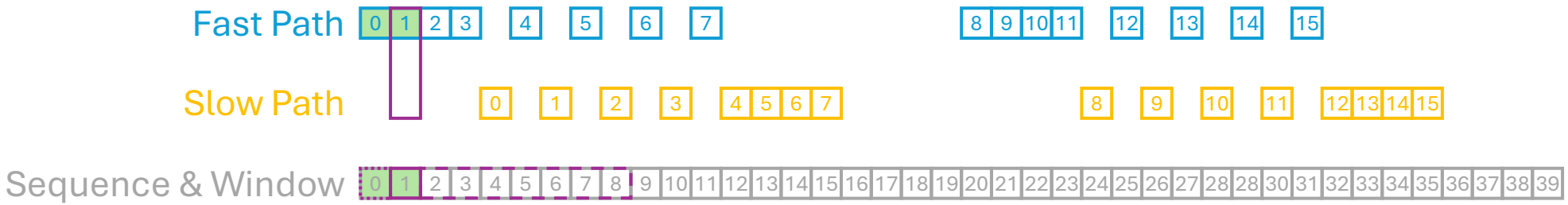
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 1

SequenceHistory

1	1	0	0	0	0	0	0
0	1	2	3	4	5	6	7

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 2

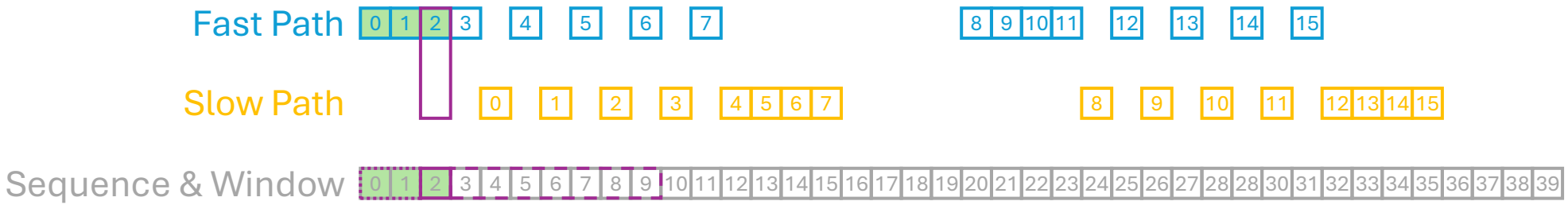
OutOfOrderPackets 0

LostPackets 1

DiscardedPackets 0

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

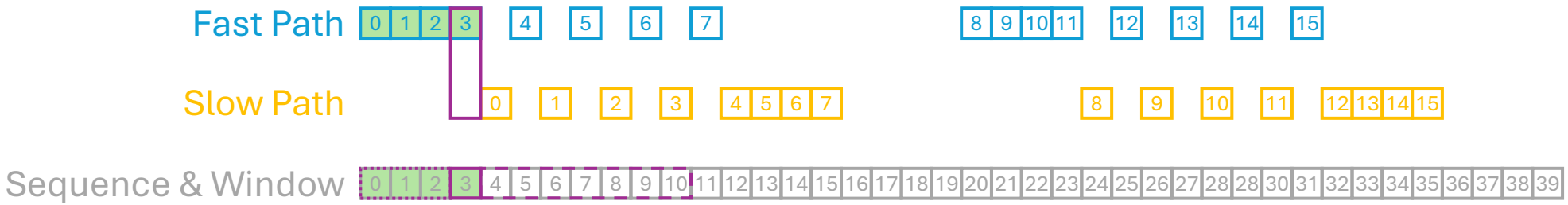
OutOfOrderPackets: 0

LostPackets: 2

DiscardedPackets: 0

RoguePackets: 0

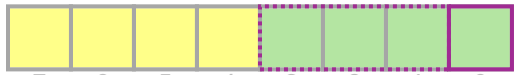
Erroneous Lost Packets



RecovSeqNum 3

SequenceHistory 1 1 1 1 0 0 0 0

0 1 2 3 4 5 6 7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 4

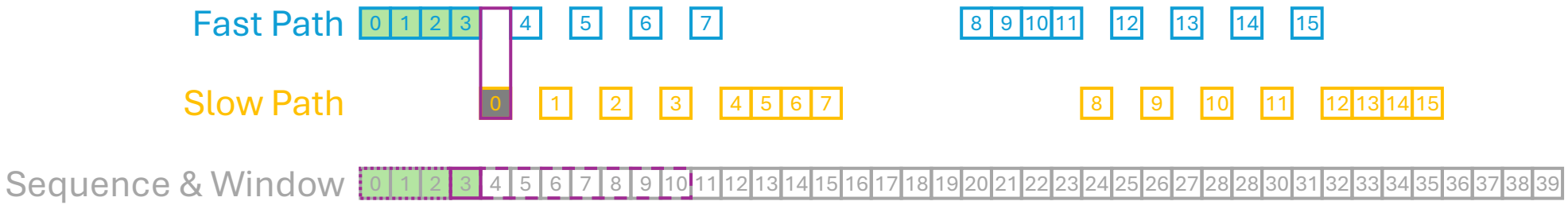
OutOfOrderPackets 0

LostPackets 3

DiscardedPackets 0

RoguePackets 0

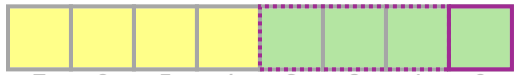
Erroneous Lost Packets



RecovSeqNum 3

SequenceHistory

1	1	1	1	0	0	0	0
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 4

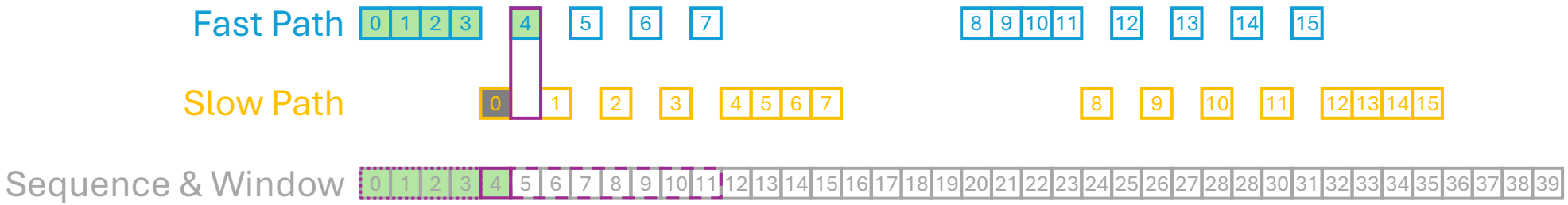
OutOfOrderPackets 0

LostPackets 3

DiscardedPackets 1

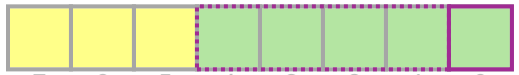
RoguePackets 0

Erroneous Lost Packets



RecovSeqNum: 4

SequenceHistory: 1 1 1 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

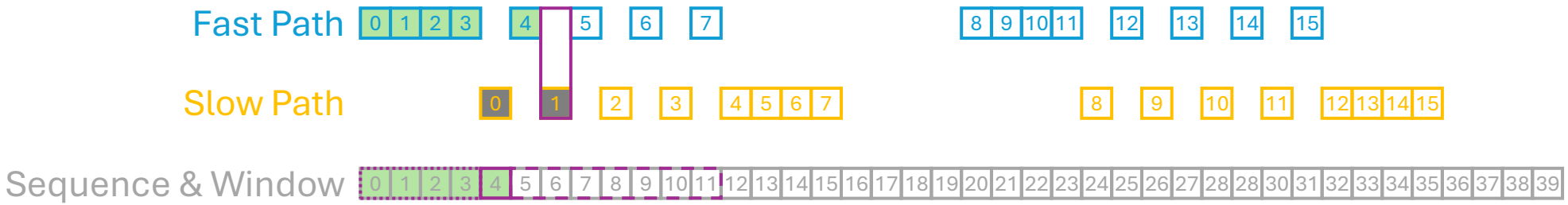
OutOfOrderPackets: 0

LostPackets: 4

DiscardedPackets: 1

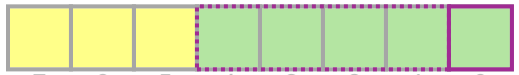
RoguePackets: 0

Erroneous Lost Packets



RecovSeqNum: 4

SequenceHistory: 1 1 1 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

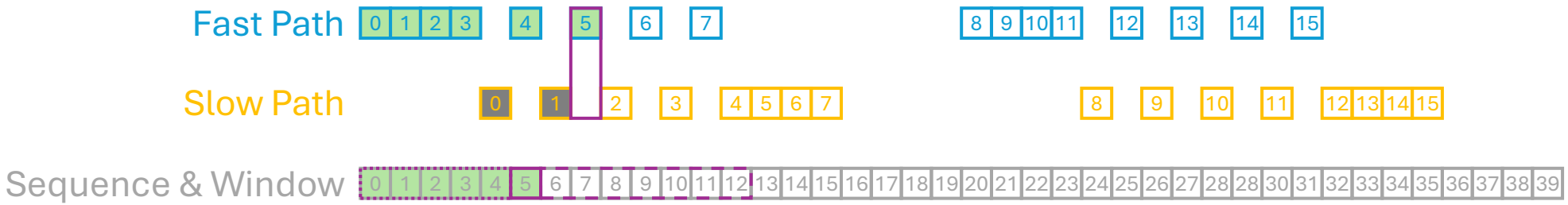
OutOfOrderPackets: 0

LostPackets: 4

DiscardedPackets: 2

RoguePackets: 0

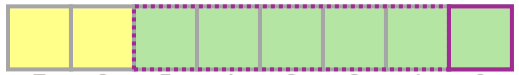
Erroneous Lost Packets



RecovSeqNum 5

SequenceHistory

1	1	1	1	1	1	0	0
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 6

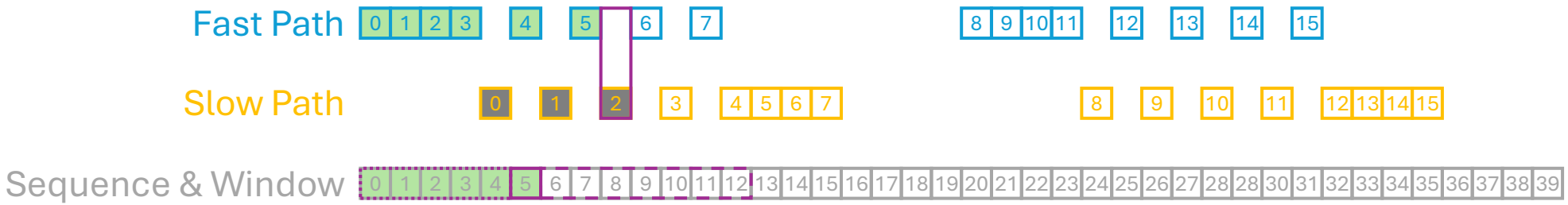
OutOfOrderPackets 0

LostPackets 5

DiscardedPackets 2

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 5

SequenceHistory 1 1 1 1 1 1 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 6

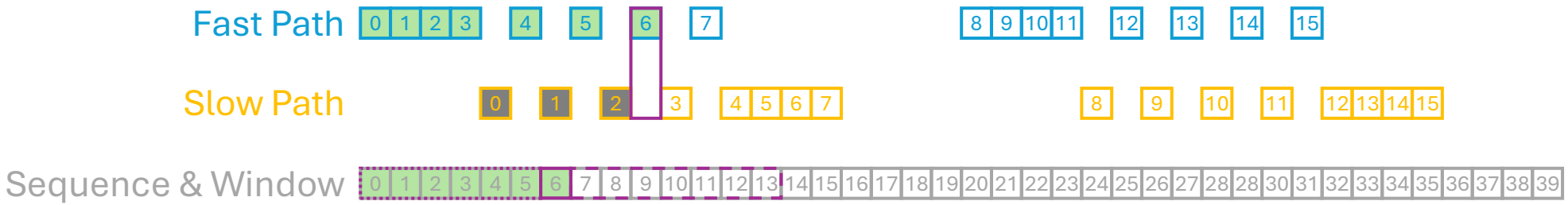
OutOfOrderPackets 0

LostPackets 5

DiscardedPackets 3

RoguePackets 0

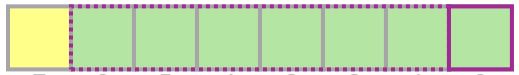
Erroneous Lost Packets



RecovSeqNum 6

SequenceHistory

1	1	1	1	1	1	1	0
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

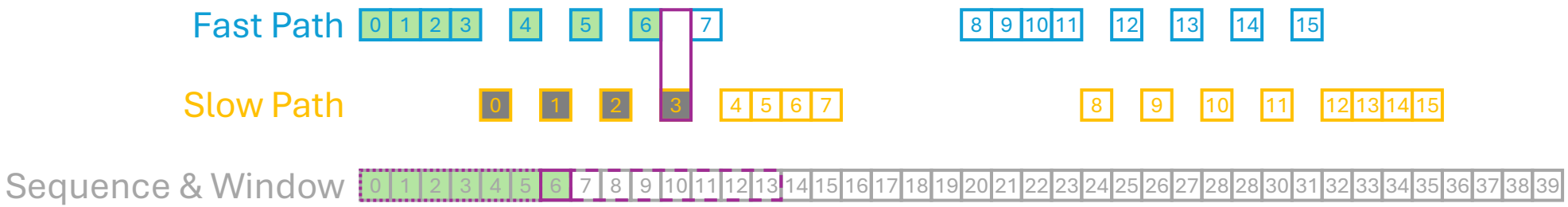
OutOfOrderPackets 0

LostPackets 6

DiscardedPackets 3

RoguePackets 0

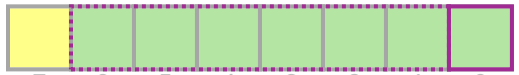
Erroneous Lost Packets



RecovSeqNum 6

SequenceHistory

1	1	1	1	1	1	1	0
0	1	2	3	4	5	6	7



frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

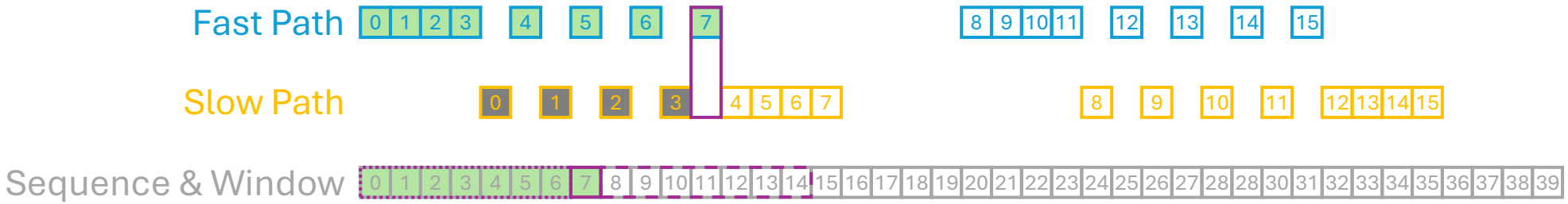
OutOfOrderPackets 0

LostPackets 6

DiscardedPackets 4

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 8

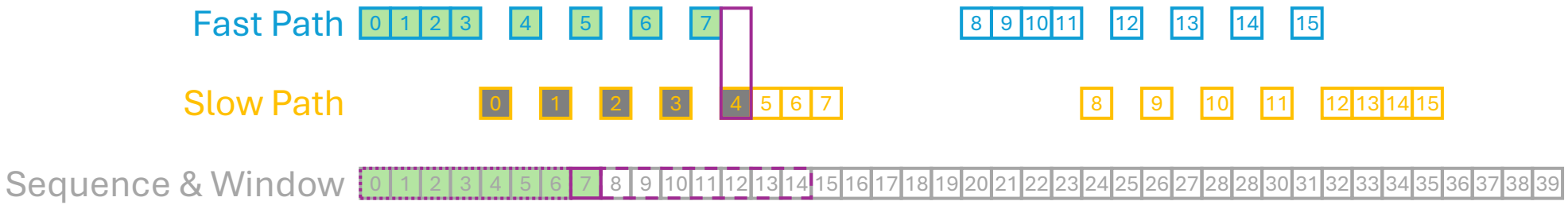
OutOfOrderPackets 0

LostPackets 7

DiscardedPackets 4

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 8

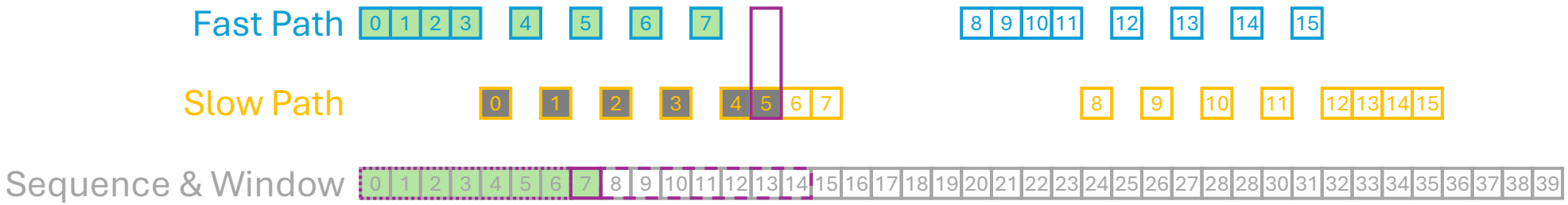
OutOfOrderPackets 0

LostPackets 7

DiscardedPackets 5

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 8

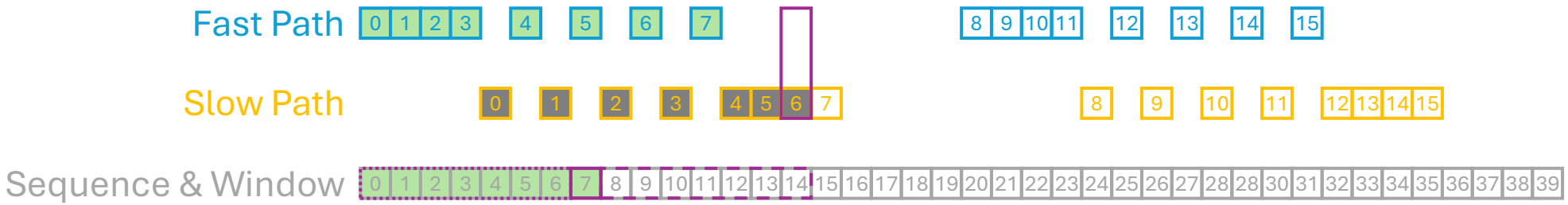
OutOfOrderPackets 0

LostPackets 7

DiscardedPackets 6

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 8

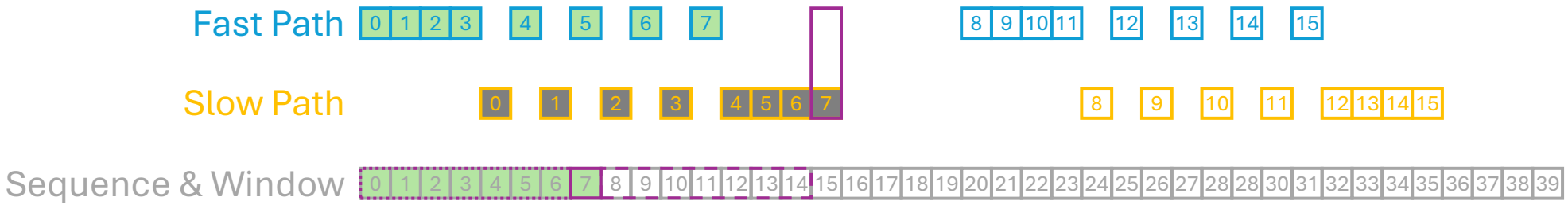
OutOfOrderPackets 0

LostPackets 7

DiscardedPackets 7

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 8

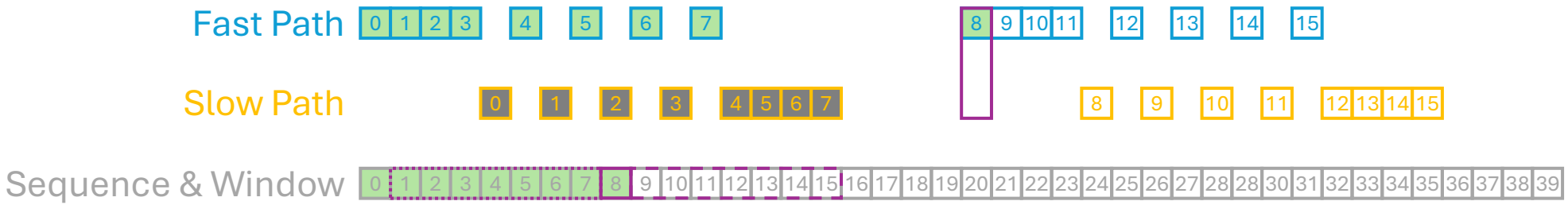
OutOfOrderPackets 0

LostPackets 7

DiscardedPackets 8

RoguePackets 0

Erroneous Lost Packets



RecovSeqNum 8

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 9

OutOfOrderPackets 0

LostPackets 7

DiscardedPackets 8

RoguePackets 0

Effect of Erroneous Lost Packets Issue

- After SequenceRecoveryReset, up to…

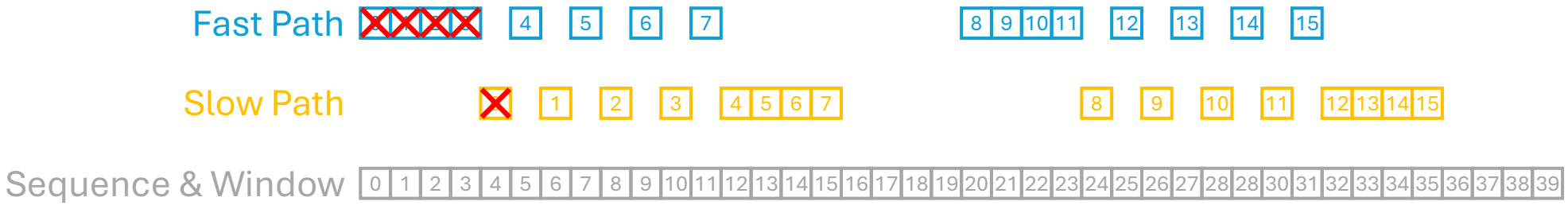
  frerSeqRcvyHistoryLength – 1

  …erroneous Lost Packets may be reported.

Solution to Erroneous Lost Packets Issue?

- Setting SequenceHistory to all 1s creates other issues when re-starting mid-stream…

Incorrectly Discarded Packets



RecovSeqNum: -

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7) | (7 6 5 4 3 2 1 0)

frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 0

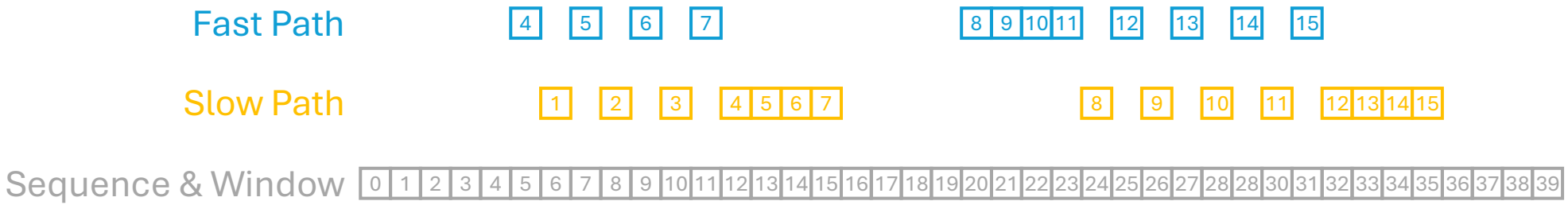
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

Incorrectly Discarded Packets



RecovSeqNum: -

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7) | (7 6 5 4 3 2 1 0)

frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 0

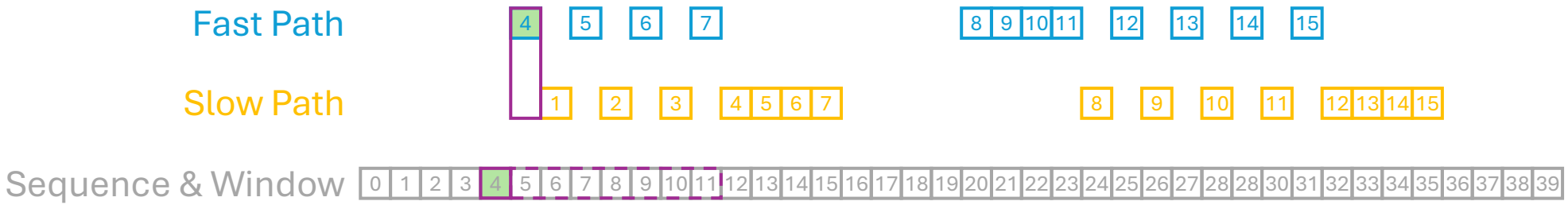
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

Incorrectly Discarded Packets



RecovSeqNum 4

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

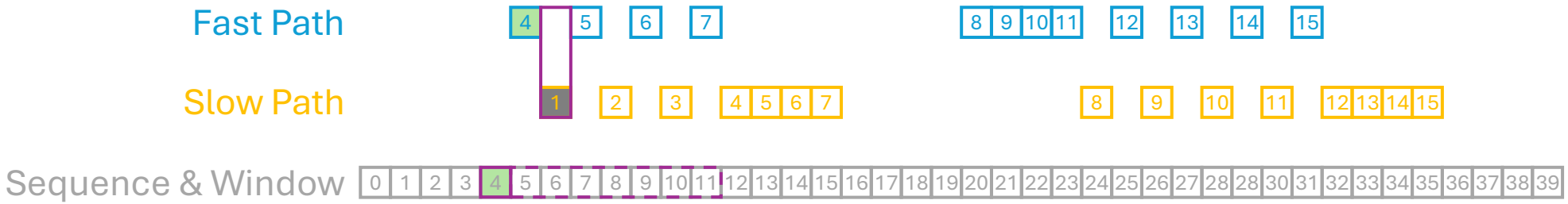
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum 4

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

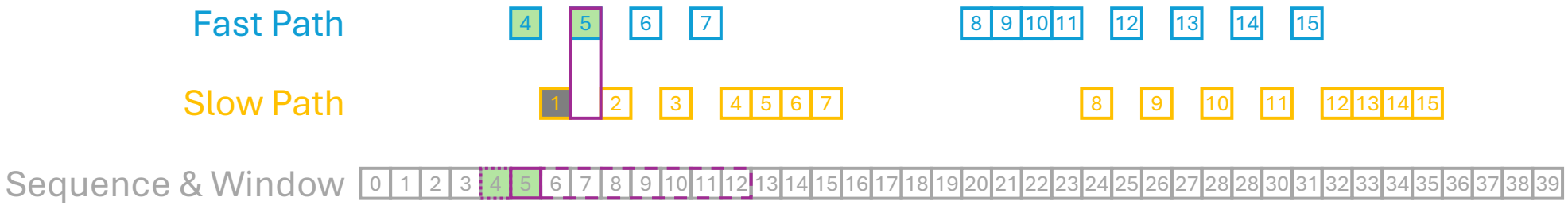
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 1

RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum 5

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 2

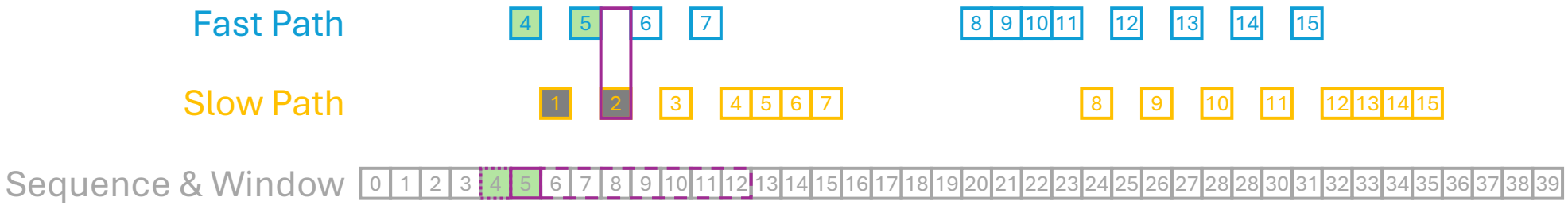
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 1

RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum 5

SequenceHistory 1 1 1 1 1 1 0 0

0 1 2 3 4 5 6 7

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 2

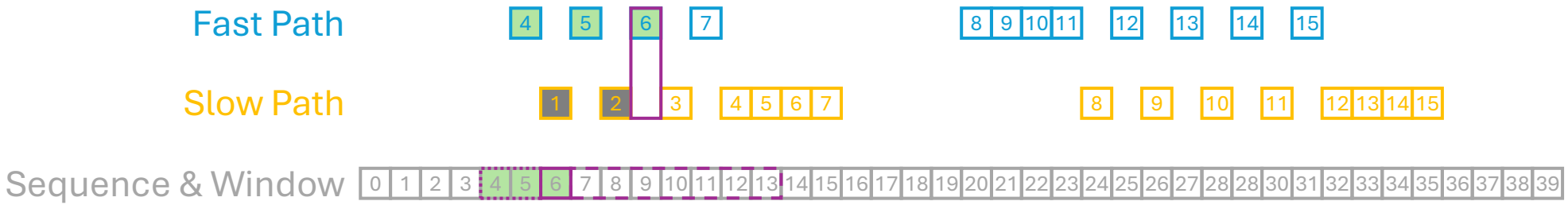
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 2

RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum 6

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

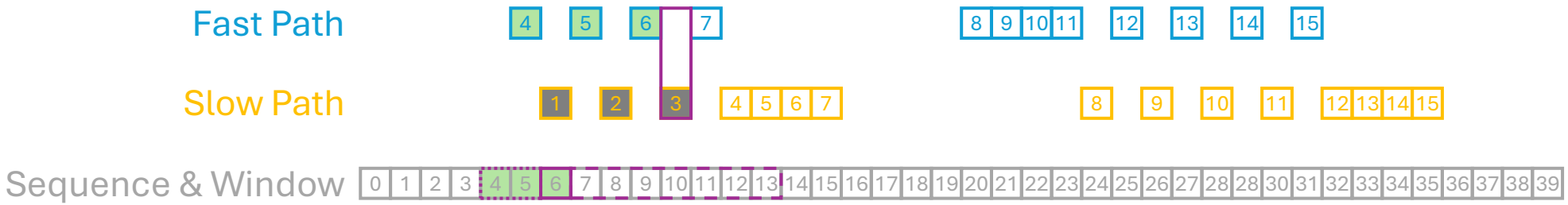
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 2

RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum 6

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

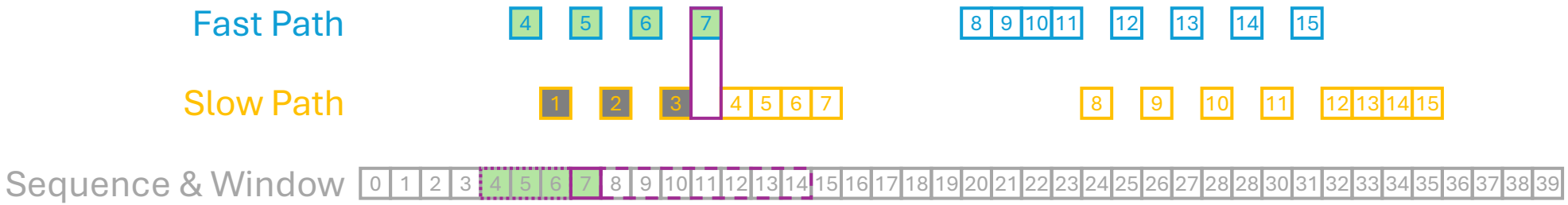
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

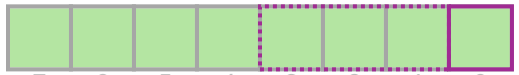
RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

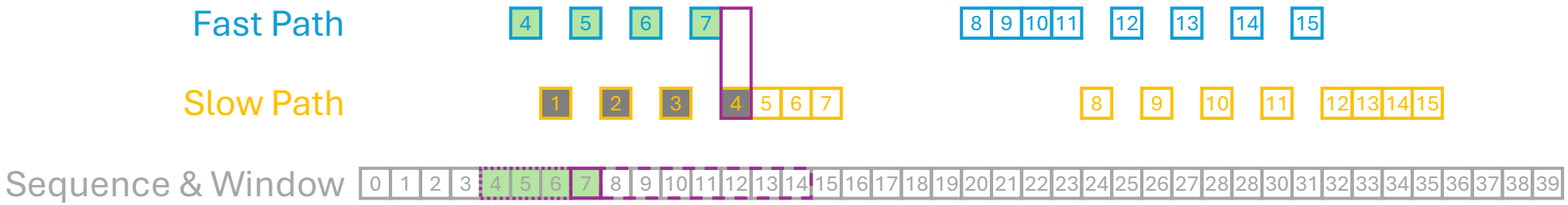
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 3

RoguePackets: 0

Incorrectly Discarded Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 4

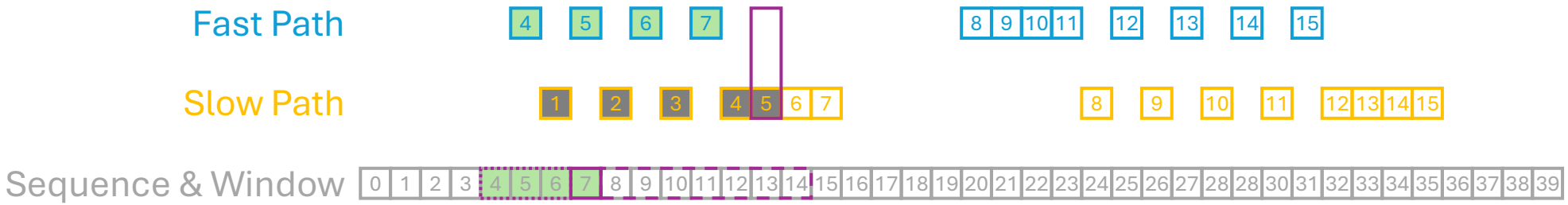
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 4

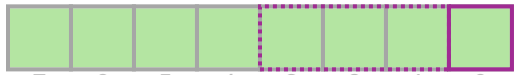
RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

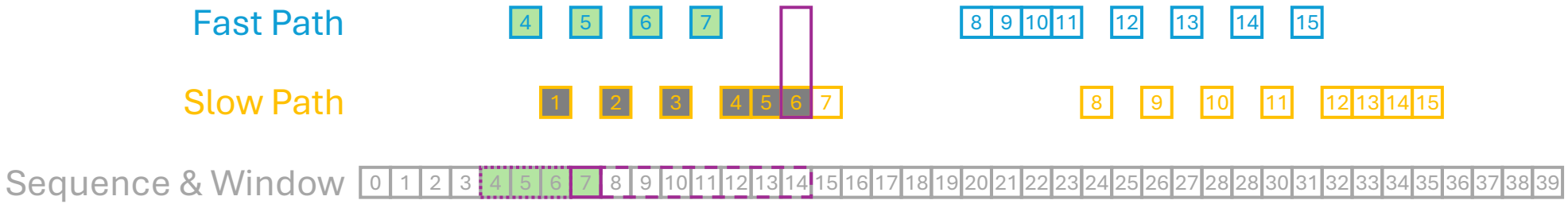
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 5

RoguePackets: 0

Incorrectly Discarded Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 4

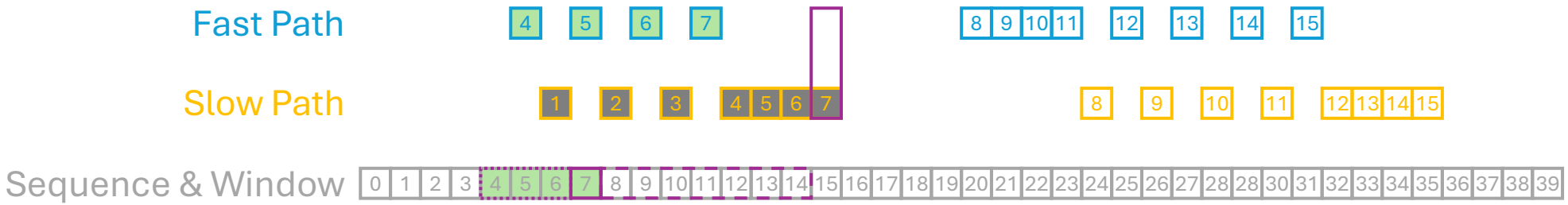
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 6

RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum 7

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 4

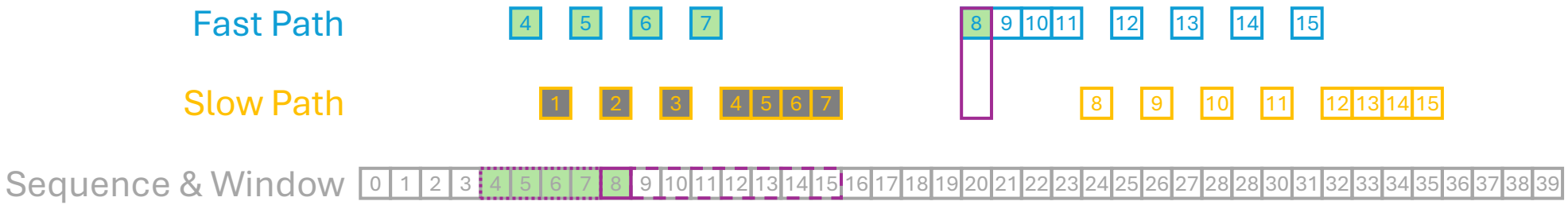
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 7

RoguePackets 0

Incorrectly Discarded Packets



RecovSeqNum 8

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 5

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 7

RoguePackets 0

Further issues…

- **Erroneous Lost Packets**: Setting SequenceHistory to all 0s after a SequenceRecoveryReset effectively assumes that all sequence numbers up to frerSequenceHistoryLength prior to the first packet received **haven't been seen** but should be and flags them as **Lost** when they aren't.

- **Incorrectly Discarded Packets**: Setting SequenceHistory to all 1s after a SequenceRecoveryReset effectively assumes that all sequence numbers up to frerSequenceHistoryLength prior to the first packet received **have been seen** and if they are seen again should be **Discarded**.

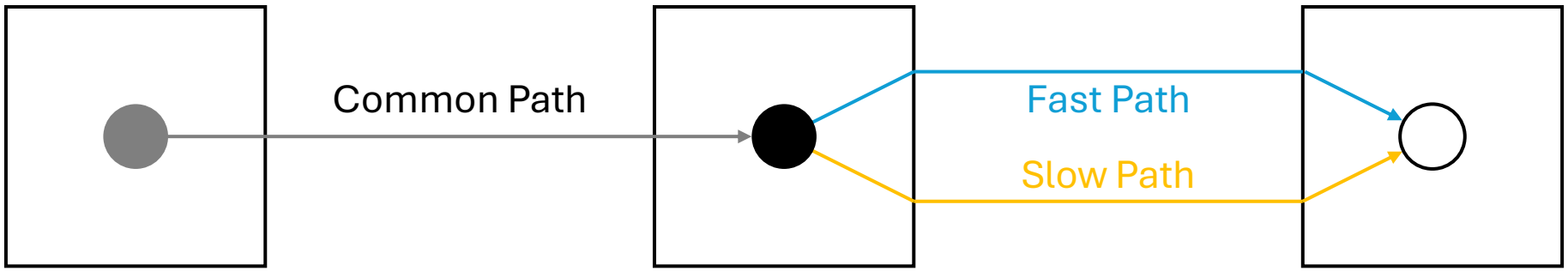
- However, depending on when and how the SequenceRecoveryReset occurred, the actual situation may be one, or the other, or something inbetween.

FRER Vector Recovery Algorithm Reasons for Aggressive Timeout

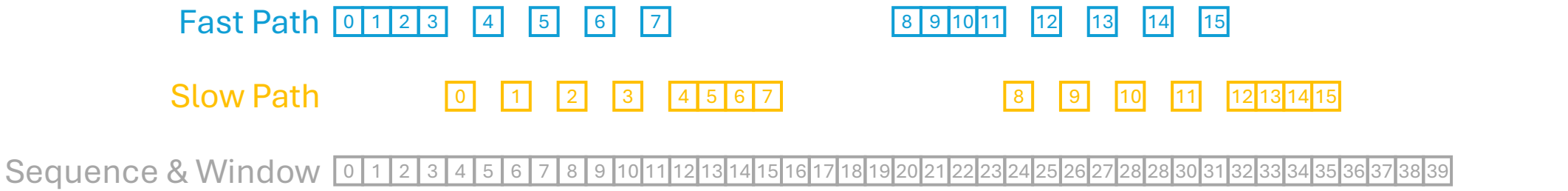
When a series of packets are lost

Loss of Packets

- Loss may occur in a portion of the network over which FRER is not operative, i.e. may affect both fast and slow paths equally.



Reasons for Aggressive Timeout



RecovSeqNum -

SequenceHistory 0 0 0 0 0 0 0 0 (0 1 2 3 4 5 6 7) | (7 6 5 4 3 2 1 0)

frerSeqRcvyHistoryLength = 8

TakeAny TRUE

PassedPackets 0

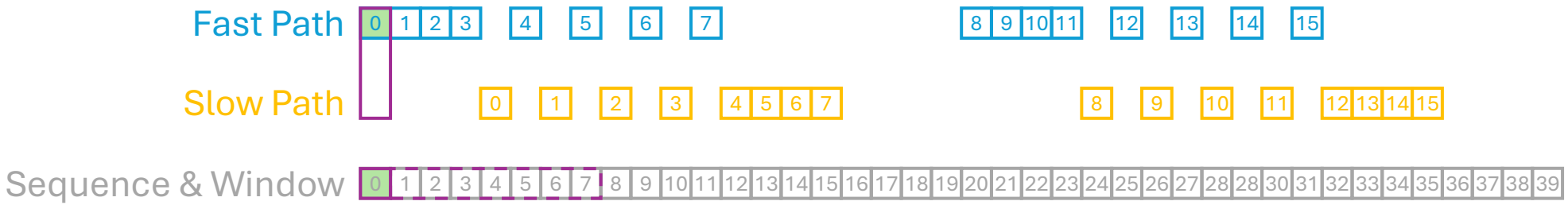
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Reasons for Aggressive Timeout



RecovSeqNum 0

SequenceHistory 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

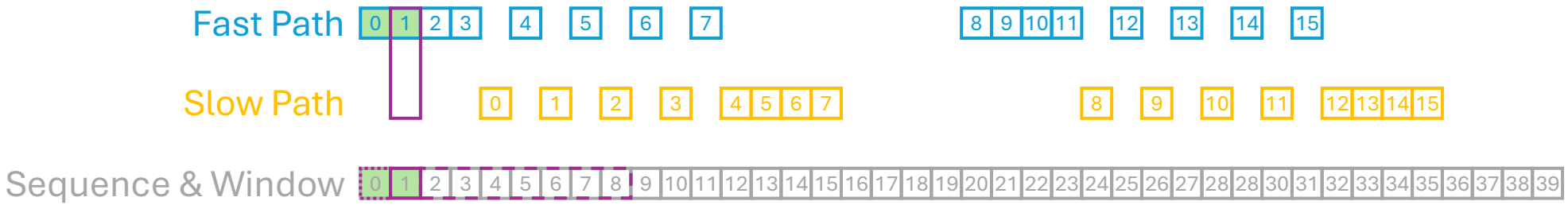
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Reasons for Aggressive Timeout



RecovSeqNum: 1

SequenceHistory: 1 1 0 0 0 0 0 0 (0 1 2 3 4 5 6 7)

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

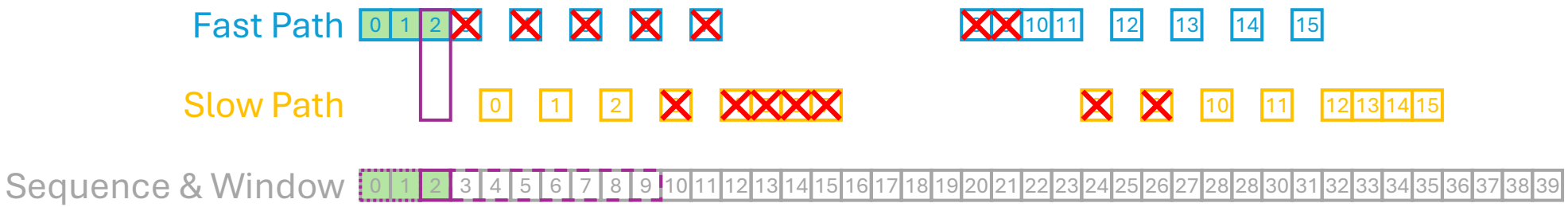
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

Reasons for Aggressive Timeout



RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Reasons for Aggressive Timeout

RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Reasons for Aggressive Timeout

RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 1

RoguePackets 0

Reasons for Aggressive Timeout

RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 2

RoguePackets: 0

Reasons for Aggressive Timeout

RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

RoguePackets 0

Reasons for Aggressive Timeout

RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

RoguePackets 1

Reasons for Aggressive Timeout

RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

RoguePackets 2

Reasons for Aggressive Timeout

RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

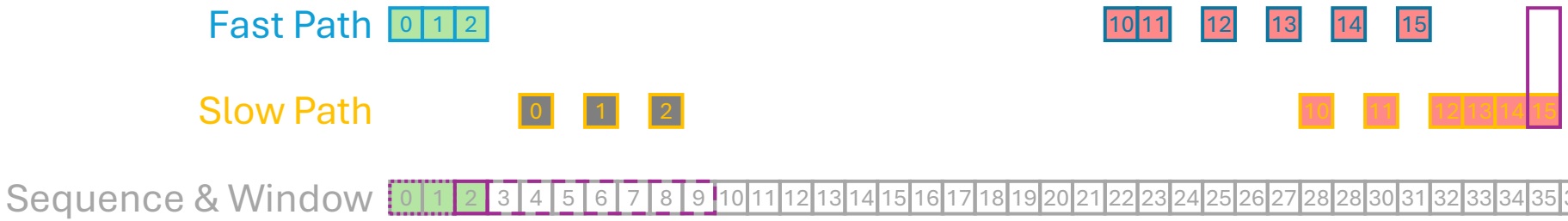
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 3

RoguePackets: 5

Reasons for Aggressive Timeout



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 3

RoguePackets: 12

Desired Behaviour?

- The use of FRER shouldn’t make things worse
  - If a series of packets is dropped somewhere in the network, using FRER shouldn’t mean that even more packets are dropped.
- An aggressive value for frerSeqRcvyResetMSec minimises the chance of any additional packet loss

Effect of Aggressive Timeout

RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

RoguePackets 0

Effect of Aggressive Timeout

RecovSeqNum 2

SequenceHistory 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 3

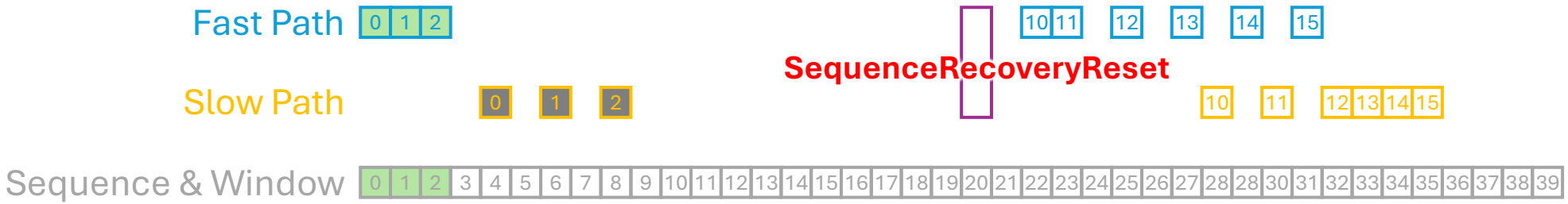
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

RoguePackets 0

Effect of Aggressive Timeout



RecovSeqNum: -

SequenceHistory: 0 0 0 0 0 0 0 0 (0 1 2 3 4 5 6 7)

(7 6 5 4 3 2 1 0)

frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 3

RoguePackets: 0

Effect of Aggressive Timeout

RecovSeqNum 10

SequenceHistory 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny TRUE

PassedPackets 4

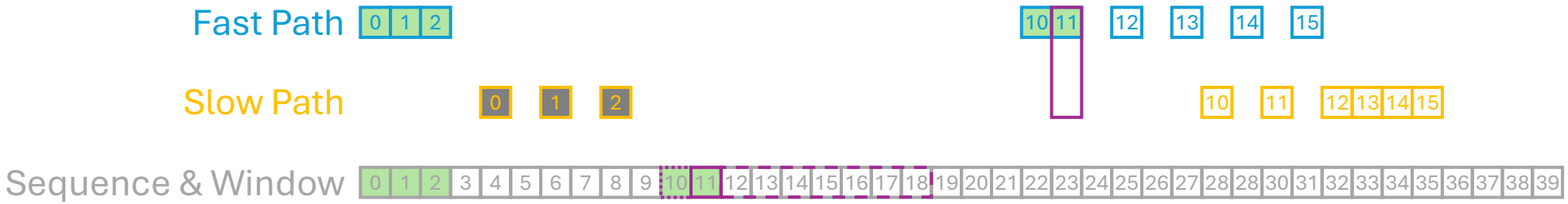
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

RoguePackets 0

Effect of Aggressive Timeout



RecovSeqNum 11

SequenceHistory 1 1 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny TRUE

PassedPackets 5

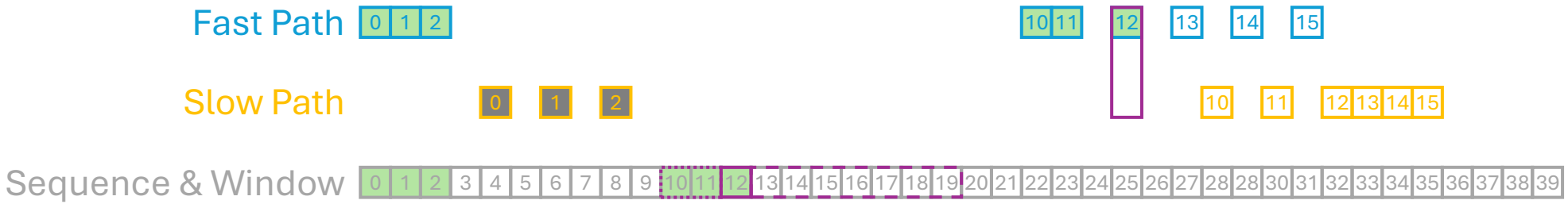
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 3

RoguePackets 0

Effect of Aggressive Timeout



RecovSeqNum 11

SequenceHistory

1	1	1	0	0	0	0	0
0	1	2	3	4	5	6	7

7	6	5	4	3	2	1	0

frerSeqRcvyHistoryLength = 8

TakeAny TRUE

PassedPackets 5

OutOfOrderPackets 0

LostPackets 0

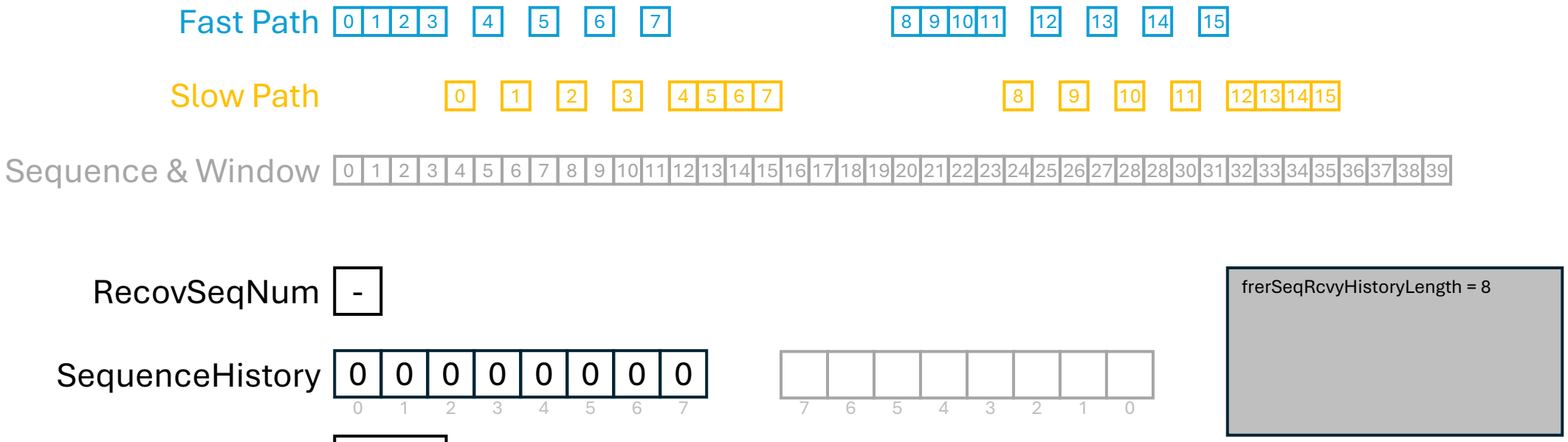
DiscardedPackets 3

RoguePackets 0

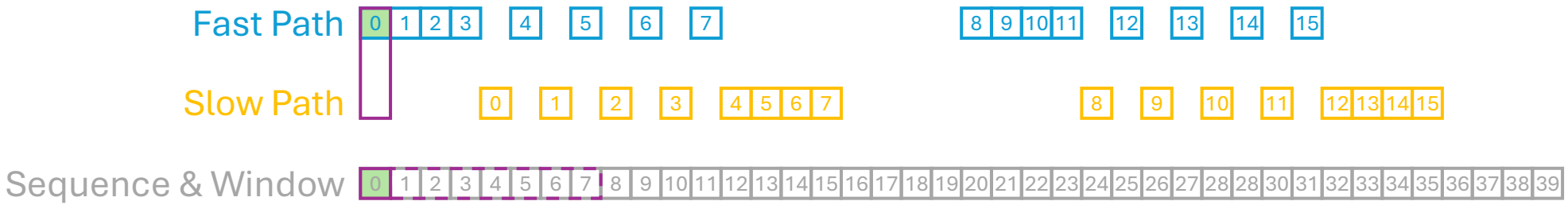
FRER Vector Recovery Algorithm Issues with Aggressive Timeout

When packets on both fast and slow paths experience delays
(or fast path drops packets when slow path has a longer than expected delay)

Issues with Aggressive Timeout



Issues with Aggressive Timeout



RecovSeqNum 0

SequenceHistory 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

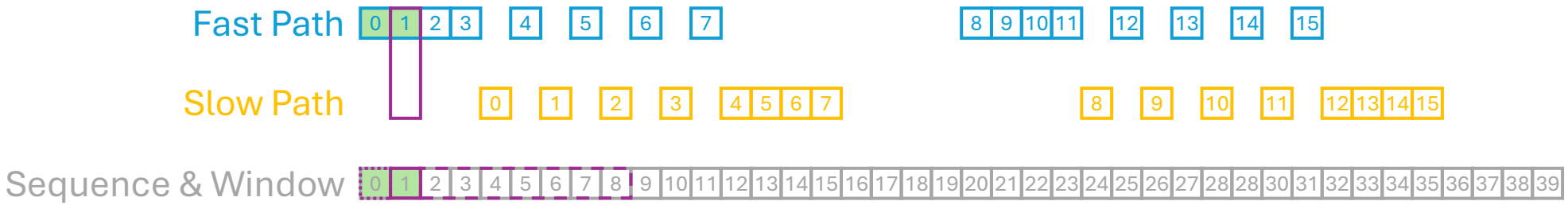
OutOfOrderPackets 0

LostPackets 0

DiscardedPackets 0

RoguePackets 0

Issues with Aggressive Timeout



RecovSeqNum: 1

SequenceHistory: 1 1 0 0 0 0 0 0 (0 1 2 3 4 5 6 7)

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

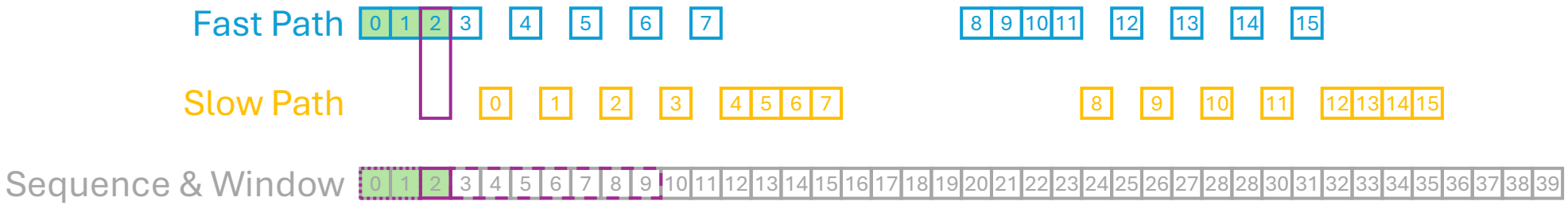
OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

Issues with Aggressive Timeout



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0 (0 1 2 3 4 5 6 7)

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

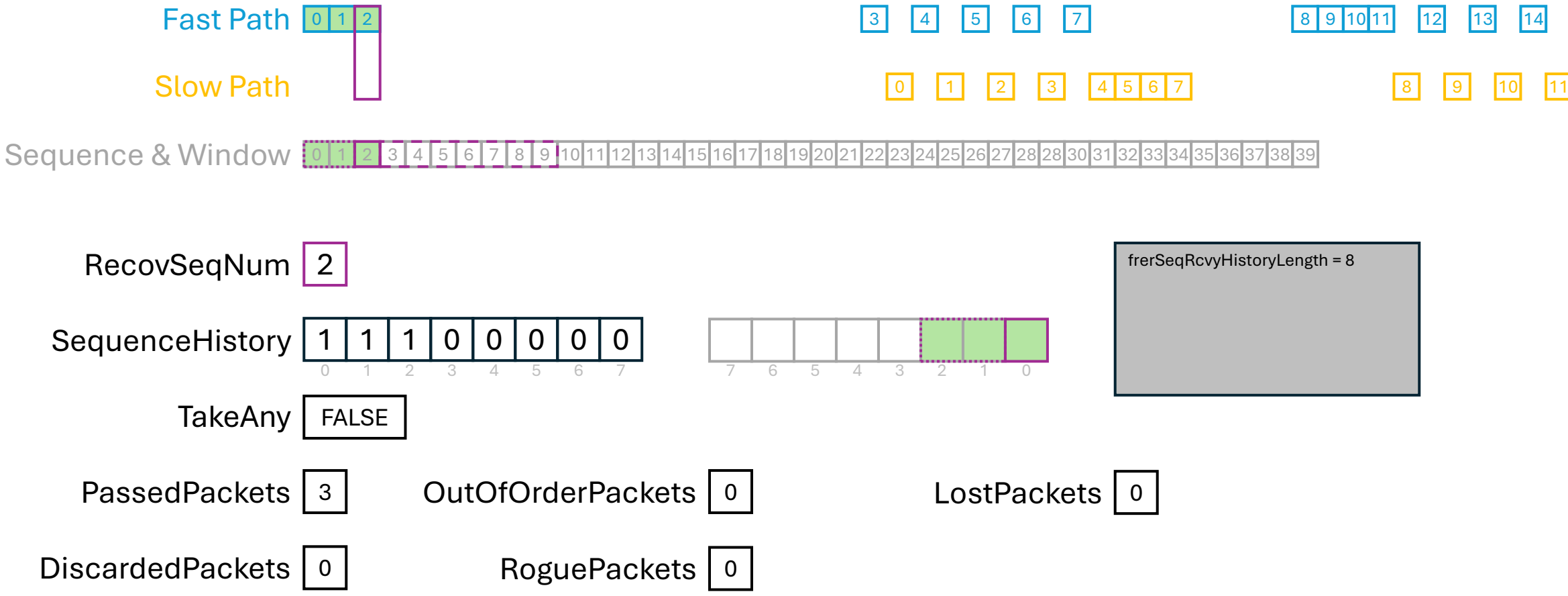
OutOfOrderPackets: 0

LostPackets: 0

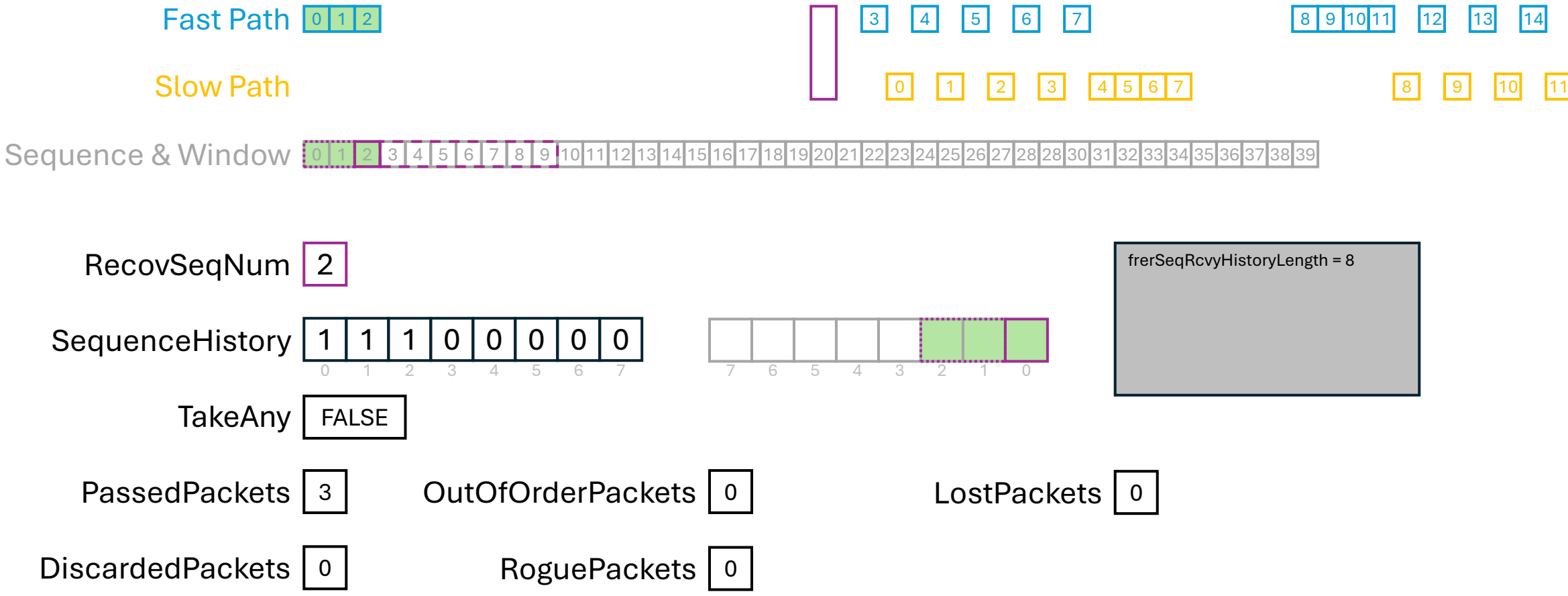
DiscardedPackets: 0

RoguePackets: 0

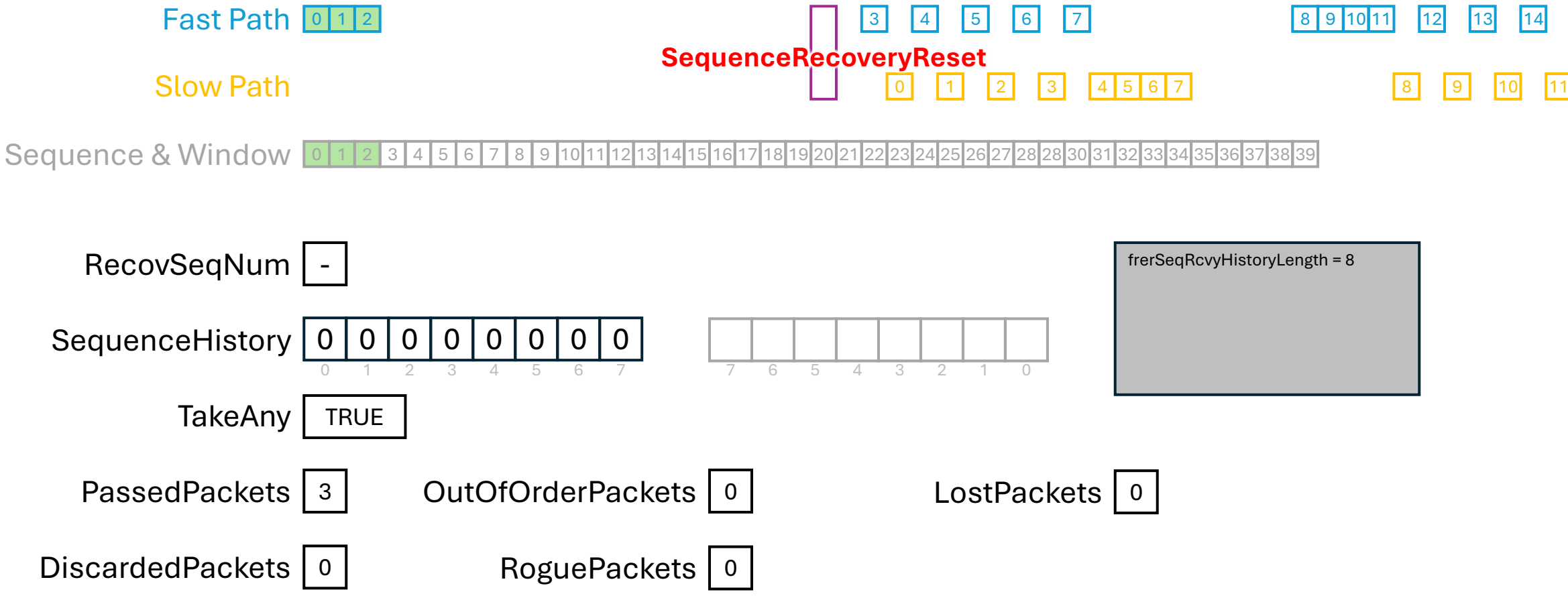
Issues with Aggressive Timeout



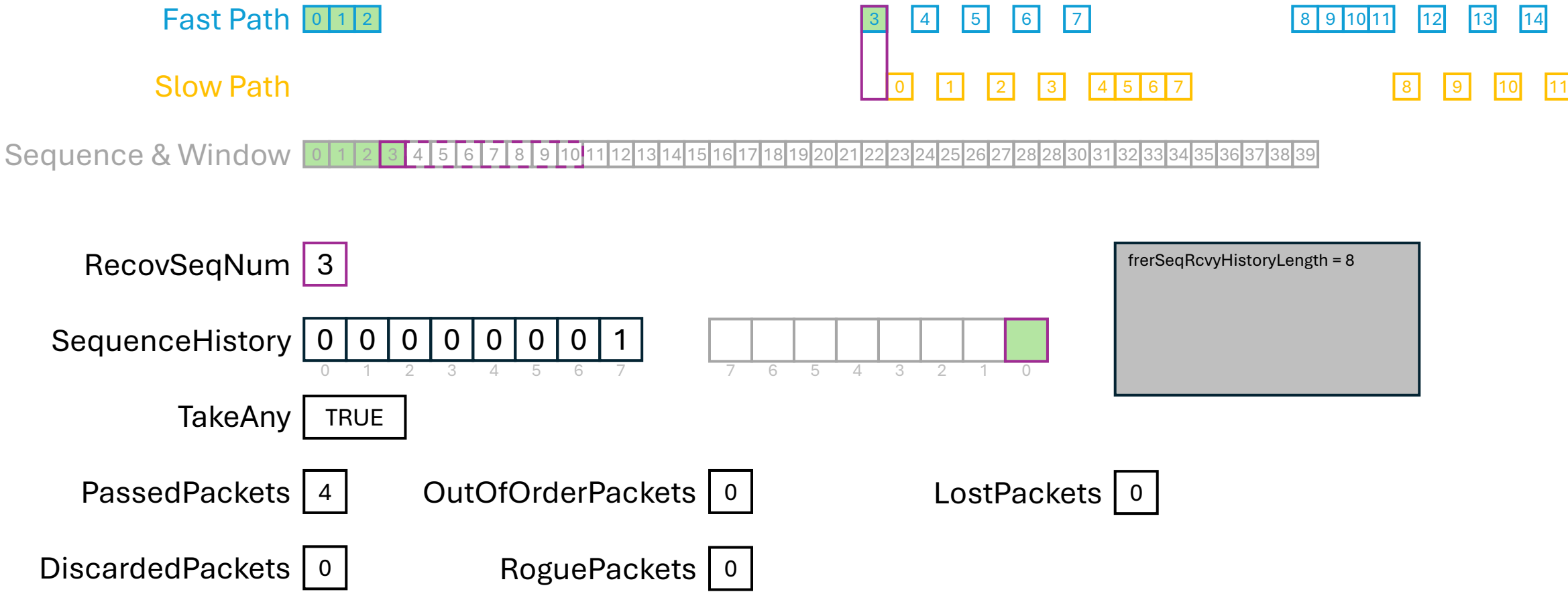
Issues with Aggressive Timeout



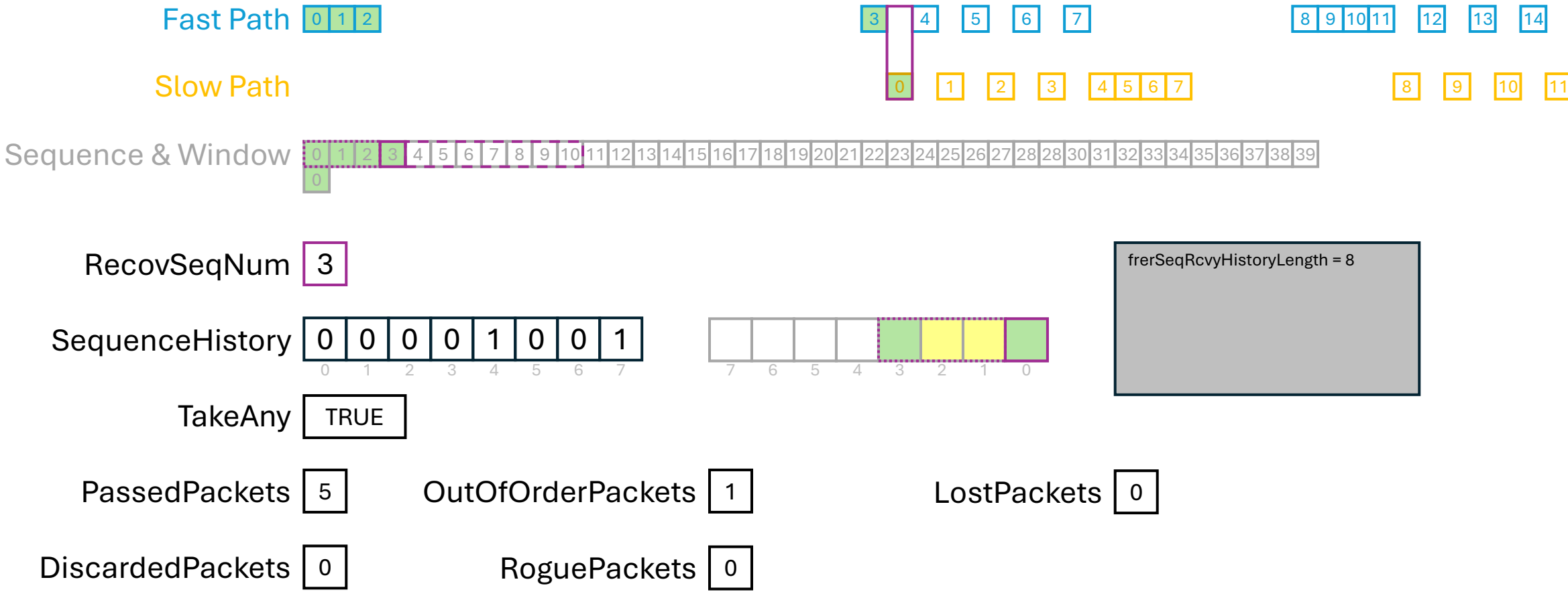
Issues with Aggressive Timeout



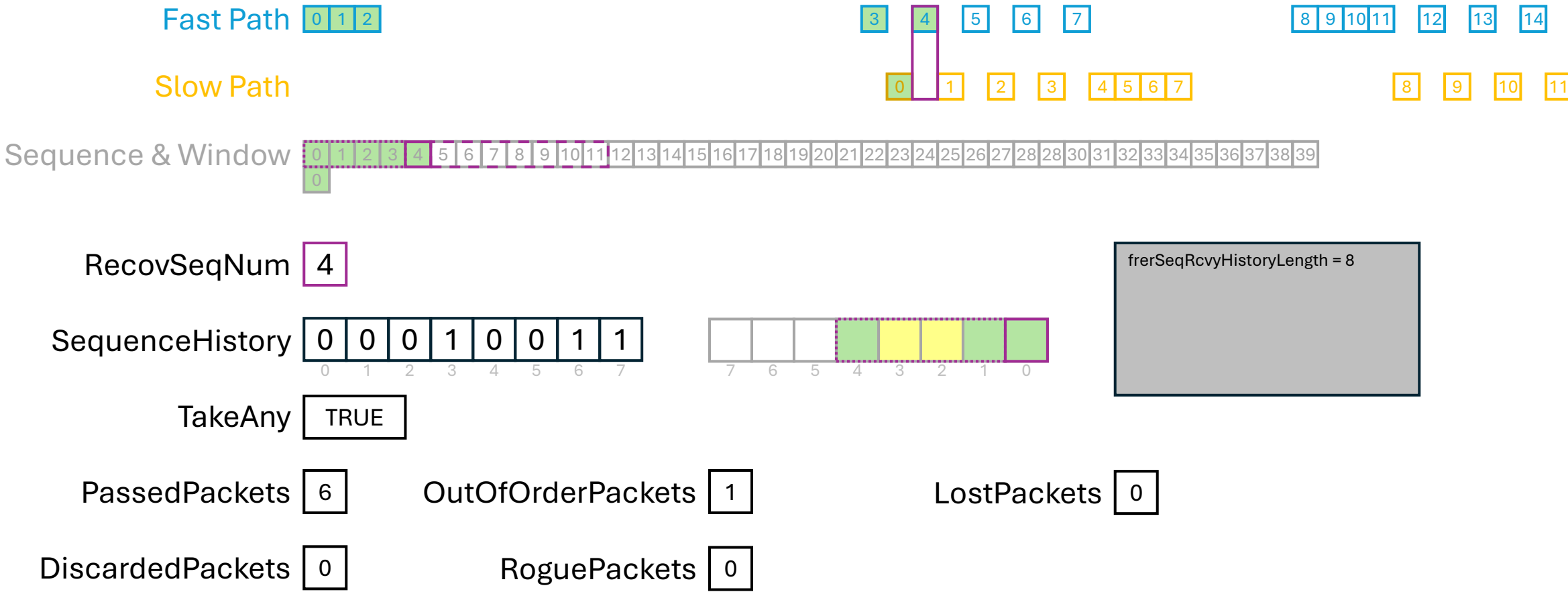
Issues with Aggressive Timeout



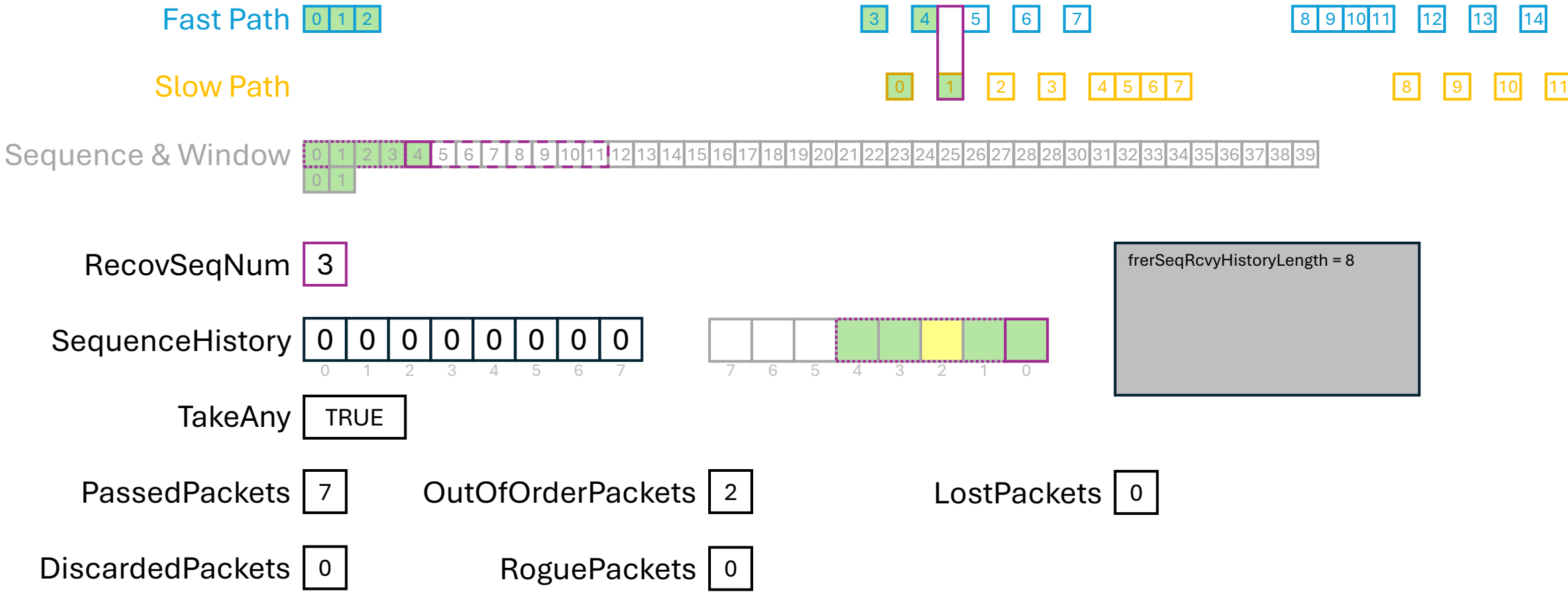
Issues with Aggressive Timeout



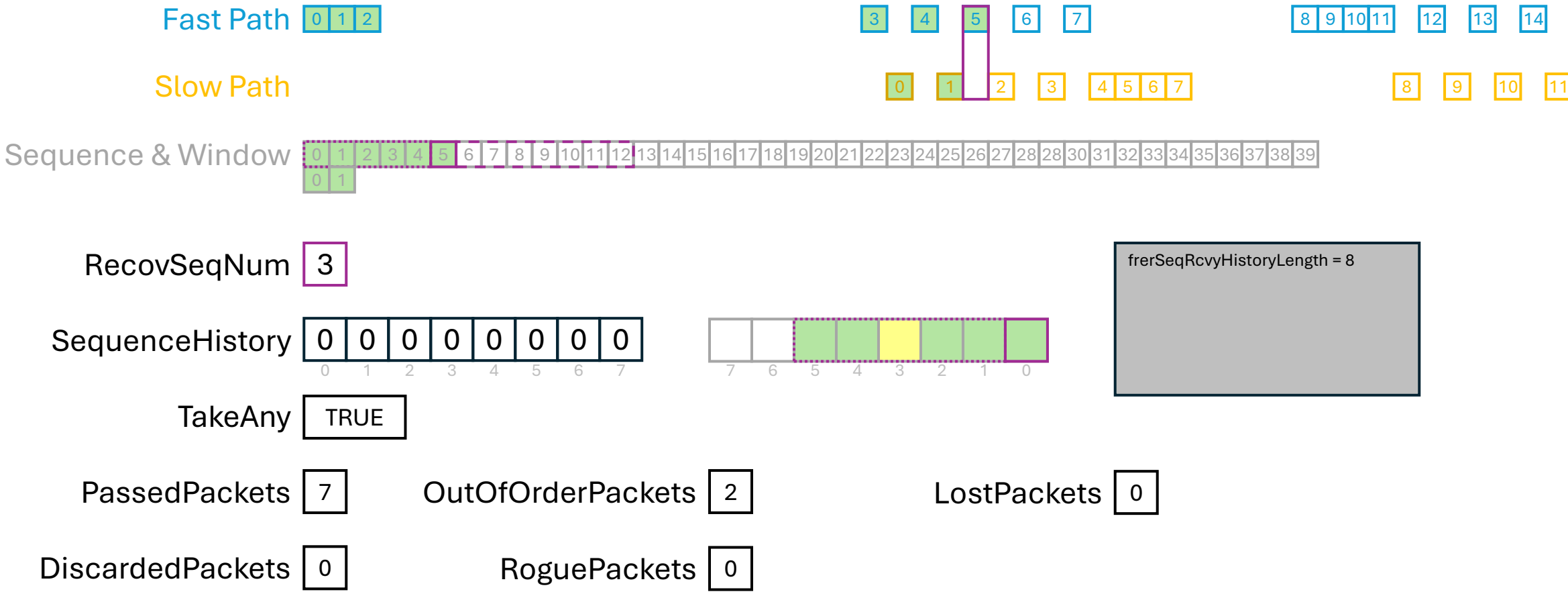
Issues with Aggressive Timeout



Issues with Aggressive Timeout



Issues with Aggressive Timeout



FRER Vector Recovery Algorithm Proposed Algorithm

Proposal based on contribution by Venkat Arunarthi

Issues with Current Algorithm

- Can generate erroneous Lost Packet counts following a reset
  - Because SeqenceHistory is set to all 0s on reset
  - Simply setting SequenceHistory to all 1s on reset could result in invalid LostPackets (i.e. not passing packets that should be passed)
- Forces a trade-off regarding timeout
  - Too long: can fail to pass valid packets
    - If many packets are lost and a valid packet falls outside the window
  - Too short: can pass duplicate packets
    - If duplicate packets are delayed and arrive after a reset
  - Achieving the right balance could be especially tricky if the network experiences variable delays on different paths
    - More likely if some of the connections are wireless

Observations – 1

- The “Erroneous Lost Packets” behaviour occurs because the algorithm can’t distinguish between 0s in SequenceHistory that are there because of a reset (and aren’t expected to be seen) and ones that actually represent packets that should be seen and marked “Lost” if they aren’t.
- Setting SequenceHistory to all 1s after a reset would generate “Incorrectly Discarded Packets” for the same reason: the algorithm can’t distinguish between 1s that are there because of a reset and packets that have actually been seen.
- Venkat Arunarthi proposed in [1] a fix for this behaviour that adds two new variables:
  - InvalidHistoryCount (INT)
    - Number of values in SequenceHistory that are the result of a reset and should be treated differently from regular 1s and 0s.
  - SequenceHistoryInit (BOOLEAN)
    - TRUE when Sequence History contains values that are the result of a reset (InvalidHistoryCount is 1 or higher)
    - FALSE when it does not (InvalidHistoryCount is 0)

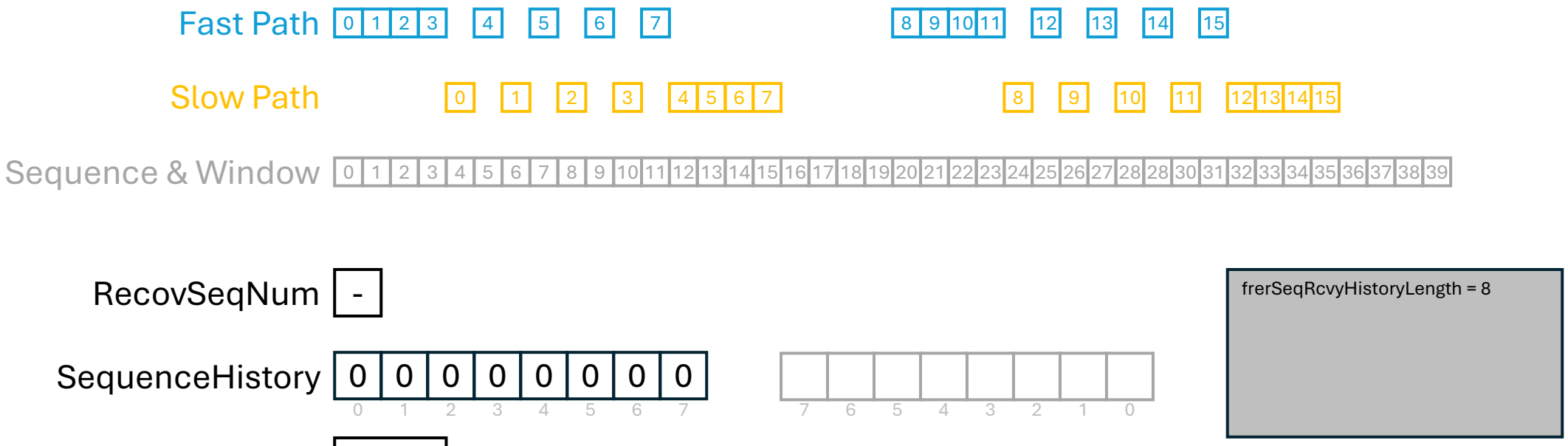
Observations – 2

- If the proposal in [1] is adopted, decisions must be made about how these variables should behave upon a reset.
- If the behaviour of SequenceHistory and RecovSeqNum upon reset are tweaked as well, the behaviour of passing duplicate packets if the timeout is overly aggressive can be eliminated.

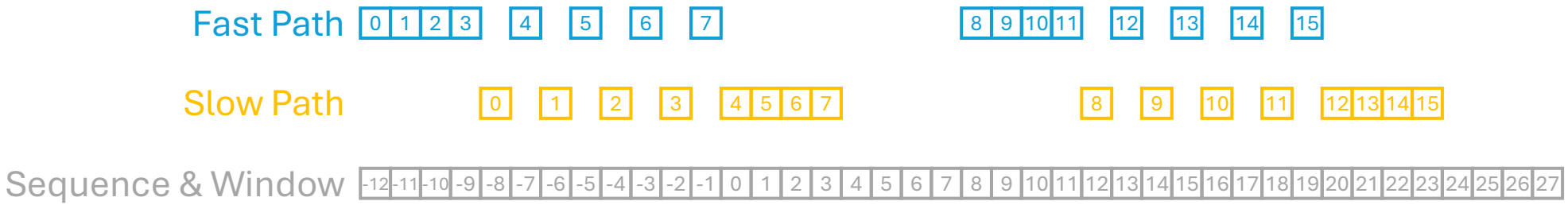
Note

- The SequenceHistory values effectively wrap around with the next value after 65,535 being 0
- To properly consider this characteristic, the Sequence/Window values in the diagrams for this section are shifted to include values before 0, but…
- “65,535” takes up a lot of space, so in this presentation I’m using the more intuitive “-1”, etc…

Proposed Algorithm



Proposed Algorithm



RecovSeqNum: -

SequenceHistory: 0 0 0 0 0 0 0 0 (0 1 2 3 4 5 6 7) | (7 6 5 4 3 2 1 0)

frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 0

OutOfOrderPackets: 0

LostPackets: 0

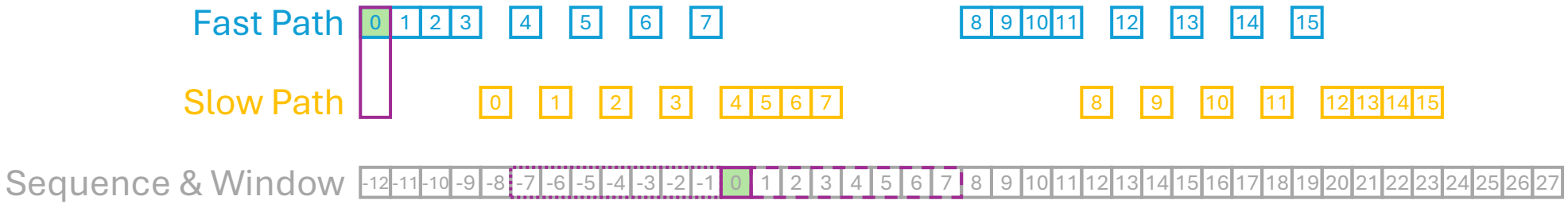
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 0

SequenceHistory: 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 1

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

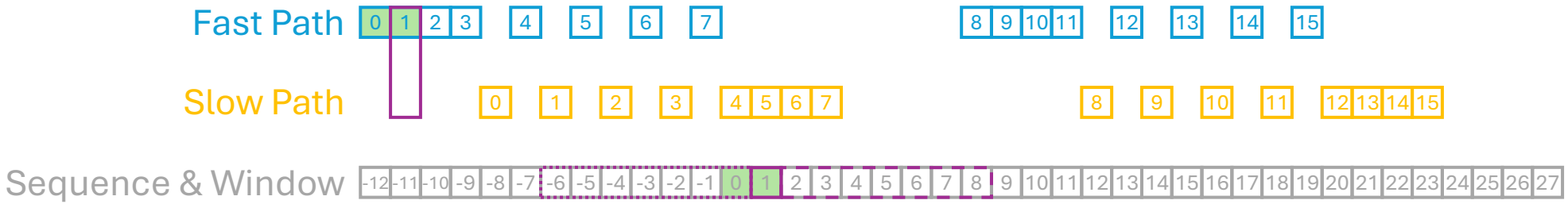
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 7

InvalidHistoryCount 7 means the highest 7 values of SequenceHistory, if 0, shouldn't be regarded as Lost Packets if shifted out of SequenceHistory.

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 1

SequenceHistory: 1 1 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 0

LostPackets: 0

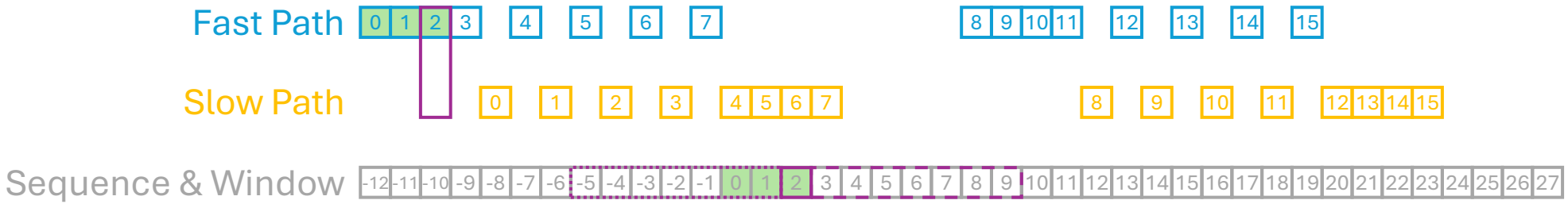
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

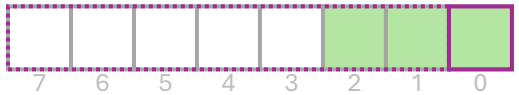
InvalidHistoryCount: 6

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

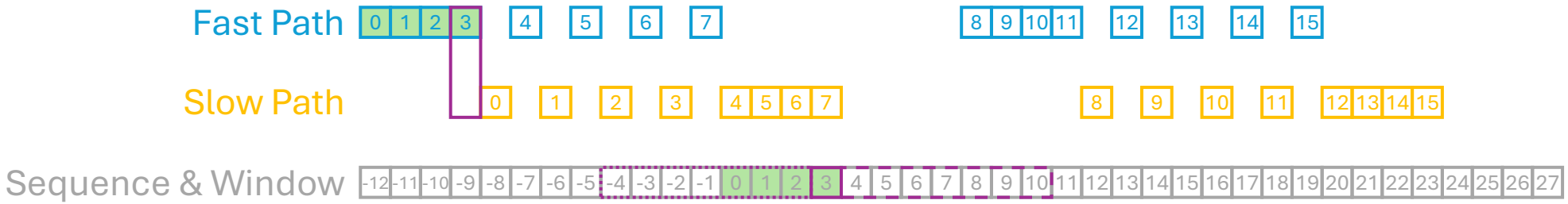
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

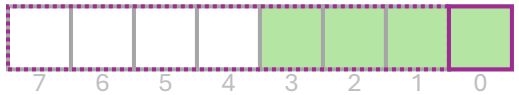
InvalidHistoryCount: 5

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 3

SequenceHistory: 1 1 1 1 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

OutOfOrderPackets: 0

LostPackets: 0

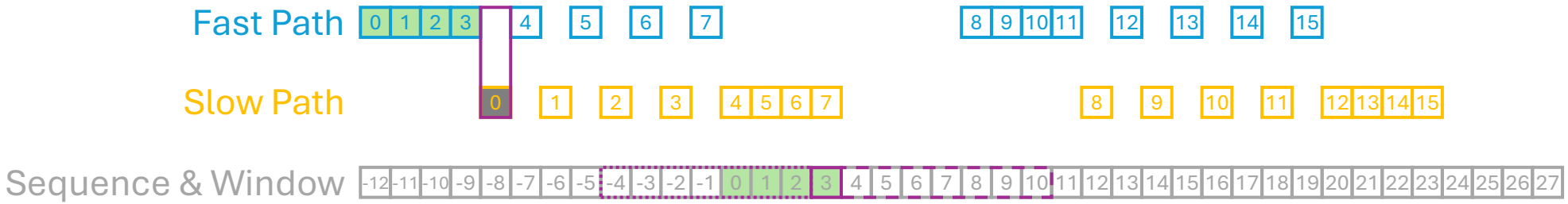
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

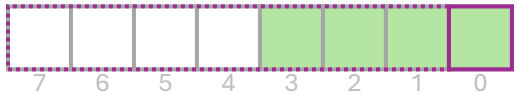
InvalidHistoryCount: 4

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 3

SequenceHistory: 1 1 1 1 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

OutOfOrderPackets: 0

LostPackets: 0

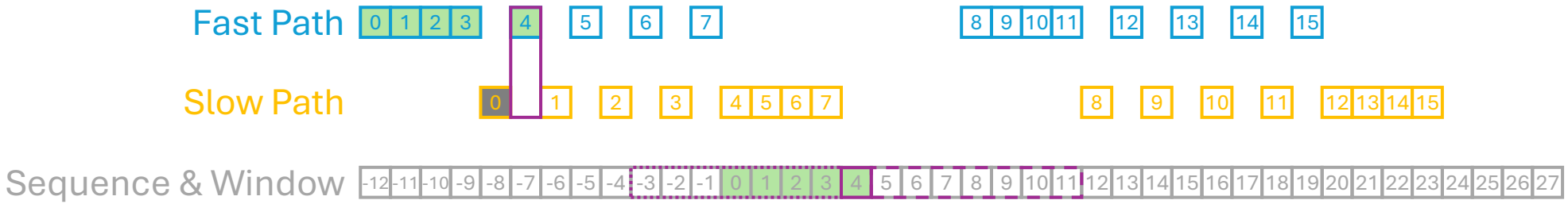
DiscardedPackets: 1

RoguePackets: 0

SequenceHistoryInit: TRUE

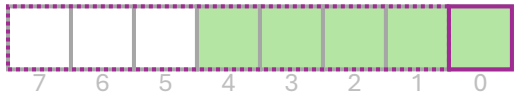
InvalidHistoryCount: 4

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 4

SequenceHistory: 1 1 1 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

OutOfOrderPackets: 0

LostPackets: 0

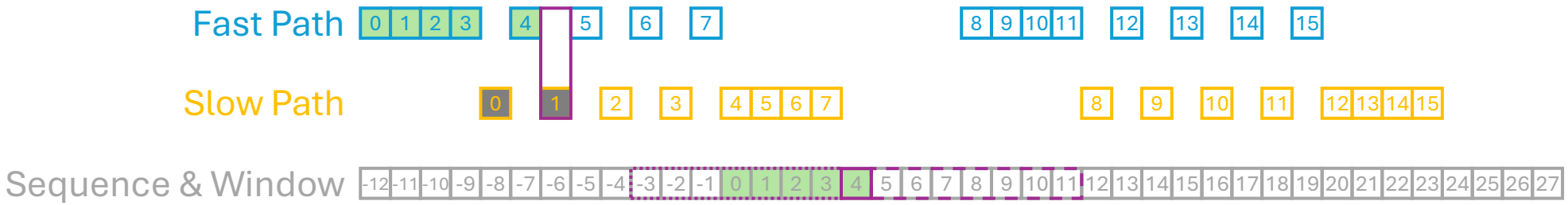
DiscardedPackets: 1

RoguePackets: 0

SequenceHistoryInit: TRUE

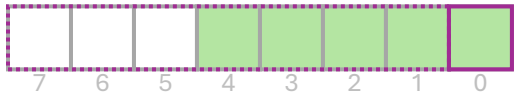
InvalidHistoryCount: 3

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 4

SequenceHistory: 1 1 1 1 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

OutOfOrderPackets: 0

LostPackets: 0

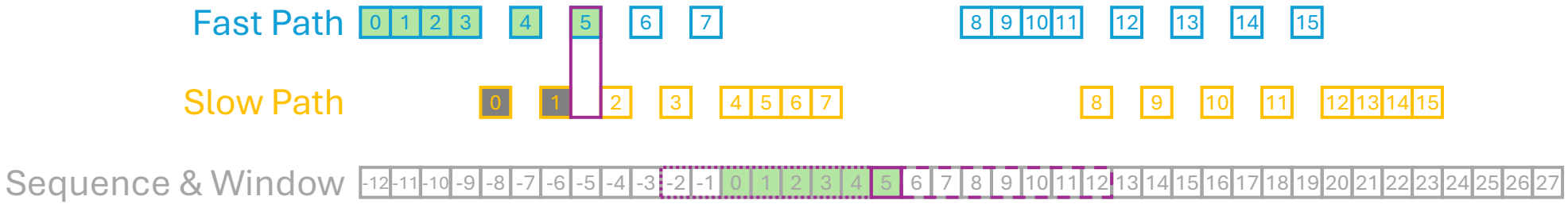
DiscardedPackets: 2

RoguePackets: 0

SequenceHistoryInit: TRUE

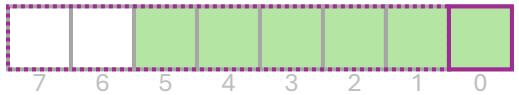
InvalidHistoryCount: 3

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 5

SequenceHistory: 1 1 1 1 1 1 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 6

OutOfOrderPackets: 0

LostPackets: 0

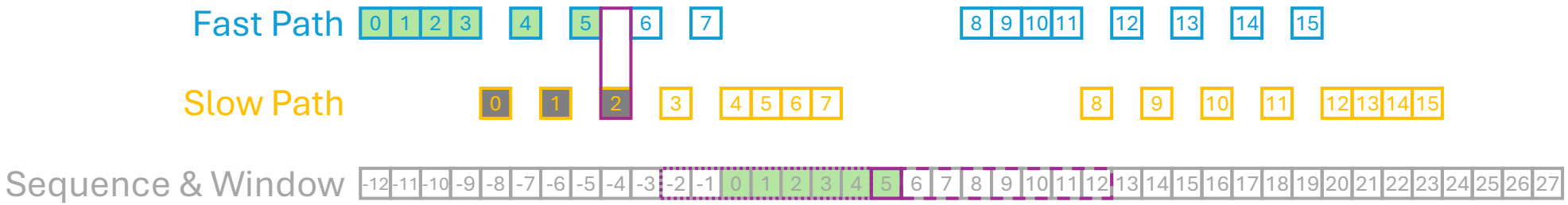
DiscardedPackets: 2

RoguePackets: 0

SequenceHistoryInit: TRUE

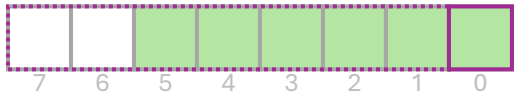
InvalidHistoryCount: 2

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 5

SequenceHistory: 1 1 1 1 1 1 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 6

OutOfOrderPackets: 0

LostPackets: 0

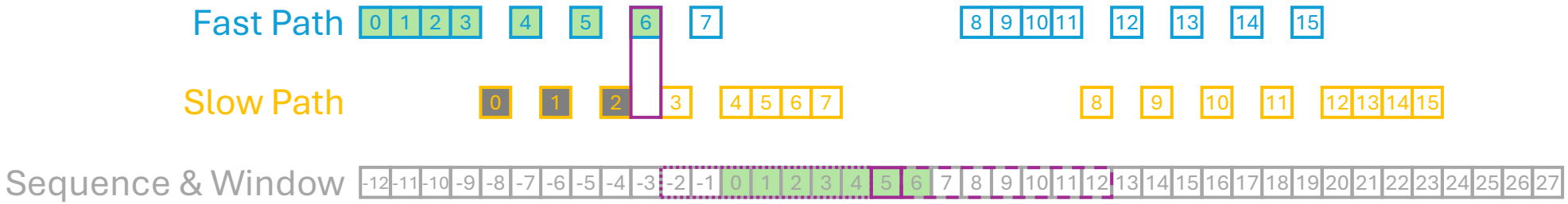
DiscardedPackets: 3

RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 2

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum 6

SequenceHistory 1 1 1 1 1 1 1 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 7

OutOfOrderPackets 0

LostPackets 0

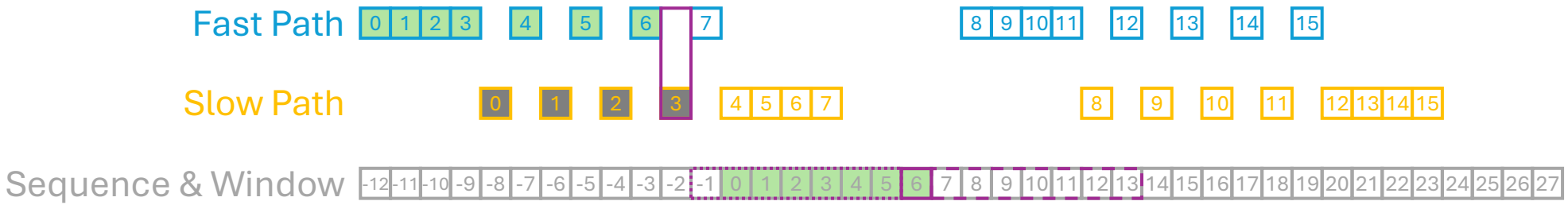
DiscardedPackets 3

RoguePackets 0

SequenceHistoryInit TRUE

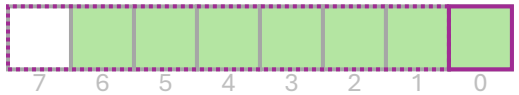
InvalidHistoryCount 1

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 6

SequenceHistory: 1 1 1 1 1 1 1 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 7

OutOfOrderPackets: 0

LostPackets: 0

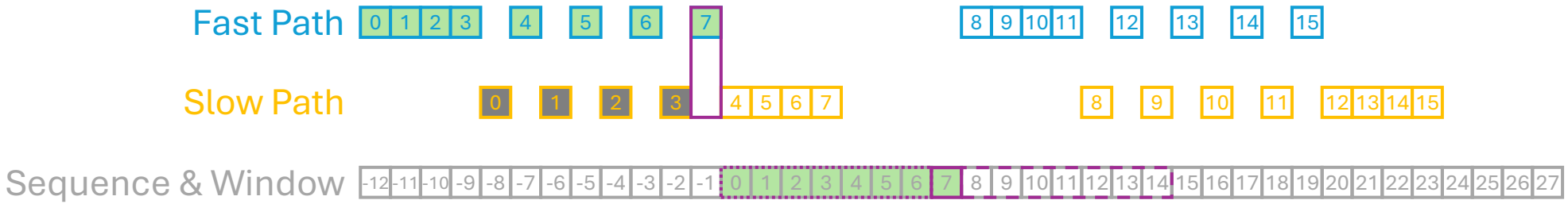
DiscardedPackets: 4

RoguePackets: 0

SequenceHistoryInit: TRUE

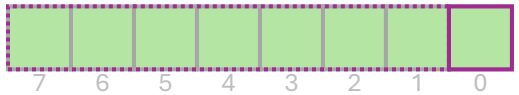
InvalidHistoryCount: 1

Proposed Algorithm – Erroneous Lost Packets?



RecovSeqNum: 6

SequenceHistory: 1 1 1 1 1 1 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 7

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 4

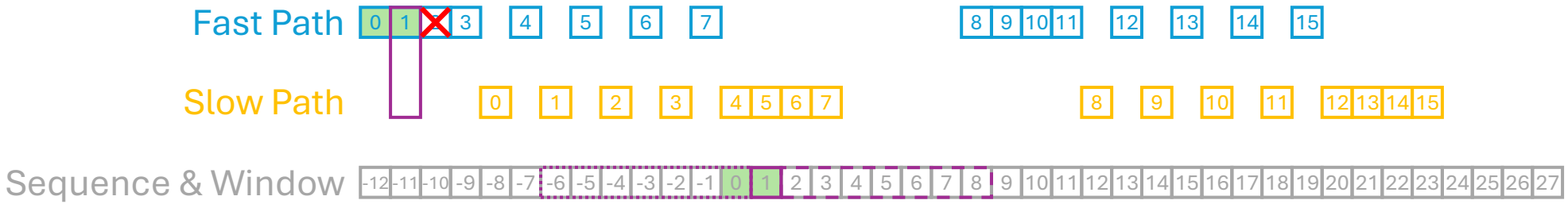
RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

InvalidHistoryCount 0 means SequenceHistoryInit is now FALSE and 0s shifted out of SequenceHistory are counted as Lost Packets.

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum: 1

SequenceHistory: 1 1 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 0

LostPackets: 0

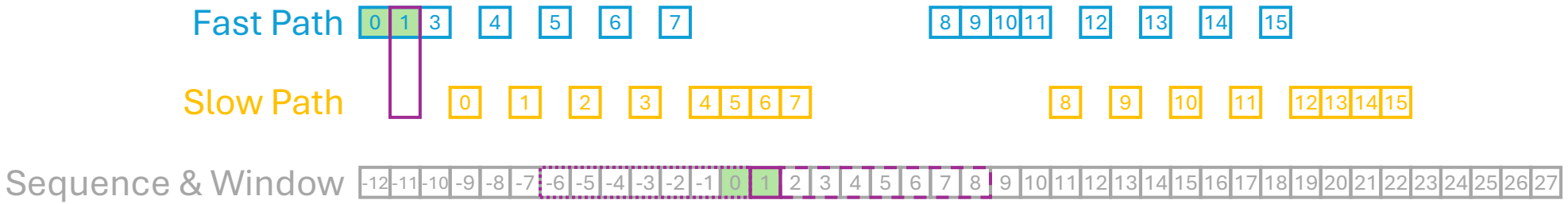
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

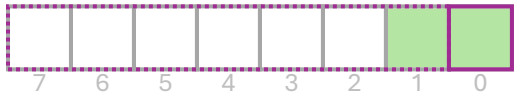
InvalidHistoryCount: 6

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum: 1

SequenceHistory: 1 1 0 0 0 0 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 0

LostPackets: 0

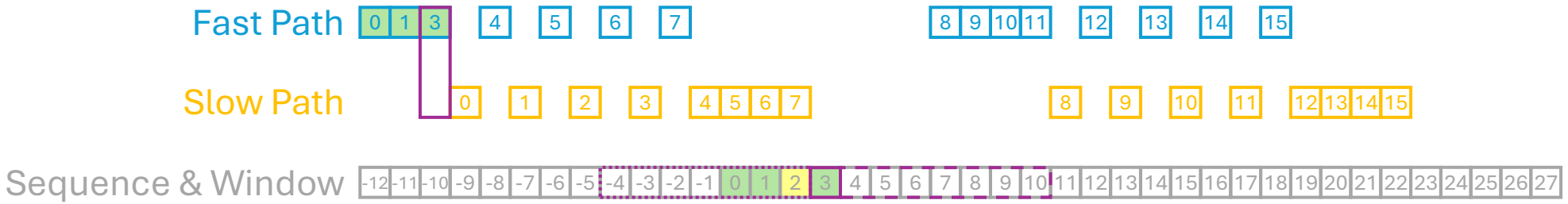
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

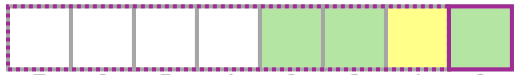
InvalidHistoryCount: 6

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum: 3

SequenceHistory: 1 0 1 1 0 0 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

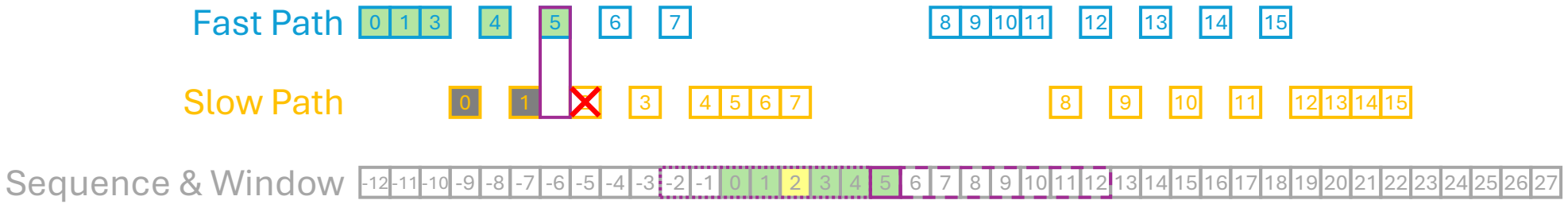
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 4

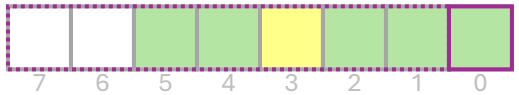
RecovSeqNum increased by 2, so InvalidHistoryCount decreased by 2. The 0 at position [1] in SequenceHistory has correctly tagged SeqNum 2 as not seen.

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum: 5

SequenceHistory: 1 1 1 0 1 1 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

OutOfOrderPackets: 0

LostPackets: 0

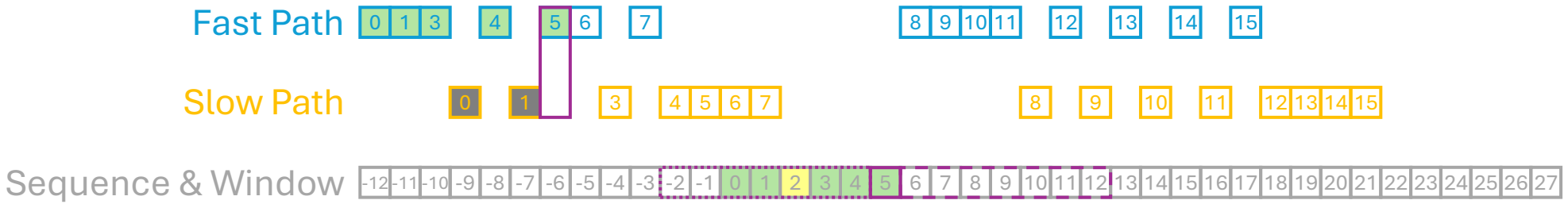
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

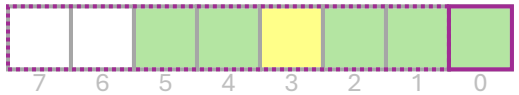
InvalidHistoryCount: 2

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum: 5

SequenceHistory: 1 1 1 0 1 1 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 5

OutOfOrderPackets: 0

LostPackets: 0

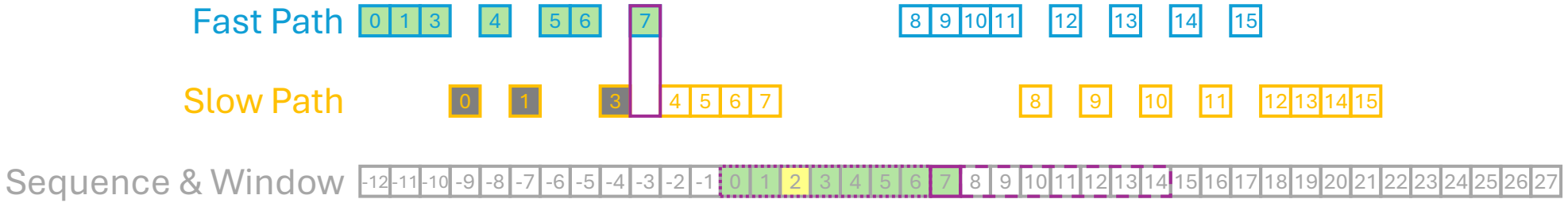
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

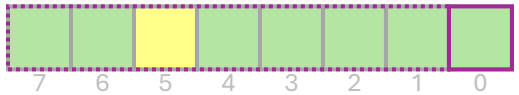
InvalidHistoryCount: 2

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 0 1 1 (0 1 2 3 4 5 6 7)



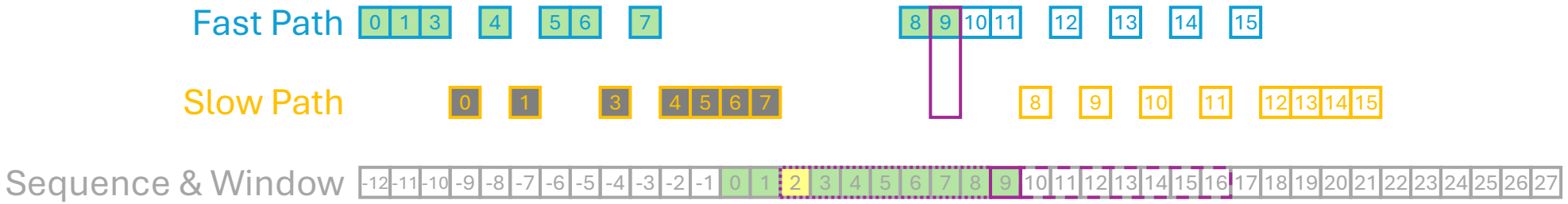
frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets	7	OutOfOrderPackets	0
DiscardedPackets	3	RoguePackets	0
SequenceHistoryInit	FALSE	InvalidHistoryCount	0

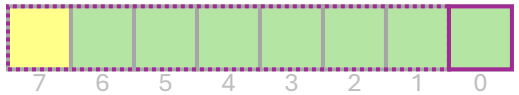
LostPackets: 0

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum: 9

SequenceHistory: 1 1 1 1 1 1 1 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 9

OutOfOrderPackets: 0

LostPackets: 0

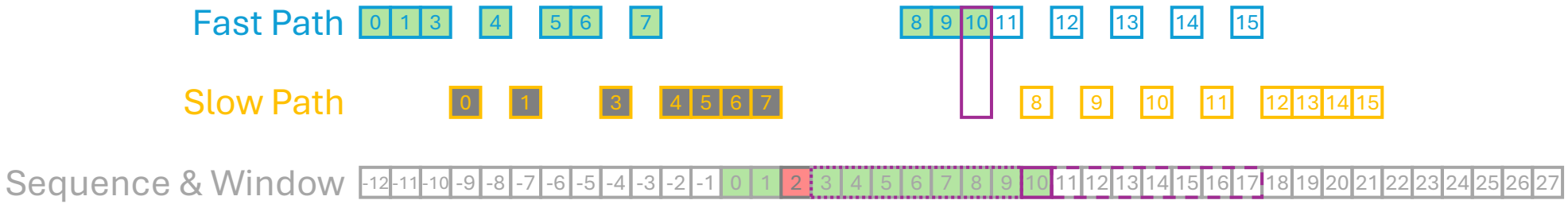
DiscardedPackets: 7

RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

Proposed Algorithm – Actual Lost Packets?



RecovSeqNum 9

SequenceHistory 1 1 1 1 1 1 1 1

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 9

OutOfOrderPackets 0

LostPackets 1

DiscardedPackets 7

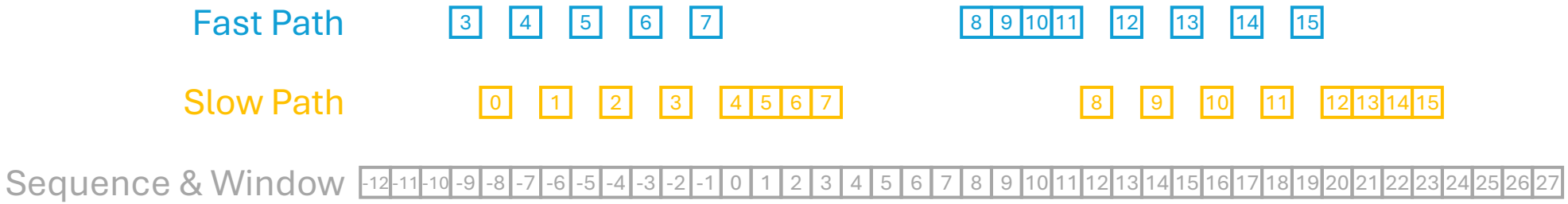
RoguePackets 0

SequenceHistoryInit FALSE

InvalidHistoryCount 0

Lost Packet is counted correctly.

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: -

SequenceHistory: 0 0 0 0 0 0 0 0 (0 1 2 3 4 5 6 7) | (7 6 5 4 3 2 1 0)

frerSeqRcvyHistoryLength = 8

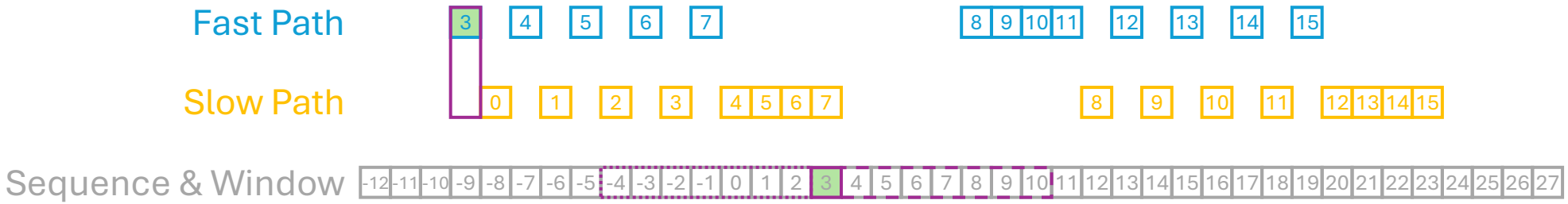
TakeAny: TRUE

PassedPackets: 0 | OutOfOrderPackets: 0 | LostPackets: 0

DiscardedPackets: 0 | RoguePackets: 0

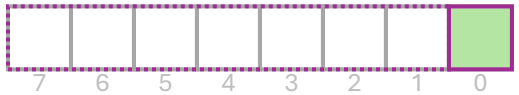
SequenceHistoryInit: FALSE | InvalidHistoryCount: 0

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 3

SequenceHistory: 1 0 0 0 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 1

OutOfOrderPackets: 0

LostPackets: 0

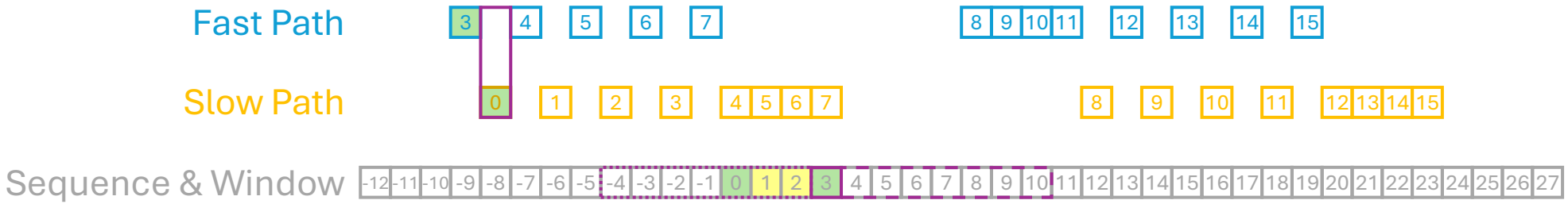
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

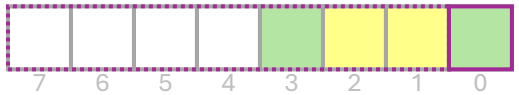
InvalidHistoryCount: 7

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 3

SequenceHistory: 1 0 0 1 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

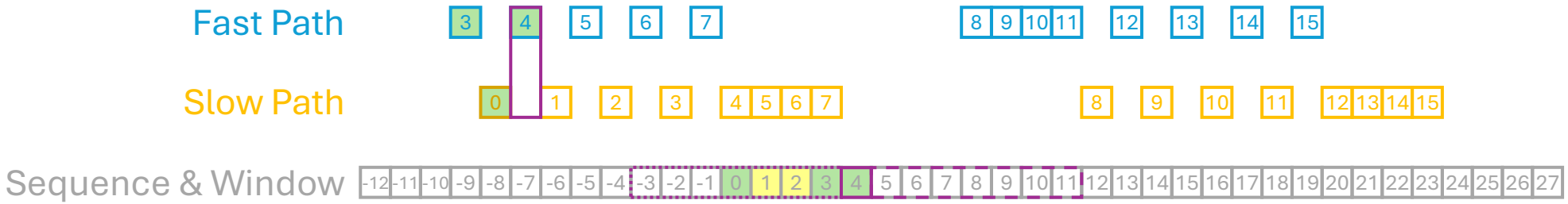
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

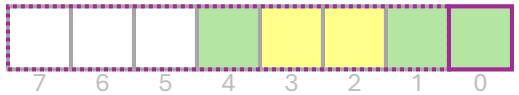
InvalidHistoryCount: 4

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 4

SequenceHistory: 1 1 0 0 1 0 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 3

OutOfOrderPackets: 1

LostPackets: 0

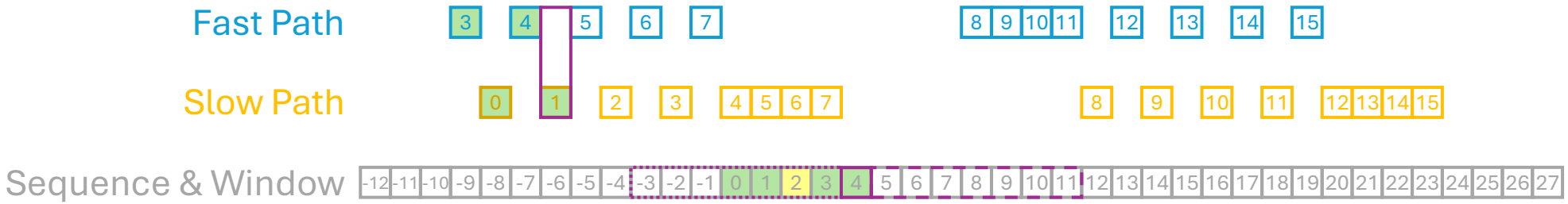
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

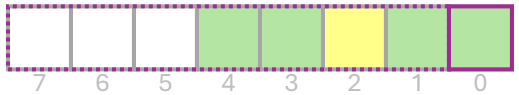
InvalidHistoryCount: 3

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 4

SequenceHistory: 1 1 0 1 1 0 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 4

OutOfOrderPackets: 2

LostPackets: 0

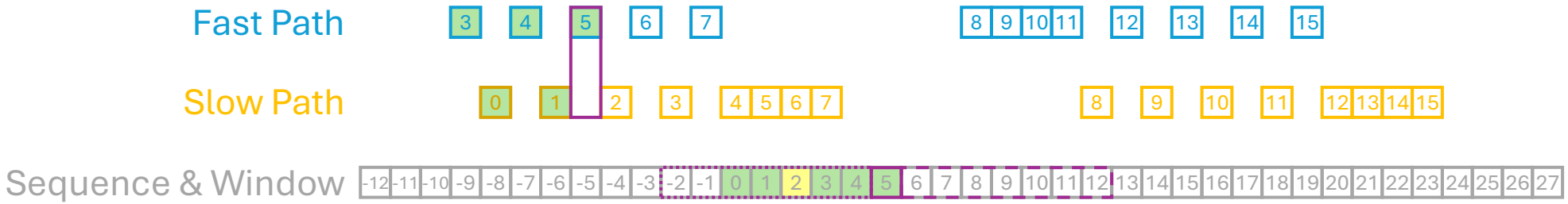
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

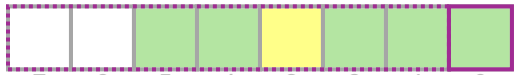
InvalidHistoryCount: 3

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 5

SequenceHistory: 1 1 1 0 1 1 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 5

OutOfOrderPackets: 2

LostPackets: 0

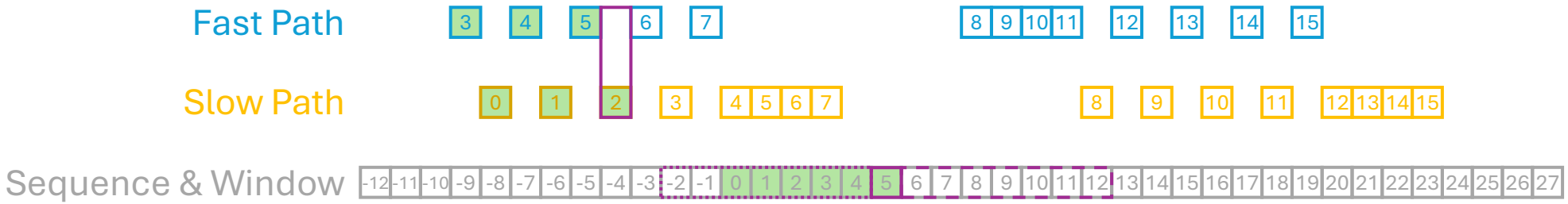
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 2

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum 5

SequenceHistory 1 1 1 1 1 1 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny TRUE

PassedPackets 6

OutOfOrderPackets 3

LostPackets 0

DiscardedPackets 0

RoguePackets 0

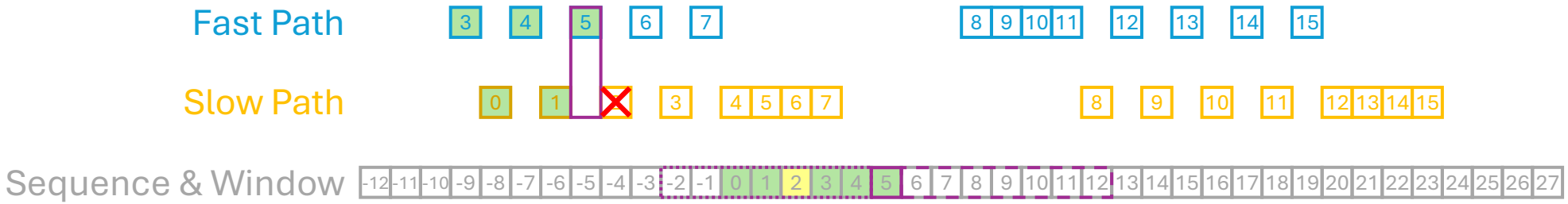
SequenceHistoryInit TRUE

InvalidHistoryCount 2

Packets are not Incorrectly Discarded.

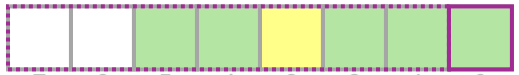
But…what if, say, Seq Num 2 was Lost?

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 5

SequenceHistory: 1 1 1 0 1 1 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 5

OutOfOrderPackets: 2

LostPackets: 0

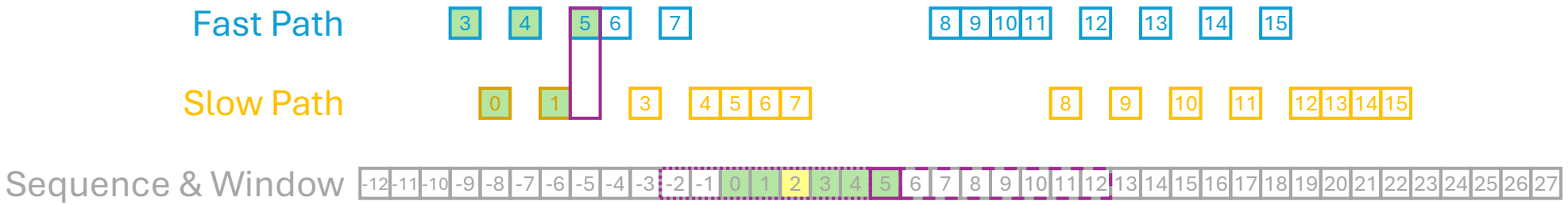
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

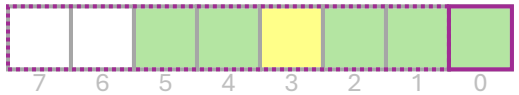
InvalidHistoryCount: 2

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 5

SequenceHistory: 1 1 1 0 1 1 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 5

OutOfOrderPackets: 2

LostPackets: 0

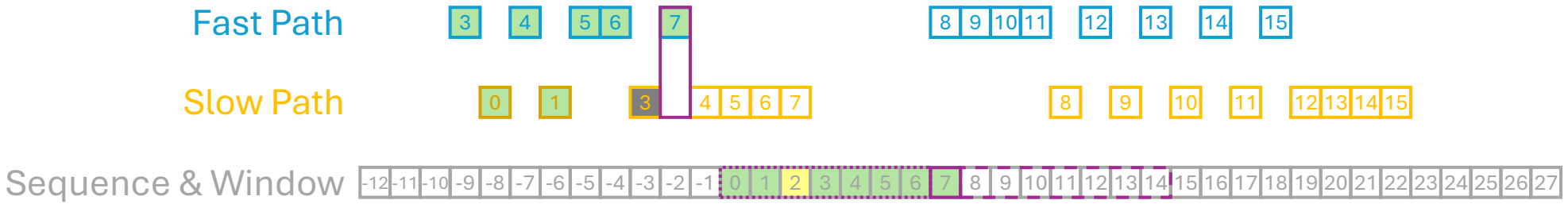
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

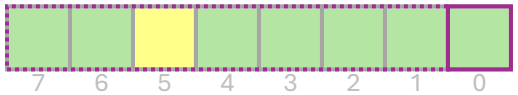
InvalidHistoryCount: 2

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 0 1 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 7

OutOfOrderPackets: 2

LostPackets: 0

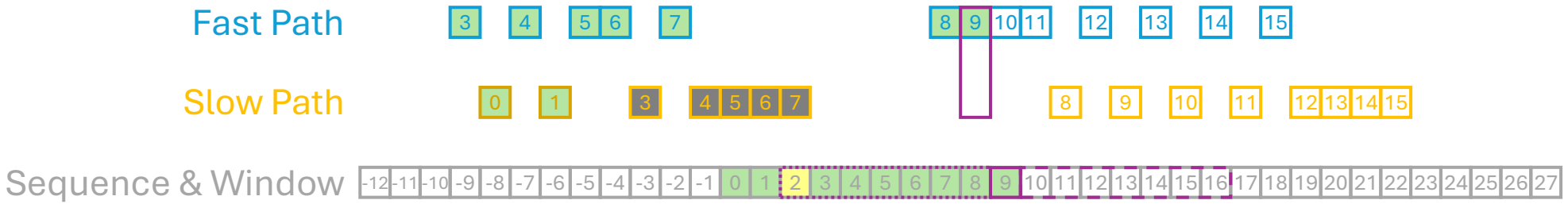
DiscardedPackets: 1

RoguePackets: 0

SequenceHistoryInit: FALSE

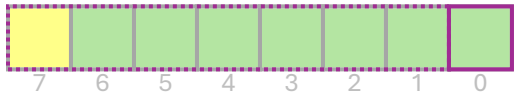
InvalidHistoryCount: 0

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 9

SequenceHistory: 1 1 1 1 1 1 1 0



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 9

OutOfOrderPackets: 2

LostPackets: 0

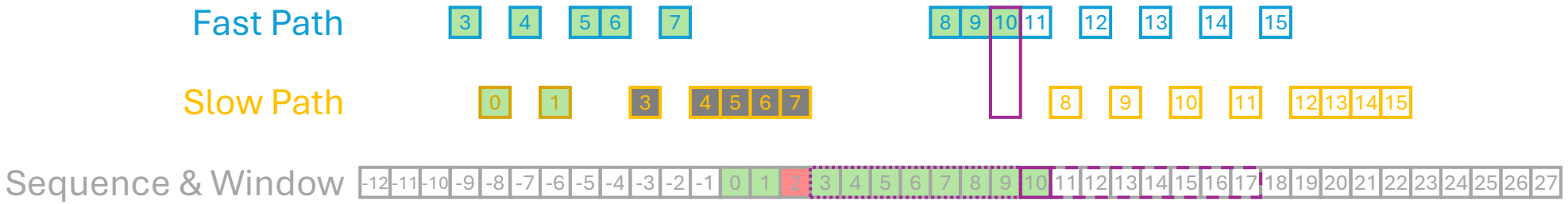
DiscardedPackets: 5

RoguePackets: 0

SequenceHistoryInit: FALSE

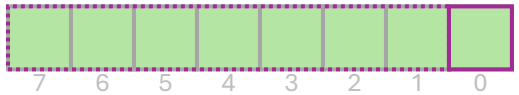
InvalidHistoryCount: 0

Proposed Algorithm – Incorrectly Discarded Packets?



RecovSeqNum: 7

SequenceHistory: 1 1 1 1 1 1 1 1



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 7

OutOfOrderPackets: 2

LostPackets: 0

DiscardedPackets: 5

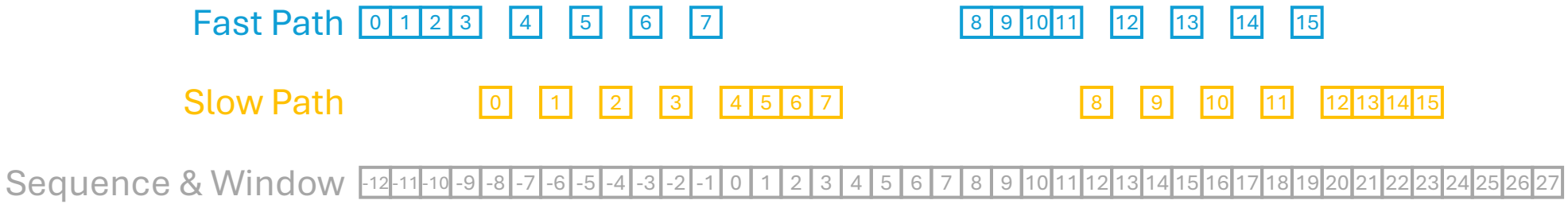
RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

Lost Packets are correctly flagged, even when out of order.

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum: -

SequenceHistory: 0 0 0 0 0 0 0 0 (0 1 2 3 4 5 6 7)

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 0

OutOfOrderPackets: 0

LostPackets: 0

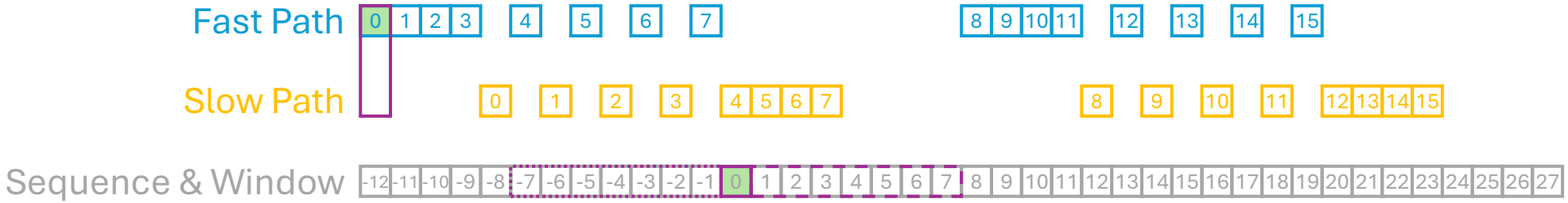
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum 0

SequenceHistory 1 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 1

OutOfOrderPackets 0

LostPackets 0

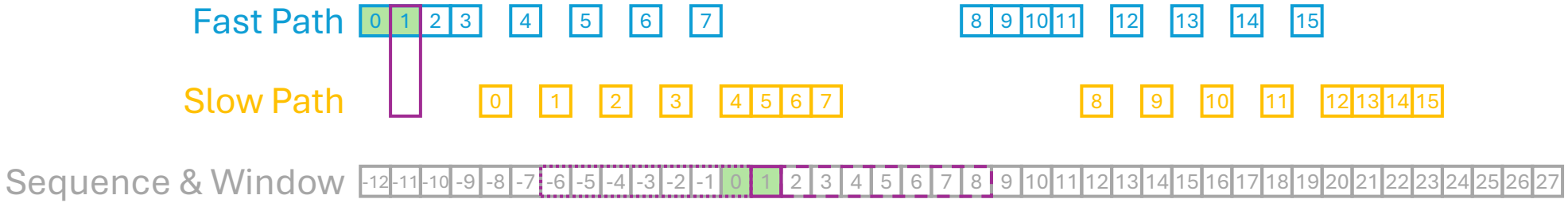
DiscardedPackets 0

RoguePackets 0

SequenceHistoryInit TRUE

InvalidHistoryCount 7

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum 1

SequenceHistory 1 1 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 2

OutOfOrderPackets 0

LostPackets 0

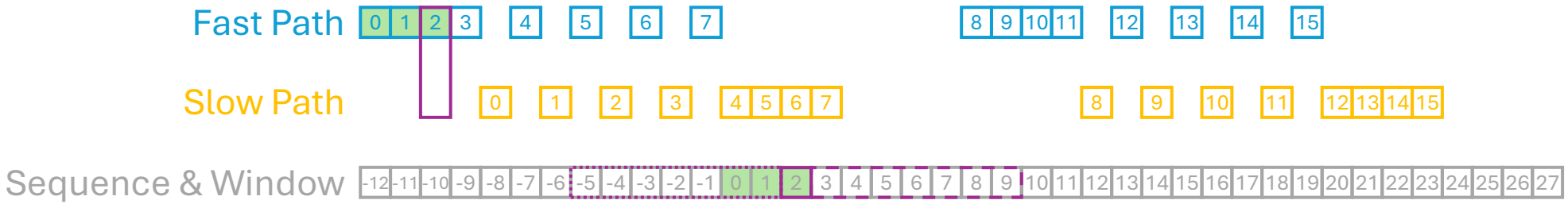
DiscardedPackets 0

RoguePackets 0

SequenceHistoryInit TRUE

InvalidHistoryCount 6

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

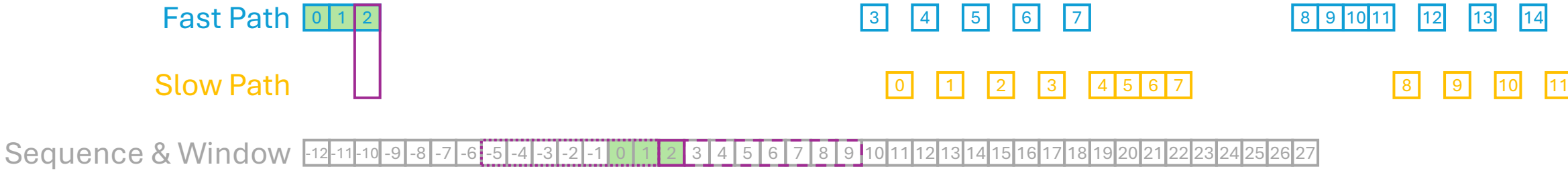
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

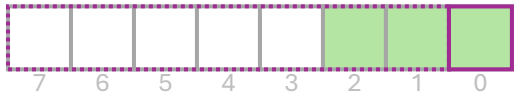
InvalidHistoryCount: 5

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

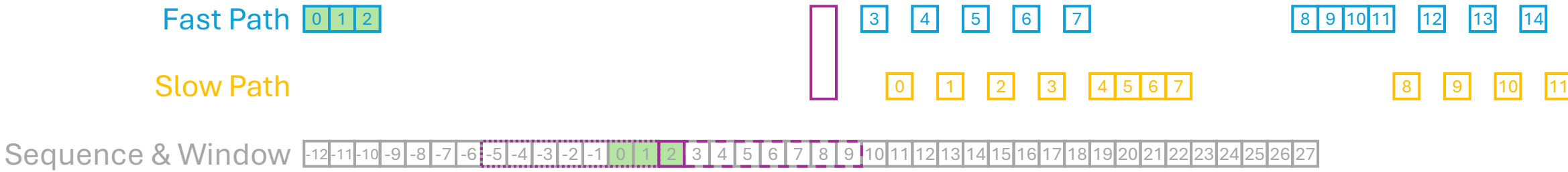
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

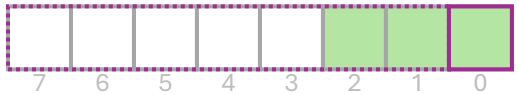
InvalidHistoryCount: 5

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

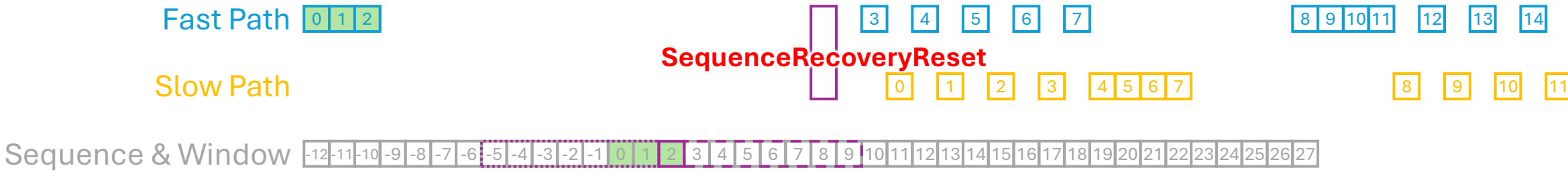
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 5

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum: 2

SequenceHistory: 1 1 1 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 3

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

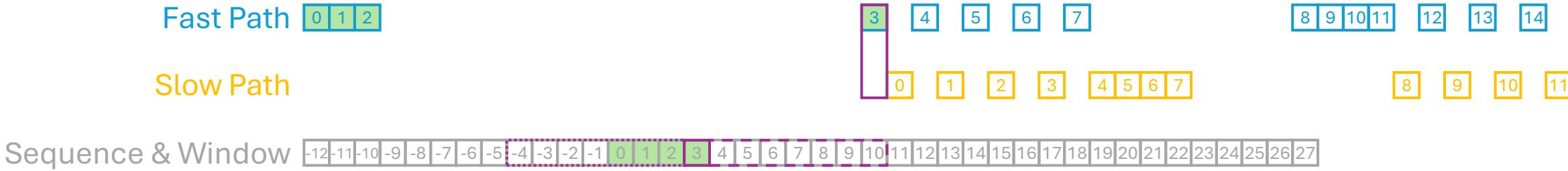
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 5

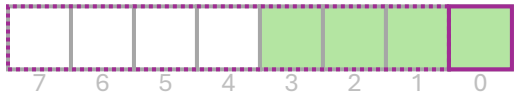
SequenceRecoveryReset only sets TakeAny to TRUE.
It does not (initially) change any of the other state information.

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum: 3

SequenceHistory: 1 1 1 1 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 0

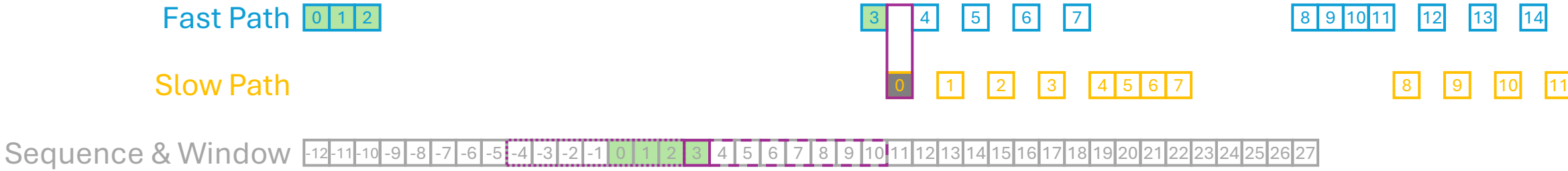
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 4

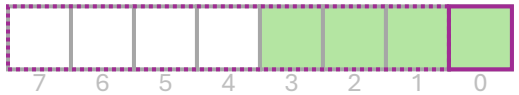
If packets have merely been delayed, the algorithm just picks up where it left off.

Proposed Algorithm – Reset Duplicate Packets?



RecovSeqNum: 3

SequenceHistory: 1 1 1 1 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 4

OutOfOrderPackets: 0

LostPackets: 0

DiscardedPackets: 1

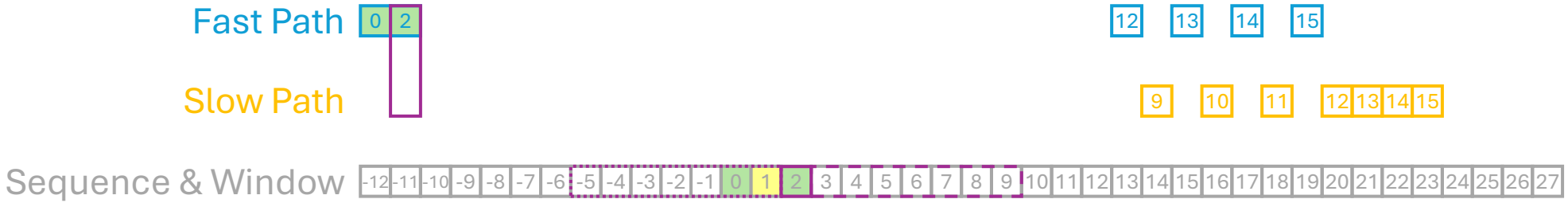
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 4

Packets are discarded correctly.
No duplicate packets are passed.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 1 0 1 0 0 0 0 0 (0 1 2 3 4 5 6 7)

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

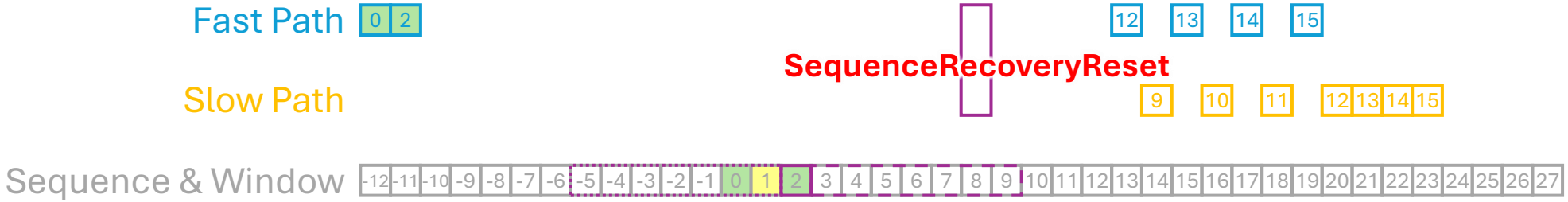
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

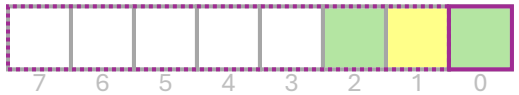
InvalidHistoryCount: 5

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 1 0 1 0 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

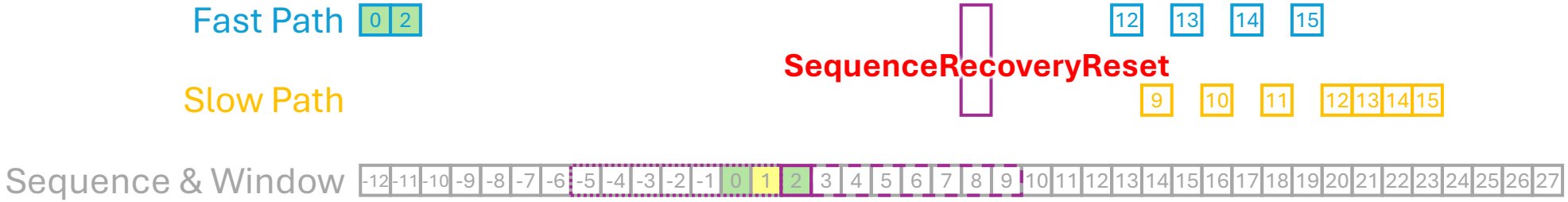
DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

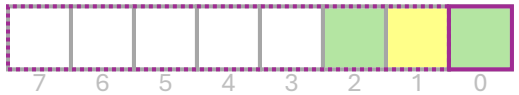
InvalidHistoryCount: 5

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 1 0 1 0 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: TRUE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

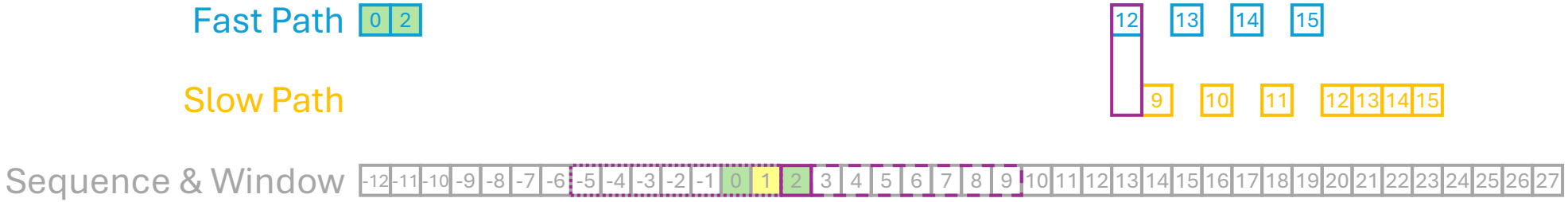
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 5

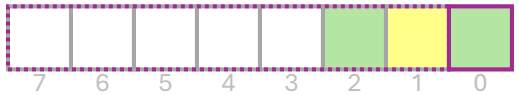
SequenceRecoveryReset only sets TakeAny to TRUE.
It does not (initially) change any of the other state information.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 1 0 1 0 0 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

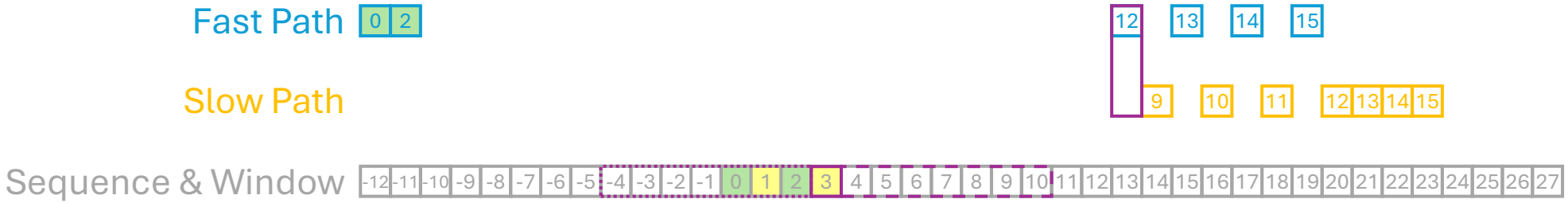
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 5

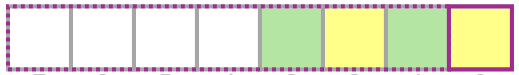
New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 0 1 0 1 0 0 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

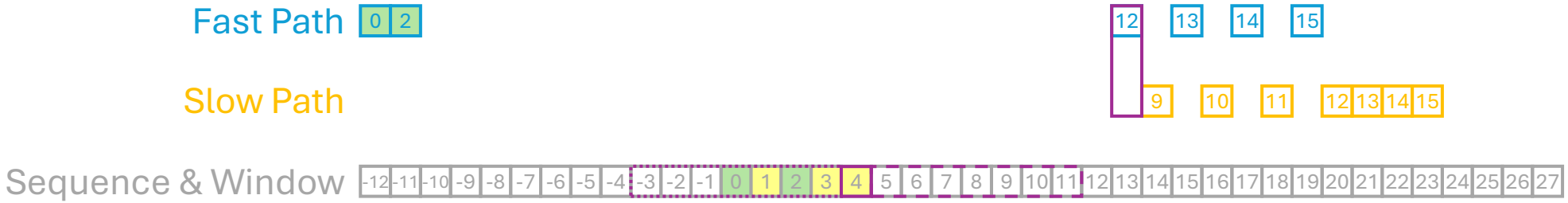
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 4

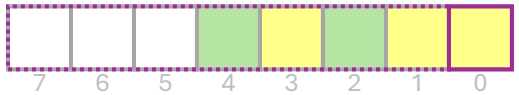
New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 0 0 1 0 1 0 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

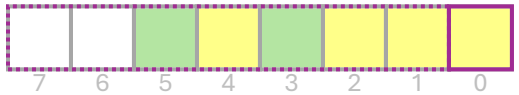
InvalidHistoryCount: 3

New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?

RecovSeqNum: 2

SequenceHistory: 0 0 0 1 0 1 0 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

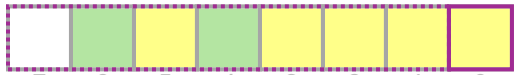
InvalidHistoryCount: 2

New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?

RecovSeqNum: 2

SequenceHistory: 0 0 0 0 1 0 1 0



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

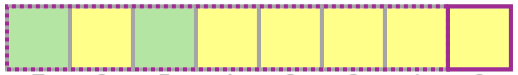
InvalidHistoryCount: 1

New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?

RecovSeqNum: 2

SequenceHistory: 0 0 0 0 0 1 0 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

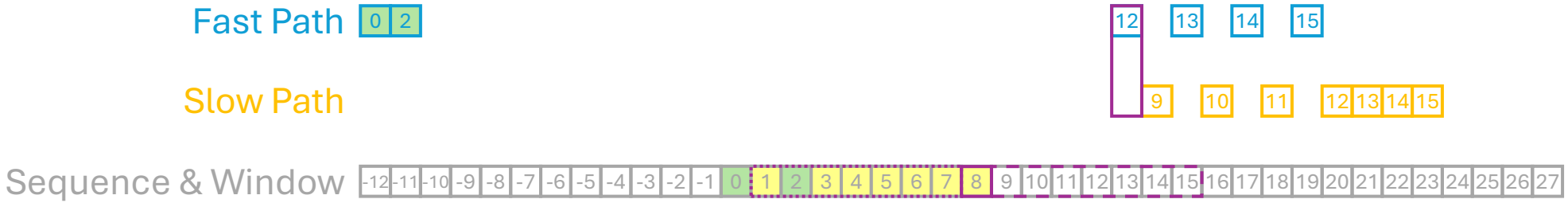
RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

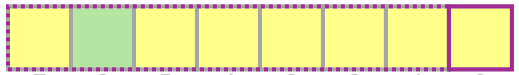
New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 0 0 0 0 0 0 1 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 0

DiscardedPackets: 0

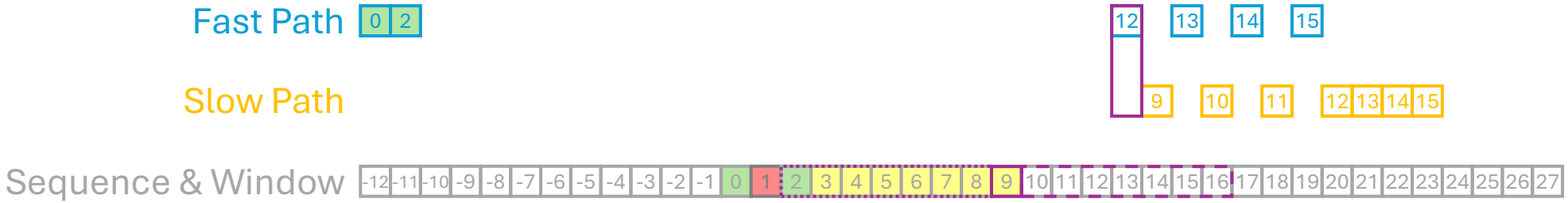
RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

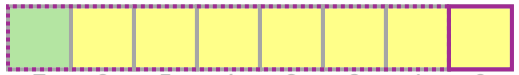
New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 0 0 0 0 0 0 0 1 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 1

DiscardedPackets: 0

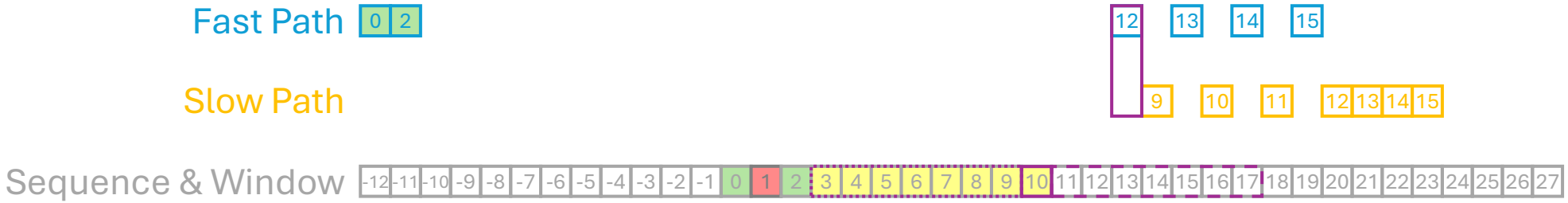
RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

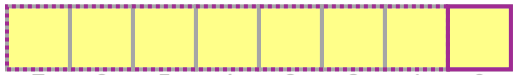
New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 0 0 0 0 0 0 0 0 (0 1 2 3 4 5 6 7)



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 2

OutOfOrderPackets: 1

LostPackets: 1

DiscardedPackets: 0

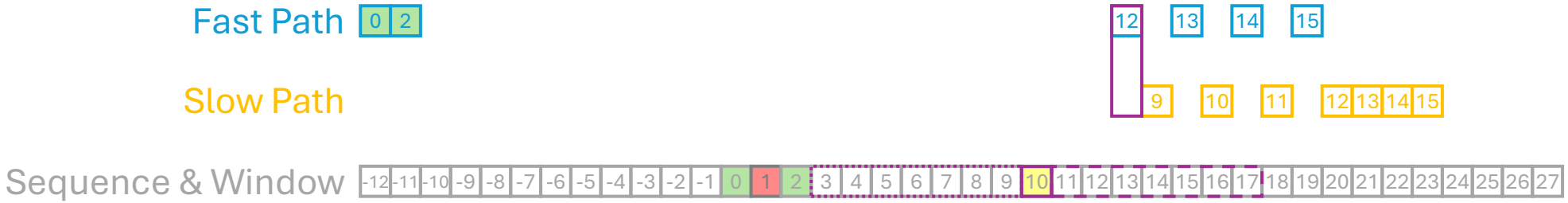
RoguePackets: 0

SequenceHistoryInit: FALSE

InvalidHistoryCount: 0

New RecovSeqNum is more than (frerSeqRcvyHistoryLength -1) ahead of the old RecovSeqNum, so SequenceHistory is shifted by frerSeqRcvyHistoryLength according to regular rules.

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum 2

SequenceHistory 0 0 0 0 0 0 0 0

0 1 2 3 4 5 6 7

7 6 5 4 3 2 1 0

frerSeqRcvyHistoryLength = 8

TakeAny FALSE

PassedPackets 2

OutOfOrderPackets 1

LostPackets 1

DiscardedPackets 0

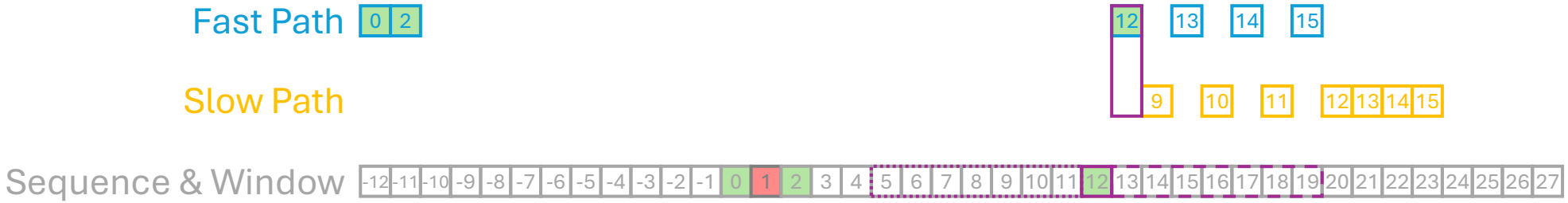
RoguePackets 0

SequenceHistoryInit TRUE

InvalidHistoryCount 7

Once processing of old SequenceHistory is complete, SequenceHistoryInit is set to TRUE and InvalidHistoryCount is set to (frereSeqRcvyHistoryLength -1)

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 0 0 0 0 0 0 0 1 (0 1 2 3 4 5 6 7)

frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 1

LostPackets: 1

DiscardedPackets: 0

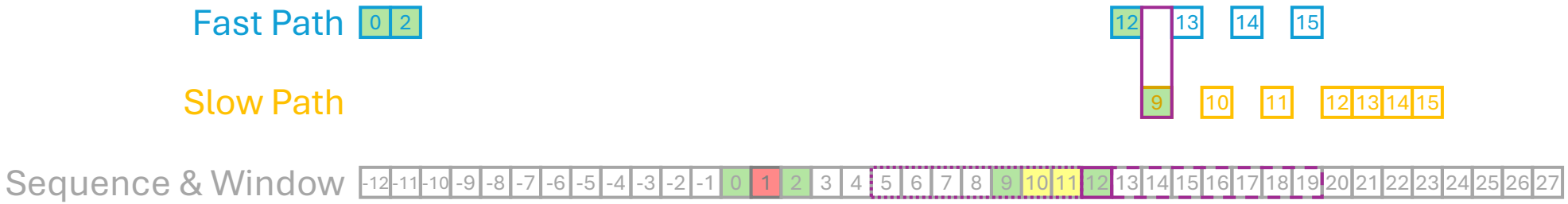
RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 7

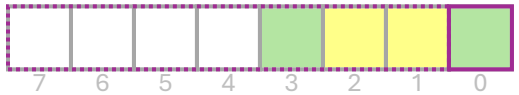
Finally, RecovSeqNum is set to incoming SeqNum and SequenceHistory[0] is set to 1

Proposed Algorithm – Reset Behaviour When Many Packets are Missed?



RecovSeqNum: 2

SequenceHistory: 0 0 0 0 1 0 0 1



frerSeqRcvyHistoryLength = 8

TakeAny: FALSE

PassedPackets: 3

OutOfOrderPackets: 1

LostPackets: 1

DiscardedPackets: 0

RoguePackets: 0

SequenceHistoryInit: TRUE

InvalidHistoryCount: 4

Summary

- Adding SequenceHistoryInit & InvalidHistoryCount solves the problem of Erroneous Lost Packets on reset.
- Two additional changes avoid allow use of an aggressive frerSeqRcvyResetMSec value without risking passing of duplicate packets.
  - Do not throw away SequenceHistory information until it’s confirmed that the next incoming sequence number is frerSeqRcvyHistoryLength or more ahead of current RecovSeqNum
  - Once it’s confirmed, process old SequenceHistory according to regular rules before advancing to new RecovSeqNum

Philosophy

- “The road to hell is paved with good intentions.”
  - Also, thoughts that “well, that would never happen.”
- Some of the scenarios “fixed” by the proposed algorithm are probably rare, but that doesn’t mean they won’t happen.
  - A robust algorithm will cope with rare situations.
- An aggressive frerSeqRcvyResetMSec value can be justified
  - See [2], Lisa Maile’s text contribution to 802.1CBec.
- Wireless networks can have higher latency variability, making the passing of duplicate packets more likely if the current algorithm is used.
  - See [3], Janos Fakas’ contribution on the issue of latency in wireless networks.

Merci.