

# Multipath extension for QUIC

## draft-ietf-quic-multipath-04

QUIC meeting @ IETF-116 Yokohama  
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## Diff from -03 to -04

Several modifications:

- Remove the use of a single packet number space on multiple paths as a fully supported option (PR#149 / #163)
- Remove Path Identifier and Path Identifier Type (PR #185/#156)
- Remove Packet number space ID (PR#167)
- Clarify path usage for PATH\_ABANDON frame (PR#174)
- Add editorial passes and explanation for packet number spaces and connection IDs used for paths (PR#161 / #187)
- Update scheduling guidances (PR#192)

Additional editorial modifications such as updates about figure of path closure examples, etc.. (see diff:

<https://author-tools.ietf.org/iddiff?url2=draft-ietf-quic-multipath-04>)

## Merged PR [#149](#) (Removed the use of spns)

- Consensus from IETF 115.
- Remove the use of a single packet number space on multiple paths as a fully supported option.
- Multipath extension requires the use of non-zero Connection IDs in both directions.
- Update IANA table for enable\_multipath transport parameter (current version 0x0f739bbc1b666d04).

Also check two technical reports on this issue:

Yingqi Tang, Yunfei Ma, and Yanmei Liu, Technical Report: Implementation of Single Packet Number Space in Multi-Path QUIC, <https://arxiv.org/abs/2210.13663>

Quentin De Coninck, The packet number space debate in multipath QUIC, <https://dl.acm.org/doi/abs/10.1145/3561954.3561956>

# Remove mentions of the "Path Identifier" [#185](#)

- The notion of Path ID could lead to confusions:
  - (1) Attempt to use a constant Path ID. E.g., does the Path ID change if the CID changes or not? Issue [#169](#).
  - (2) Attempt to rely on 4-tuple (the definition of a path) for identification purpose. E.g., Regular ACK frames when multipath has been negotiated. Issue [#181](#).
- In essence, a loose path ID model (more discussions later).

# Stable path ID vs. a loose path ID model?

## Stable path ID

Pros.: simplify our mental model.

Cons.: (1) 4-tuple is volatile. (2) How to differentiate NAT rebinding, genuine path migration, and opening a new path?

E.g., what if CID rotation and NAT rebinding happen at the same time?

## Loose path ID model (Use DCID sequence number for identification)

Pros.: (1) no problems in handling NAT rebinding, path migration, and opening new path. (2) no ambiguity when PNS changes.

Cons.: (1) path ID is not stable. (2) may not be intuitive at first glance.

## Error code for missing CID during handshake [#157](#)

If an `enable_multipath` parameter set to 1 is received **and** the carrying packet does not contain a non-zero length connection ID, the receiver **MUST** treat this as a connection error of type `TRANSPORT_PARAMETER_ERROR` and close the connection." ?

## Alternative status values in PATH\_STATUS [#186](#)

The draft currently defines two possible values in the PATH\_STATUS frame (i.e., Standby and Available).

Two questions:

1. Do we want to introduce alternative values?
2. What should a receiver behave when receiving an alternative value?

## ACK\_MP can be received on any path [#190](#)

The current text says that "ACK\_MP frame (defined in {{ack-mp-frame}}) SHOULD be sent on (the same) path." The motivation is to ease RTT estimation and loss recovery.

Questions:

1. Should we encourage returning ACK\_MP from any paths?
2. What is a simple and effective algorithm for RTT estimations?



Discuss what to do if path\_status is detected as lost or needs to be resent otherwise [#200](#)?

Path\_status is identified by CID sequence number, which leaves several questions:

1. Do we need to update path\_status when the CID is changed? Or we don't bother sending a new path\_status as we assume the state is the same as before?
2. Should path\_status frame hold information for multiple CIDs?
3. Should path\_status frame hold information for future CIDs?

## PATH\_SETUP frame [#180](#)

Current draft use mechanisms from QUICv1 to setup new path. Do we want to have a separate Path\_Setup frame?

Would require path identifier (But authors agree to remove explicit Path ID in the current draft ).

Deviates from design requirement to just align with path creation in RFC 9000.

Probably not necessary.

Can use path\_setup to signal path status and path parameters. (some overlapping functionality with path\_status frame)

## Next step

- IANA Registration for Transport parameter, Frame Types and Error Code
- Finalize discussion on remaining open issues
- More implementation experience is still desired