Spencer Dawkins

Mini-agenda

- **“If you don’t have multipath, are you even a transport protocol?”**
- RFC 9049 meets “Multipath Extension for QUIC”
- What Spencer thinks we could be looking at, in PANRG
- What Smarter People think we could be looking at, in PANRG

Multipath takes over the Internet? The IETF? TSV?

- SCTP Experimenting with Load Sharing since 2010
- We've had Multipath TCP as an Experimental RFC since 2013
- TSVWG adopted Multipath DCCP at IETF 111
- QUIC hummed to adopt Multipath QUIC yesterday (checking on list)

Becoming more common
More deployable
More ambitious

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“Unifying the Multipath extensions”

- Multipath Extension for QUIC submitted before IETF 112
  - Roughly the intersection of three individual drafts
- Presented at IETF 112 QUIC session
- Focus on core components
  - Negotiation
  - Path management
  - Basic scheduling
  - Packet transmission/retransmission

The draft authors are the experts - this is my summary

Design Principles

- Reuse as much as possible from RFC 9000
- Path defined as a bidirectional 4-tuple
- Replace path “migration” by path “simultaneous use”
- Add signaling for removal of abandoned paths
- New transport parameter during handshake negotiation (enable_multipath)
- Two new frames (PATH_ABANDON and ACK_MP)
- One remaining decision - One or Multiple Packet Number Space?

The draft authors are the experts - this is my summary

Remember RFC 9049 Lessons Learned? 😎

Lesson	Category
Justifying Deployment (Section 4.1)	Invariant
Providing Benefits for Early Adopters (Section 4.2)	Invariant
Providing Benefits during Partial Deployment (Section 4.3)	Invariant
Outperforming End-to-End Protocol Mechanisms (Section 4.4)	Variable
Paying for Path Aware Techniques (Section 4.5)	Invariant
Impact on Operational Practices (Section 4.6)	Invariant
Per-Connection State (Section 4.7)	Variable
Keeping Traffic on Fast Paths (Section 4.8)	Variable
Endpoints Trusting Intermediate Nodes (Section 4.9)	Not Now
Intermediate Nodes Trusting Endpoints (Section 4.10)	Not Now
Reacting to Distant Signals (Section 4.11)	Variable
Support in Endpoint Protocol Stacks (Section 4.12)	Variable
Planning for Failure (Section 4.13)	Invariant

Table 1

How Multipath QUIC looks in RFC 9049 (1)

Lesson	Is Spencer concerned (yet)?
Justifying Deployment	Depends on path selection strategy
Benefits for Early Adopters	Adoption decision is at endpoints
Benefits during Partial Deployment	Only endpoints must be upgraded to deploy Multipath QUIC
Outperforming End-to-End Protocol	Signals used by QUIC, including Multipath QUIC, are E2E
Paying for Path Aware Techniques	Extensions to RFC 9000 are encrypted - not in invariant fields
Impact on Operational Practices	Minimal - QLOG may need to be enhanced for multipath
Per-Connection State	All connection state is in endpoints

No Problem Think First Big Problem

How Multipath QUIC looks in RFC 9049 (2)

Lesson	Is Spencer concerned (yet)?
Keeping Traffic on Fast Paths	No impact on any IP header field/extension header field
Endpoints Trusting Midpoints	Additions to RFC 9000 are encrypted - not in invariant fields
Midpoints Trusting Endpoints	Additions to RFC 9000 are encrypted - not in invariant fields
Reacting to Distant Signals	Signals used by QUIC, including Multipath QUIC, are E2E
Support in Endpoint Stacks	Potential user space stack but scheduling is work in progress
Planning for Failure	Rich QUIC versioning but need to recognize dysfunction

No Problem Think First Big Problem

How Multipath QUIC looks to Spencer

- Really good (especially for a -00 individual draft!)
  - Out of 13 “lessons learned”, 1 + ½ + ½ are worth thinking about
  - Neither of the “trust” lessons are relevant - they are big problems
- “Justifying Deployment” does depend on path selection strategy
  - Bandwidth aggregation more motivating than some others
  - Redundancy might work just as well under application control
- “Support in Endpoint Stacks” depends on “advanced scheduling”
  - If “advanced scheduling” isn’t advanced enough, your app has to do it
- “Planning for Failure” depends on knowing when to discard paths

We should pause for a moment of appreciation

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The Multipath Landscape

- Becoming more common - increasing number of multipath transports
- More deployable - multipath protocols in user space stacks
- More ambitious - not just active/standby or load sharing
- Multipath work in protocol groups (and that's a good thing)
- Opportunity for common approaches to multipath problems
  - Identifying path failures, address discovery, etc.
- For some problems, that may happen in the IETF
- For other problems, that could happen in PANRG
  - **Selecting paths for packets** versus **selecting paths to achieve a goal**

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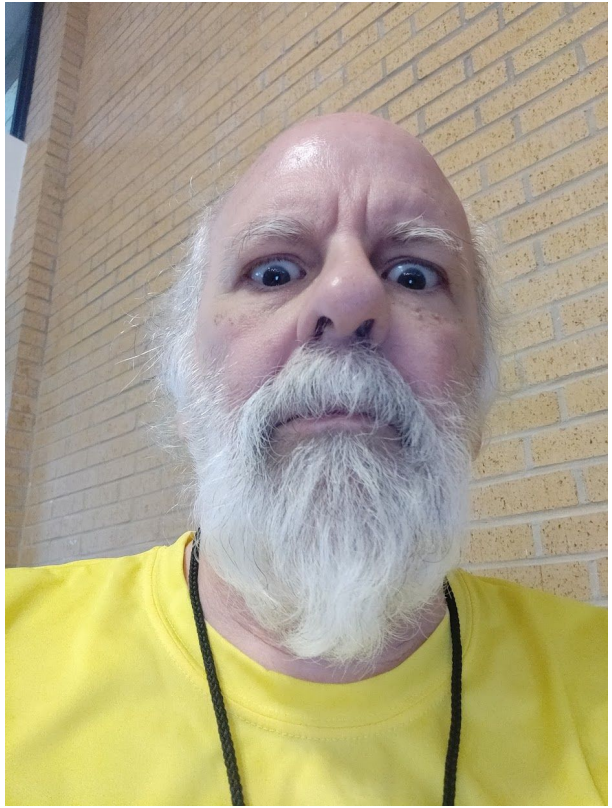
So, what am I missing?

This is your time to … have thoughts.



Found something new to say when I leave a room.

Thank you all!

And please,
Make Good Choices