Multipath Transports at Apple
Siri

Goal

• Minimize latency
• Reduce network errors

Traffic & Environment

• Thin bi-directional stream
• Frequently used in mobile scenarios
Siri

Path Management

• Immediate TCP sub-flows on both Wi-Fi and Cell
  - Enables immediate use of a path
  - Provides initial RTT measurements

Scheduling

• “Interactive Mode” [1]

• Continuous evaluation of path characteristics (RTT & packet-loss)

• Per-packet scheduling on most optimal path
  - RTT-based with threshold
  - Adapts if retransmission timeout is too large
  - Loss-based on retransmission timeout

Siri

QUIC Requirements

• Continuous measurement of path quality
• Ability to rapidly switch between paths
  - Wireless quality changes drastically in short time-frames
  - E.g., lossy low-latency Wi-Fi combined with high-latency cellular
Apple Music

Goal
• Reduce playback stalls
• Reduce stall duration

Traffic & Environment
• Uni-directional bulk-data transfer (entire song)
• Playback buffer “hides” most networking issues
Apple Music

Path Management

• Enable cellular subflow only when really necessary
  - Keeps cellular data usage at strict minimum

Scheduling

• Schedule aggressively on both paths [1]
  - Resource Pooling to aggregate path capacities
  - When cellular is brought up, we need data as fast as possible to avoid the stall

Apple Music

QUIC Requirements

• Deliver data as fast as possible to the client
• Minimize cellular data usage