Client-Server Explicit Performance Measurements

draft-cfb-ippm-spinbit-measurements-02

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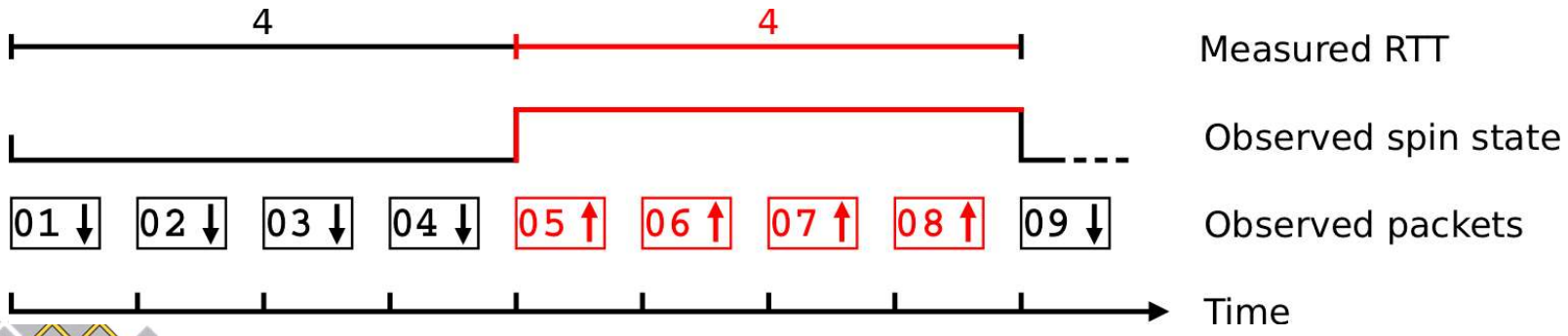
Explicit Performance Monitoring (EPM)

- Explicit Performance Monitoring (EPM) enables a passive Observer (probe) to measure delay and packet loss only watching the marking (a few bits) of production traffic packets (it works on client-server protocols: QUIC, TCP, ...)

- EPM metrics described in this draft:
  - **Precise RTT**: Spin bit + Delay bit (**D-bit**):
  - **Round Trip Packet Loss**: Packet Loss bit (**PL-bit)**
  - **OW Packet Loss**: sQuare bit (**Q-bit**) + Reflection sq. bit (**R-bit**)

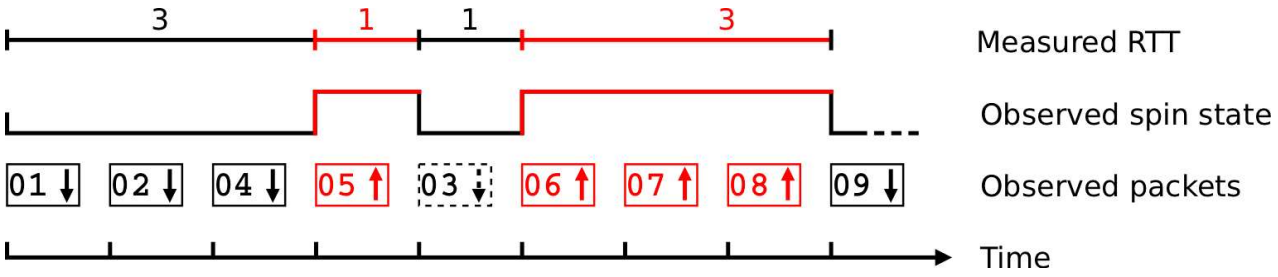
Round Trip Time: Spin bit

- Spin bit for RTT measurement was the first case of Explicit PM.
- It's implemented, optionally, in QUIC protocol (https://www.ietfjournal.org/enabling-internet-measurement-with-the-quic-spin-bit/)
- The spinbit idea is to create a square wave signal on the data flow, using a bit, whose length is equal to RTT.
- An observer in the middle (wherever is located) can measure the end-to-end RTT only watching the spinbit.



Spin bit limitations

- Packet loss will tend to cause wrong estimates of RTT due to period width changes.
- Reordering of a spin edge will cause drastic underestimates of RTT since it will cause multiple edges to be observed per RTT. So we need an extra instrument to correctly recognize periods, eluding overlapping.



- “Holes” in the traffic flow can introduce delay in the edge reflection.

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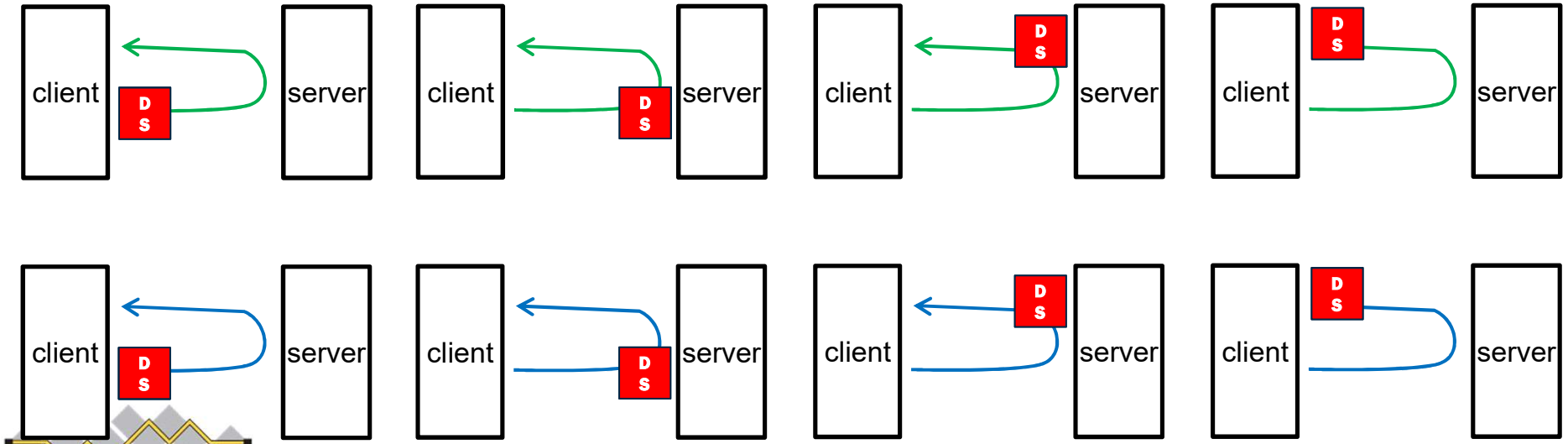
Precise RTT: Delay bit

- The idea is to have a single packet, with a second marked bit, called «Delay Bit», that bounces between client and server. This is the Delay Sample (DS).
- Only one Delay Sample «inside» each Spin Bit period (created by the Client when the measurement starts and regenerated by the Client only when the Delay Sample is lost).
- The Delay Sample is a reference for every precise round trip calculation (in addition to Spin bit signal used for an approximate RTT calculation when the Delay Sample is not present).



Delay Sample red, Spin Bit green or blue

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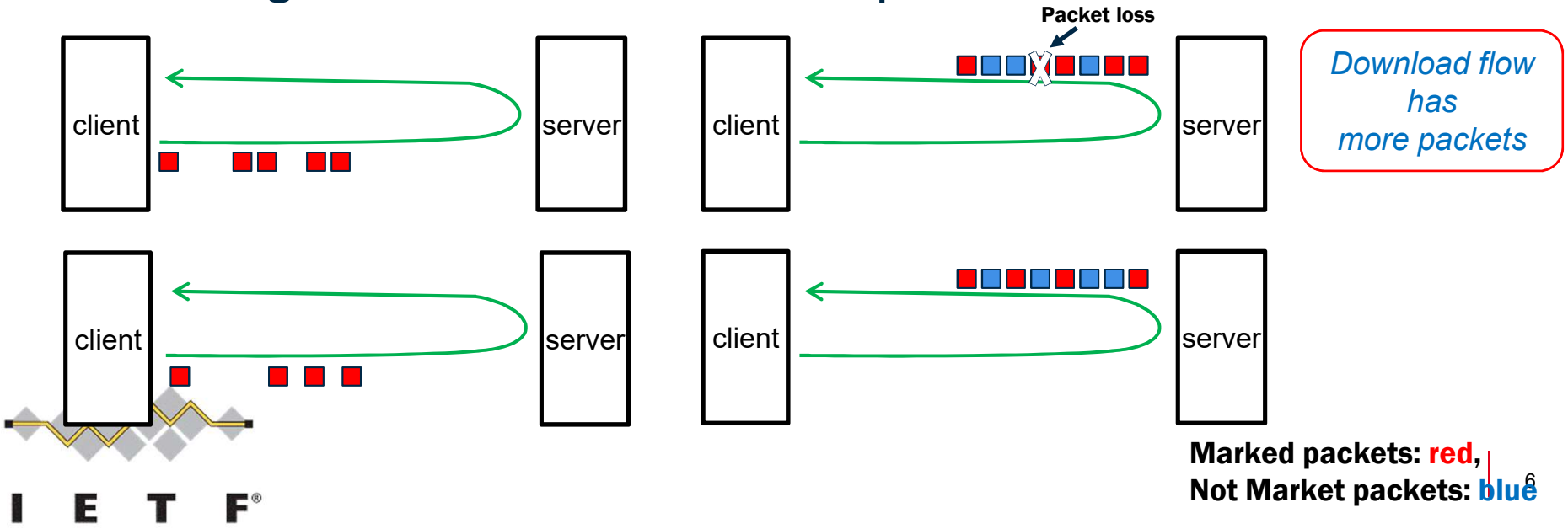
Round Trip Packet Loss: PL-bit

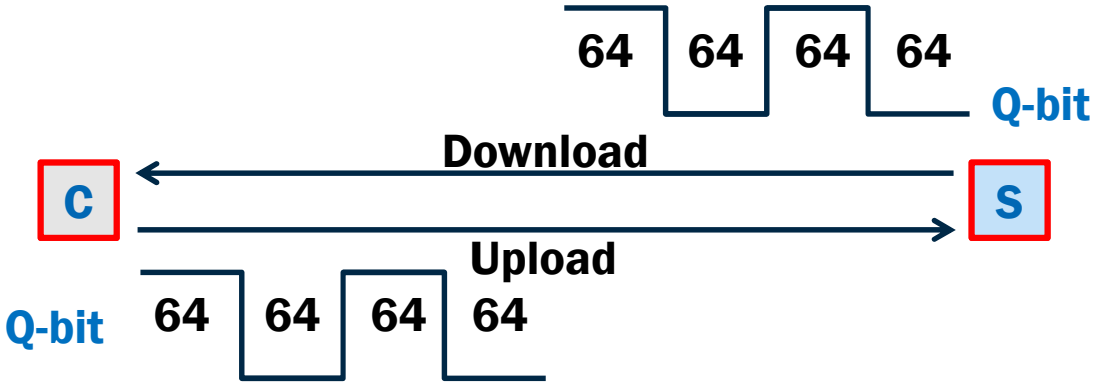
- The Client generate a «train» of market packets (using the Packet Loss bit)
- The Server «reflects» these packets (marking production packets flowing in the opposite direction). The Server inserts some not marked packets if download flow has more packets than upload flow.
- The Client reflects the marked packets.
- The Server again reflects the marked packets (two complete Client-Server rounds, so an intermediate Observer can see the «train» twice and compare the marked packets number to measure the RT Packet Loss).
- The Client generate a new train of market packets and so on.



One-Way Packet Loss: sQuare bit (Q-bit)

This method uses 2 bits: the sQuare bit (Q-bit) and Reflection square bit (R-bit).

- The Q-bit (firstly described in draft-ferrieuxhamchaoui-quic-lossbits) creates square waves of a known length (e.g. 64 packets) as defined in the Alternate Marking RFC 8321



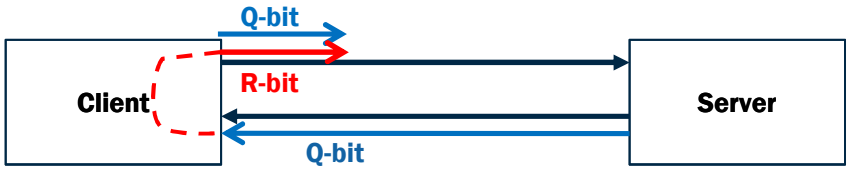
OW Packet Loss: Reflection square bit (R-bit)

The new idea is to reflect the Q-bit in the opposite direction using the R-bit.

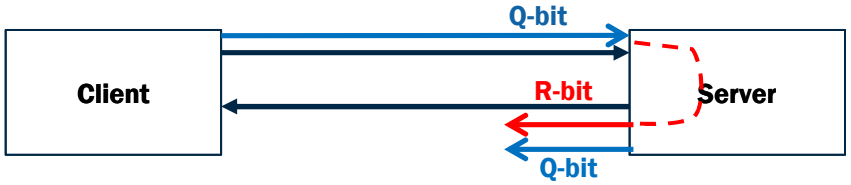
The sizes of the transmitted R-bit blocks are the "average sizes" of the received Q-bit blocks.

This idea allows to have continuous alternate marked packet blocks in both directions.

The Client generates the Q-bit signal and reflects the received Q-bit signal using the R-bit signal:

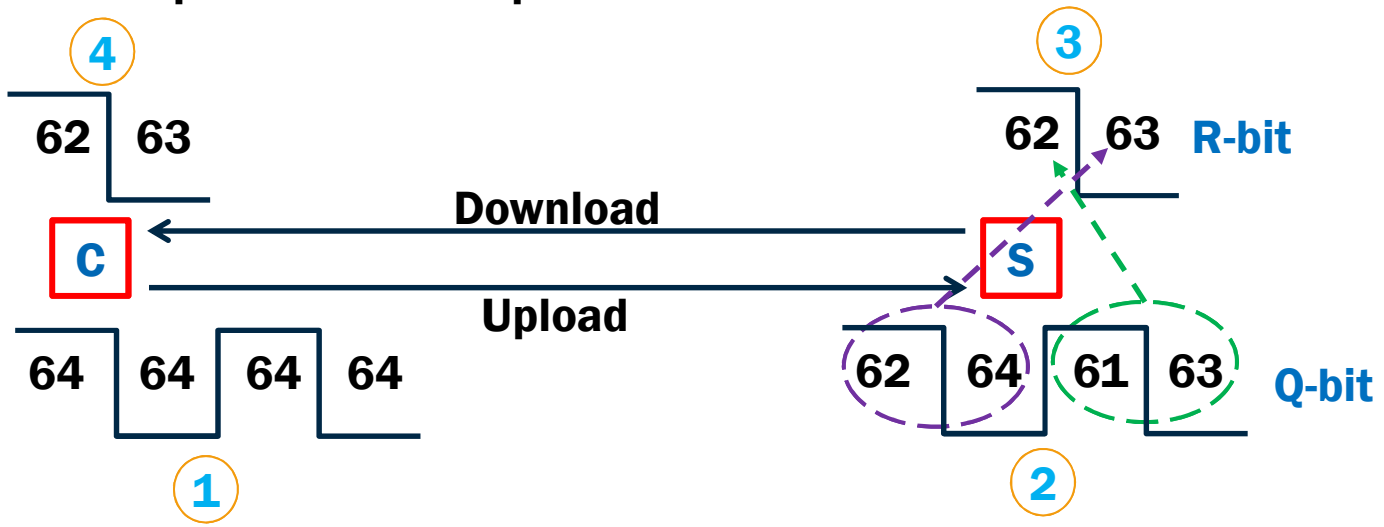


The Server does the same in the opposite direction:

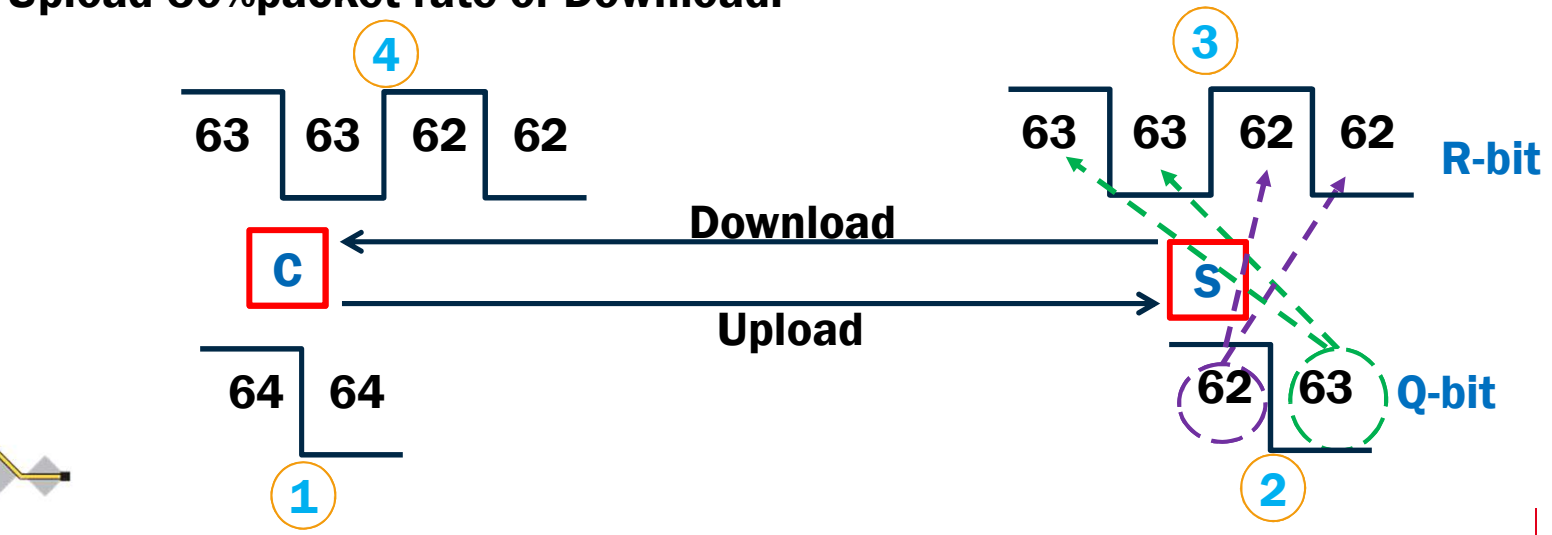


Example: Upload Packet Loss with different packet rates

Download 50% packet rate of Upload:



Upload 50%packet rate of Download:



R-bit Algorithm

«When the transmission of a new R-block starts, its size M is set equal to the size of the last Q-marked period whose reception has been completed;

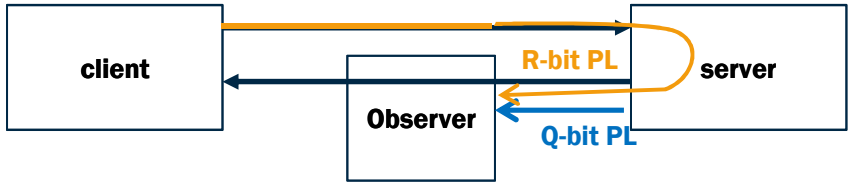
if, before transmission of the R-block is terminated, the reception of at least one further Q-marked period is completed, the size of the R-block is updated to the average size of the further received Q-marked periods»

Algorithm properties:

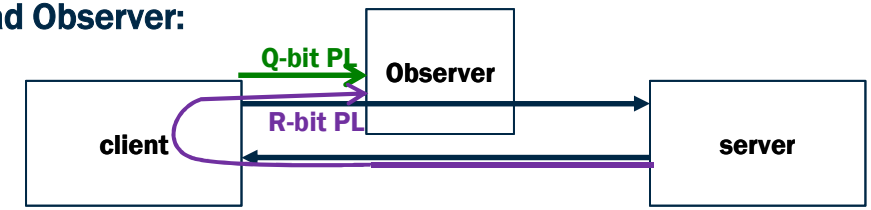
- It works in both cases when the reflected packets number is greater than those received and when the reflected packets number is lower.
- All traffic is measured (all the production traffic has both the Q-bit and the R-bit marked)

One direction Observer:

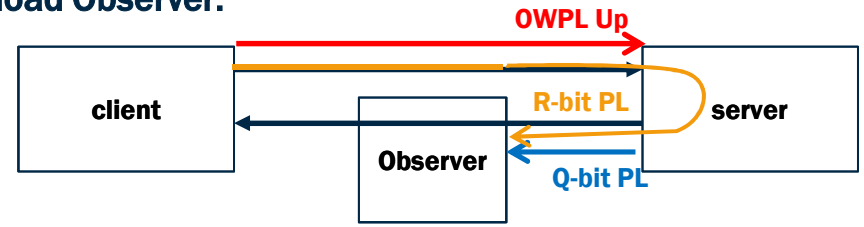
- **Download Observer:**



- **Upload Observer:**

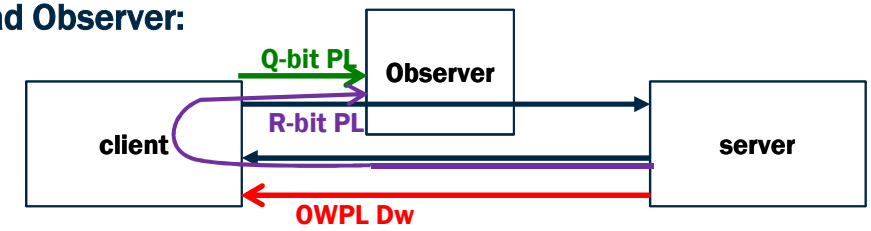


- **Download Observer:**



OWPL Up = R-bit PL Dw – Q-bit PL Dw

- **Upload Observer:**

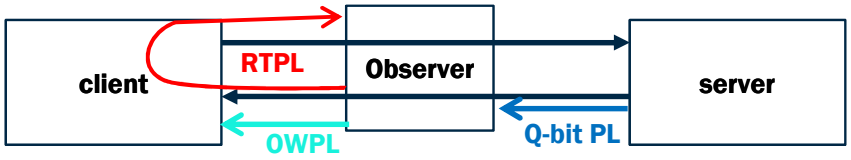


OWPL Dw = R-bit PL Up – Q-bit PL Up

OWPL: One Way Packet Loss

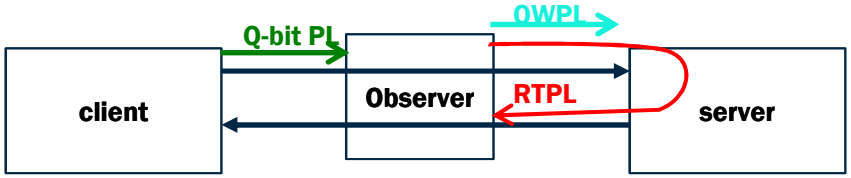
Two direction Observer:

- **Observer-Client RTPL and OWPL:**



RTPL =R-bit PL Up – Q-bit PL Dw ⇨ RTPL – Q-bit PL Up= OWPL

- **Observer-Server RTPL and OWPL:**

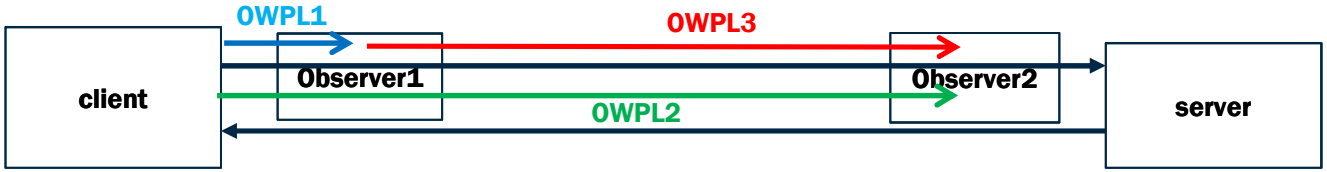


RTPL =R-bit PL Dw – Q-bit PL Up ⇨ RTPL – Q-bit PL Dw= OWPL

RTPL: Round Trip Packet Loss
OWPL: One Way Packet Loss

2Point One-Way Packet Loss (Q-bit only)

- Observer2-Observer1 OWPL:



Observer2-Observer1 One-Way: OWPL2 – OWPL1 = OWPL3

- Observer1-Observer2 OWPL:

Observer1-Observer2 One-Way: OWPL1 – OWPL2 = OWPL3

3bit Explicit Performance Monitoring

If there are only 3 bits for EPM (e.g. QUIC):

- Option 1:
  - Precise RTT (Spin bit + Delay bit)
  - RT Packet Loss (Packet Loss bit)
- Option 2:
  - RTT (Spin bit)
  - One-Way Packet Loss (Q-bit + R-bit)

A proposal:

a new draft version or brand new draft?

See also: HotRFC “How to measure Network Performances with users’ devices”

(Some additional slides)

Explicit Performance Monitoring issues

Open issues:

- Who decides whether to mark traffic?
  - Explicit measures only work if both the Client and the Server mark the production traffic (not so frequent in QUIC protocol implementations).
- Scalability:
  - Network probes could monitor all the connections?
    If they can't, which ones to choose?
- How to monitor both traffic directions?
  - It’s not always possible for network probes (asymmetric connections)

Proposal: EPM Probes on users' devices

- **We propose to put the Explicit Performance Observer also on the user device (e.g. mobile phones, PCs).**
- **Issues answers:**

1. **Scalability**. On the user device there are few connections to monitor.
2. **Which connections to monitor**? The ones that have problems!

   User device and network probes coordination. It's possible to set alarm thresholds on the user device (and to signal to network probes to monitor only the sessions with impairments, in order to segment the performance measurements and to locate the faults). In this case network probes, also embedded into network nodes, need to monitor only a limited number of connections.
3. **Both directions monitoring.**
4. **Who decides to mark? The device owners!**

Device owner activates Explicit PM

- The decision whether to activate the marking (e.g. Spin Bit) or not should be made by the device owner configuring the applications (e.g. browsers) based on client-servers protocols that supports explicit meaurements (e.g. QUIC).
- All applications should provide for the activation or deactivation of packet marking (providing a user interface or exposing API).
- So, during the Client-Server handshake, the Client will decide whether the marking is active or not within a session and the Server should follow.

Who will see the Performance Data?

- Performance information is displayed on the device and possibly sent to "external bodies" if the owner agrees.
- The main recipient would be the Internet Service Provider (see “**User device and network probes coordination**”), but these data could also be of great interest or requested by the national regulatory authorities or others authorized subjects.

Draft next steps

- **Explicit Measurements are gaining interest for encrypted transport protocols:**
  - already discussed in TSVWG and QUIC WG;
  - implementation at IETF Hackathon;
  - thread on the IPPM mailing list.
- **Evaluate WG adoption for this document as the basis to give it a place.**
- **Welcome questions and comments.**