One-way Passive Measurement of End-to-End Quality
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Abstract

This draft describes a passive measurement method for one-way end-to-end quality. The method consumes a small resources therefore it can be adapted to many protocols that have sequence number field.

Table of Contents

1. Introduction ................................................. 3
   1.1. Requirements notation ............................... 3
2. Metrics ...................................................... 4
3. Measurement Method ......................................... 5
   3.1. Counters and Functions ............................... 5
   3.2. Measurement Algorithm ............................... 5
4. Algorithm Behavior ......................................... 7
5. Security Considerations .............................. 12

Appendix A. Acknowledgements ............................. 13

6. References ................................................ 14
   6.1. Normative References .............................. 14
   6.2. Informative References .............................. 14

Authors’ Addresses ...................................... 15
Intellectual Property and Copyright Statements .......... 16
1. Introduction

This draft describes a passive measurement method for one-way end-to-end connections quality. The algorithm uses the sequence numbers of the packets in a flow and consumes a small space and a small computing power. Therefore, it is easy to apply to protocols that have a sequence number field in their packet headers, such as GRE[2][3], PWE3[4] and RTP[5]. The method satisfies the quality measurement requirements for tunneling protocols [6].

1.1. Requirements notation

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [1].
2. Metrics

We firstly define the types of irregular packet.

- **loss**: packet that does not arrive in-sequence except duplication
- **duplication**: packet that is identical to the immediately preceding arrival packet
- **reordering**: packet that arrives after the successive packets’ arrival

Note that “duplication” does not mean naive “duplicate packets”, because they should arrive uninterruptedly according to the definition.

We secondly define the metrics of a channel as follows.

- **The number of packets in each irregular type since the channel appeared.**

[7]
3. Measurement Method

In this section, we illustrate a method to measure qualities defined in the previous section. The protocol should have the sequence number field in its headers.

3.1. Counters and Functions

The egress host of a flow must have the following counters.

- **reccount**: maintains the number that the successive packet should have
- **losscnt**: the number of packets lost
- **duplcnt**: the number of packet duplications
- **reodcnt**: the number of reordering packets

Let the counters above be unsigned integer and initialized by 0. The length of the counters should be the same as the sequence number field defined in the protocol.

3.2. Measurement Algorithm

This algorithm determines whether a receiving packet is normal or not while comparing a counter "revcnt" with the sequence number of the packet named "seqno". The basic idea consists of the following conditions.

1. if revcnt and seqno are same then "in-sequence",
2. else if seqno is just a predecessor of revcnt then "duplicate";
3. otherwise if seqno proceed then "loss" else "reordering".

The following C-like codes specifies the algorithm in detail. The function measure will be invoked by every one of the reception of packets.
boolean measure(packet_t packet)
{
    unsigned int seqno;
    seqno = packet->header->seqno;  // get seq # from header

    if (seqno == recvcnt) {        // no problem
        recvcnt++;
        return true;
    } elsif (seqno+1 == recvcnt) {  // same seq # as predecessor
        duplcnt++;
        return false;
    }

    signed int diff;
    diff = (signed int)(seqno - recvcnt);
    if (diff > 0) {                 // means skips some packets
        losscnt += diff;          // determines packets loss
        recvcnt = seqno;
    } else {                        // means it is a past packet
        reodcnt++;                // determines reordering
    }
    return false;
}

Figure 1

The function ‘measure’ returns true only if the packet is in_sequence. The value can be used to discard the packet when the protocol does not allow to pass irregular packets to its higher layer.
4. Algorithm Behavior

The following diagrams show the behavior of the algorithm on receiving out_of_sequence packets. Figure 3 shows the legend of flow diagram here. The left and right sides represent the sender and receiver of a GRE tunnel respectively. Time flows upper to lower in the diagrams. This illustrates a normal transmission with the sequence number n.

<table>
<thead>
<tr>
<th>time</th>
<th>sender</th>
<th>receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>n 0 0 0</td>
</tr>
<tr>
<td>n</td>
<td>[seq #: n]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n+1</td>
<td>n+1 0 0 0</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

Figure 2

Figure 3, Figure 4 and Figure 5 show simple cases, such as loss, duplication and reordering of packets respectively.
Figure 3
Figure 4
Figure 5

Figure 6 and Figure 7 show cases in a little bit complex situations. Figure 6 shows that the algorithm can not distinguish a combination of duplication and loss from a reordering. Compare the flow to former of Figure 5.
Figure 7 shows that the algorithm interprets a duplication as reordering when a duplicated packet does not arrive in succession. It is not possible to hold all of the information contained in the arrival packets needed to measure accurately.

Figure 6

Figure 7

5. Security Considerations

The passive measurements do not use any additional packets and flows, so that most security considerations boils down to the issues of the original protocols. For example, fraud sequence numbers cause the measurement process to become disorganized. This discussion boils down to the issues of the header protection.
Appendix A. Acknowledgements

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6. References

6.1. Normative References


6.2. Informative References


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