TWAMP Value Added Octets

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Capacity metrics

› Capacity metrics are defined in both IETF and ITU-T
  – Benchmarking Methodology for Network Interconnect Devices (RFC 2544)
  – Defining network capacity (RFC 5136)
  – IP packet transfer and availability performance parameters (ITU-T Y.1540)

› Capacity metrics are increasingly important to operators
  – System activation and commissioning
  – Service Level Agreement (SLA) monitoring
  – Capacity planning
  – Troubleshooting
  – …

How will TWAMP measure the capacity metrics?

Capacity measurements

› Capacity measurements require sending and receiving packets in trains
  – Each train is transmitted at a specific rate
  – Multiple trains are transmitted

› Capacity measurements require bidirectional self-induced congestion
  – For accurate estimates, some trains must cause momentary congestion
  – The congestion is only transient for the duration of the train which is typically short (methodology-specific)
  – Train rates are evaluated independently in the forward/reverse directions

› Capacity estimates depends on IP-type-P
  – DSCP and test packet size should be "fixed" during test interval
  – Multiple concurrent test sessions with different characteristics may be needed between the same pair of hosts

Challenges and proposed solutions (1)

› Challenge
  – The different trains within a test session cannot be distinguished

› Proposed solution
  – Session-Sender identifies the trains within original packet stream and both endpoints keep track of the current train

Challenges and proposed solutions (2)

› Challenge
  – Reverse path testing depends upon the forward transmission rate, available capacity in the forward direction and time taken to generate the reflected test packets

› Proposed solution
  – Session-Reflector buffers each train and transmits the packets at desired reverse transmission rates provided by the Session-Sender
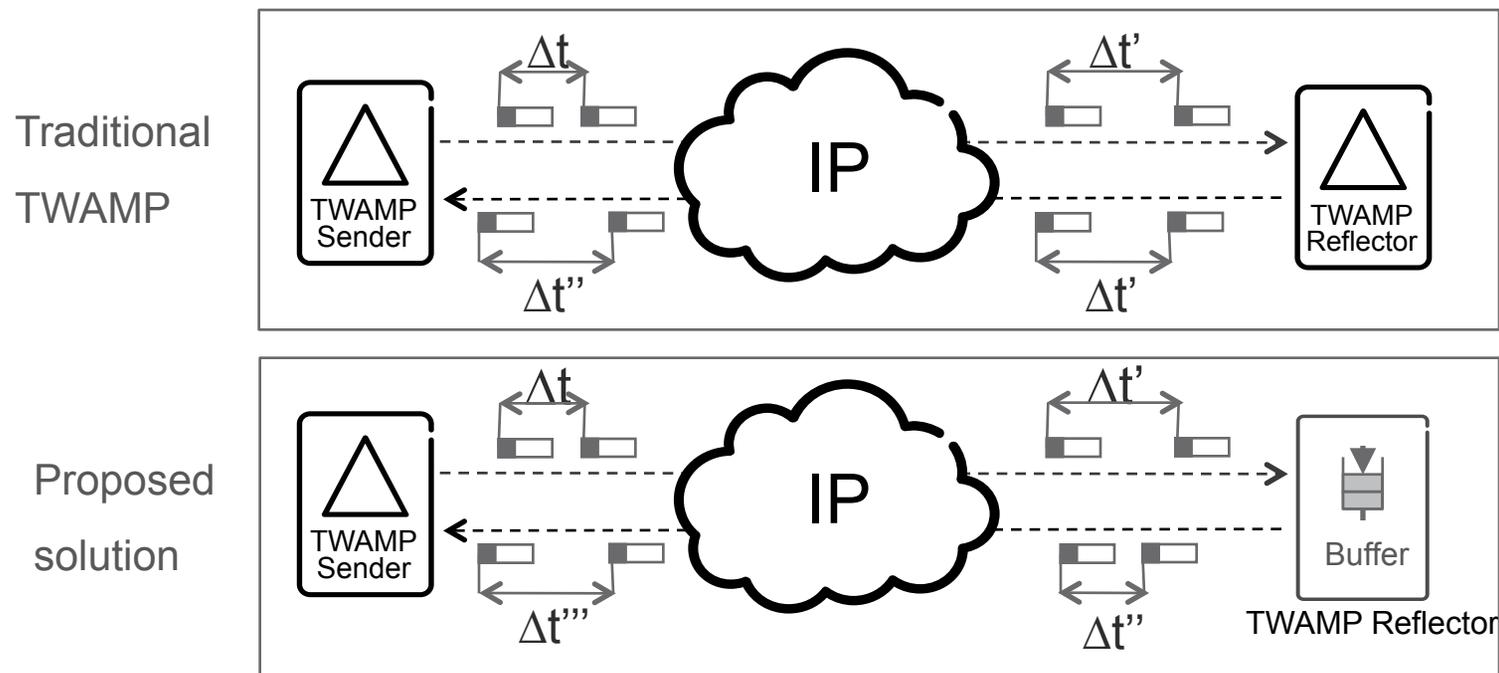
Challenges and proposed solutions (3)

› Challenge
  – The mechanism for de-multiplexing the received test packets to the proper session is implementation-specific and IP-layer de-multiplexing may not be sufficient or desirable

› Proposed solution
  – Session-Sender tags the test packets belonging to the original packet stream and both endpoints use the tags to map the packets to the correct sessions

Proposed design

› Insert and reflect a number of meaningful fields in the TWAMP padding octets
  – "Sender discriminator" for session de-multiplexing
  – "Last Seqno In Train" for train identification
  – "Desired Reverse Packet Interval" for reverse rate

› Field properties and layout
  – Each field is associated with a flag bit which indicates its presence
  – A version number identifies the version of the padding octets and meaning of the flag bits
  – Each field is optional and may be used in conjunction with other field(s) including future value-added octet fields

› Introduce a new TWAMP mode to identify the ability of the Server/Session-Reflector to read and act upon the new fields
  – New mode = Value-Added Octets Version 1
  – Both endpoints must be able to read and extract the information in the new fields
  – The expected behavior of the Session-Reflector is well-defined but the actual behavior can be adjusted based on local configuration, policy or implementation

Proposed Session-Sender test packet

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sequence Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Timestamp                           |
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Error Estimate         |  Ver  |S|L|D|    Reserved    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Sender Discriminator (SD)                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Last Seqno In Train (LSIT)                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Desired Reverse Packet Interval (DPRI)           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Additional Packet Padding                  |
.                                                              .
.                                                              .
.                                                              .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Modes = Unauthenticated + Value-Added Octets Version 1 with S=1, L=1 and D=1

Proposed reflector behavior

S	L	D	Behavior Description
0	0	0	SHOULD transmit packets as quickly as possible (RFC 5357)
0	0	1	SHOULD transmit packets as quickly as possible (RFC 5357)
0	1	0	MUST extract LSIT and SHOULD buffer packets for the current train SHOULD transmit packets as quickly as possible (RFC 5357)
0	1	1	MUST extract LSIT and SHOULD buffer packets for the current train MUST extract DPRI and SHOULD transmit each packet at the desired interval
1	0	0	MUST extract SD and SHOULD use it to associate test packets SHOULD transmit packets as quickly as possible (RFC 5357)
1	0	1	MUST extract SD and SHOULD use it to associate test packets SHOULD transmit packets as quickly as possible (RFC 5357)
1	1	0	MUST extract SD and SHOULD use it to associate test packets MUST extract LSIT and SHOULD buffer packets for the current train SHOULD transmit packets as quickly as possible (RFC 5357)
1	1	1	MUST extract SD and SHOULD use it to associate test packets MUST extract LSIT and SHOULD buffer packets for the current train MUST extract DPRI and SHOULD transmit each packet at the desired interval

Summary

› TWAMP Value-Added Octets benefits

– Measurement of capacity metrics in both forward and reverse directions

– De-multiplexing of test sessions using TWAMP layer tag

– Structure for future padding fields and behaviors

› IPR Disclosure provided on January 13, 2011

› Running Code

– Android application measures forward and reverse UDP throughput using a TWAMP responder enhanced with support for capacity metric measurements

User Equipment
(UE)

Δt

$\Delta t'$

IP

Buffer

TWAMP Controller
(Prague)

$\Delta t'''$

$\Delta t''$

TWAMP Responder
(Stockholm)
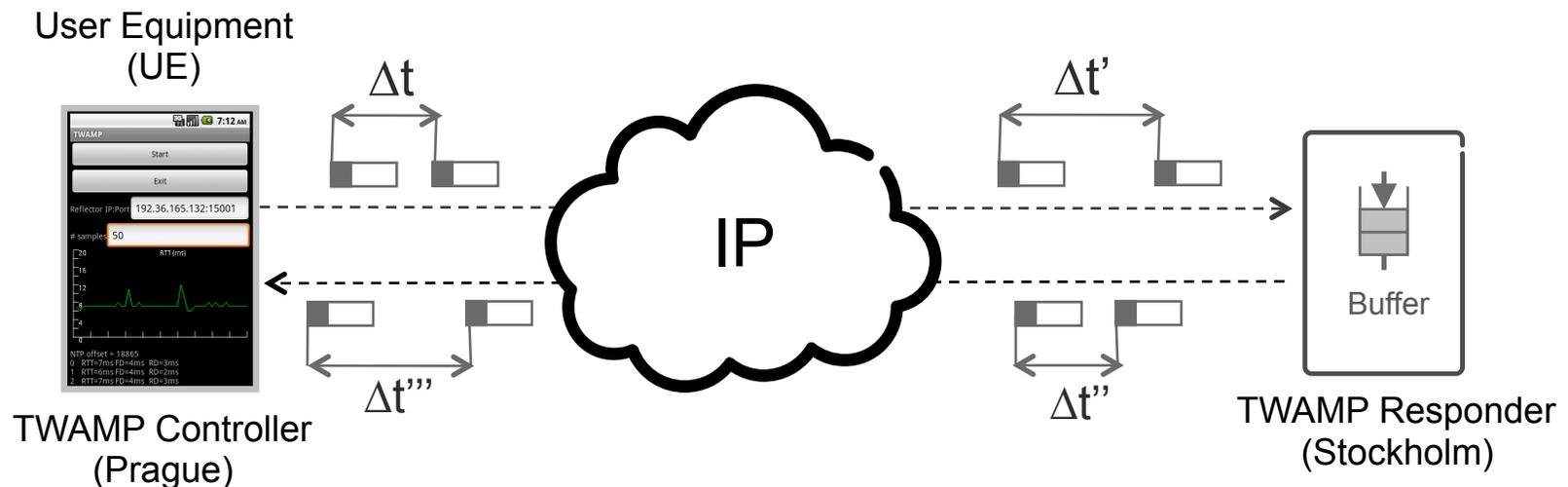
Appendix (1)

Metric	RFC 5357	New Draft
1) One-way packet delay	√	√
2) Two-way packet delay	√	√
3) One-way PDV	√	√
4) One-way APC/TSC		√
5) One-way UDP Throughput		√

Appendix (2)

› Examples of capacity measurement methods that can utilize the new TWAMP draft

– BART

– PathChirp

– Pathload

– Spruce