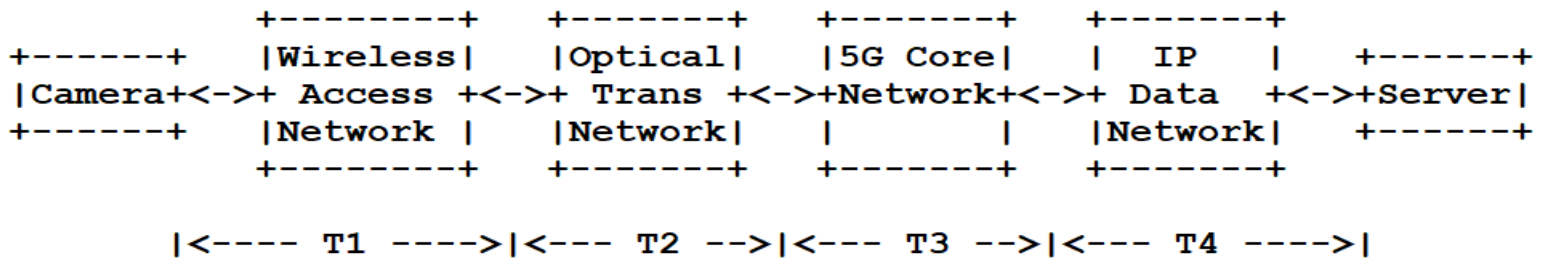
One-way Delay Measurement Based on Reference Delay

draft-li-ippm-ref-delay-measurement-00

Presenter:Danyang Chen (China mobile)

Background & Introduction

- End-to-end one-way delay (OWD) measurement
  - E2E OWD is an important performance indicator for SLA guarantee
  - E2E OWD measurement is of great significance



- An example: HD video surveillance service scenario in 5G network
  - The end-to-end one-way delay is the sum of T1+T2+T3+T4

- Existing methods
  - End-to-end deployment of accurate clock synchronization, such as PTP or GPS.
  - Round-trip delay (RTT) is used to estimate end-to-end one-way delay; the accuracy is low.

- **A new method**
  - Accurately measure end-to-end one-way delay using reference delay without deploying clock synchronization.
  - Reference delay is bounded and has low jitter.

Network Topology

- Sender to Receiver Network:
  - End-to-end one-way delay from the sender to the receiver is measured.
  - Intermediate devices other than the sender and receiver are hidden for simplicity.
- Clock Offset
  - The sender and receiver do not deploy time synchronization.
  - the time deviation between the sender and receiver is the clock offset.

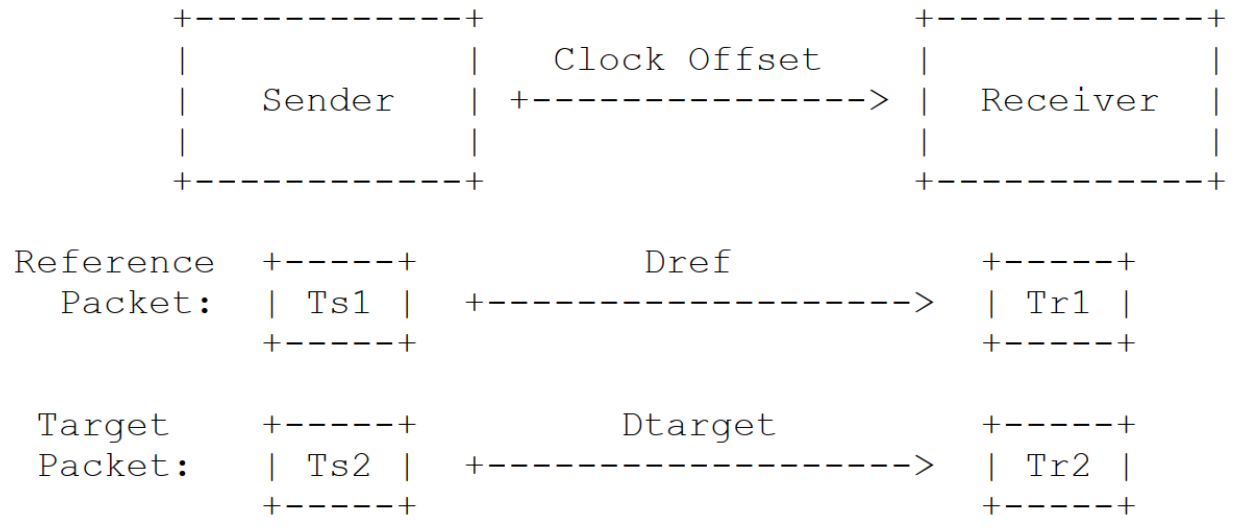
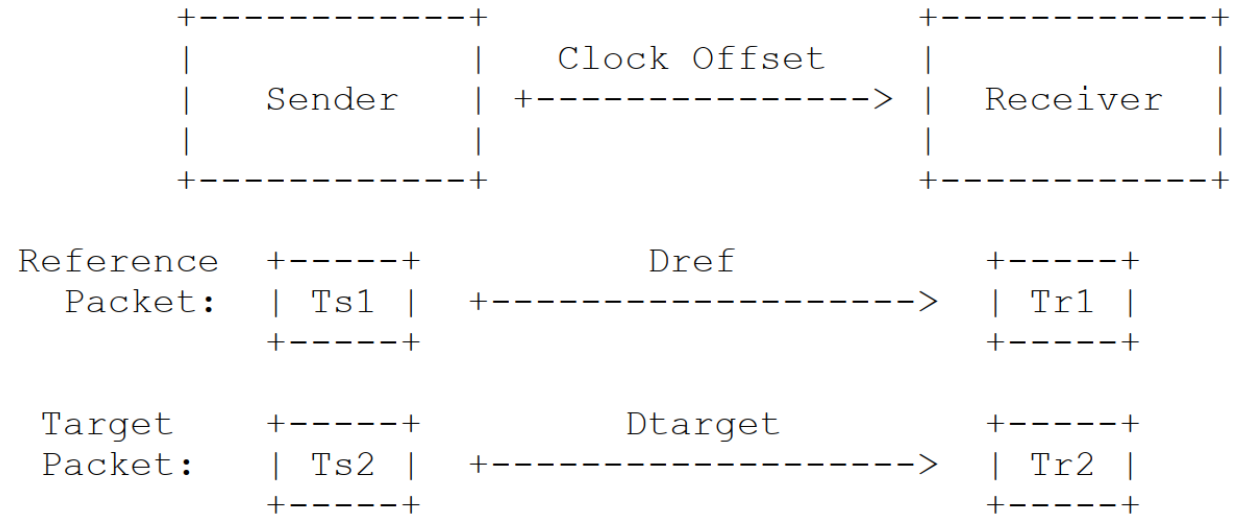


Figure 2:Topology of One-way Delay Measurement

Packets Sent and Timestamps

- Reference Packet:
  - The E2E one-way delay for reference pkt is stable and bounded, denoted as Dref.
- Target Packet:
  - The E2E one-way delay for target pkt is the measurement target, denoted as Dtarget.
- Timestamping:
  - We timestamp reference and target pkt on the sender and receiver side respectively, denoted as Ts1, Ts2, Tr1 and Tr2.



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Proposed OWD Calculation Method

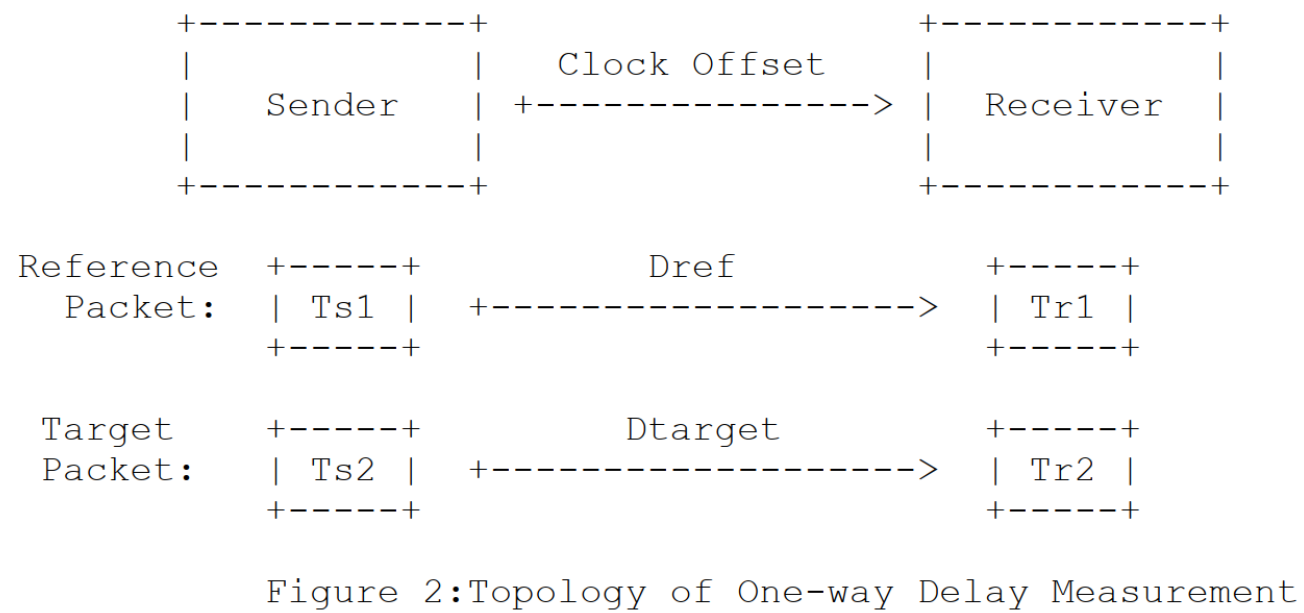
- For reference packet and target packet, we can get Equation 1 and Equation 2, respectively.

$$Tr1 - Ts1 = Dref + Offset1 \quad (1)$$

$$Tr2 - Ts2 = Dtarget + Offset2 \quad (2)$$

- When sending time interval between reference and target pkt is small, Offset1 = Offset2.
- (Equation 2 – Equation 1), we get Equation 3. Now we can calculate Dtarget.

$$Dtarget = (Tr2 + Ts1) - (Tr1 + Ts2) + Dref \quad (3)$$



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Detailed Measurement Procedures

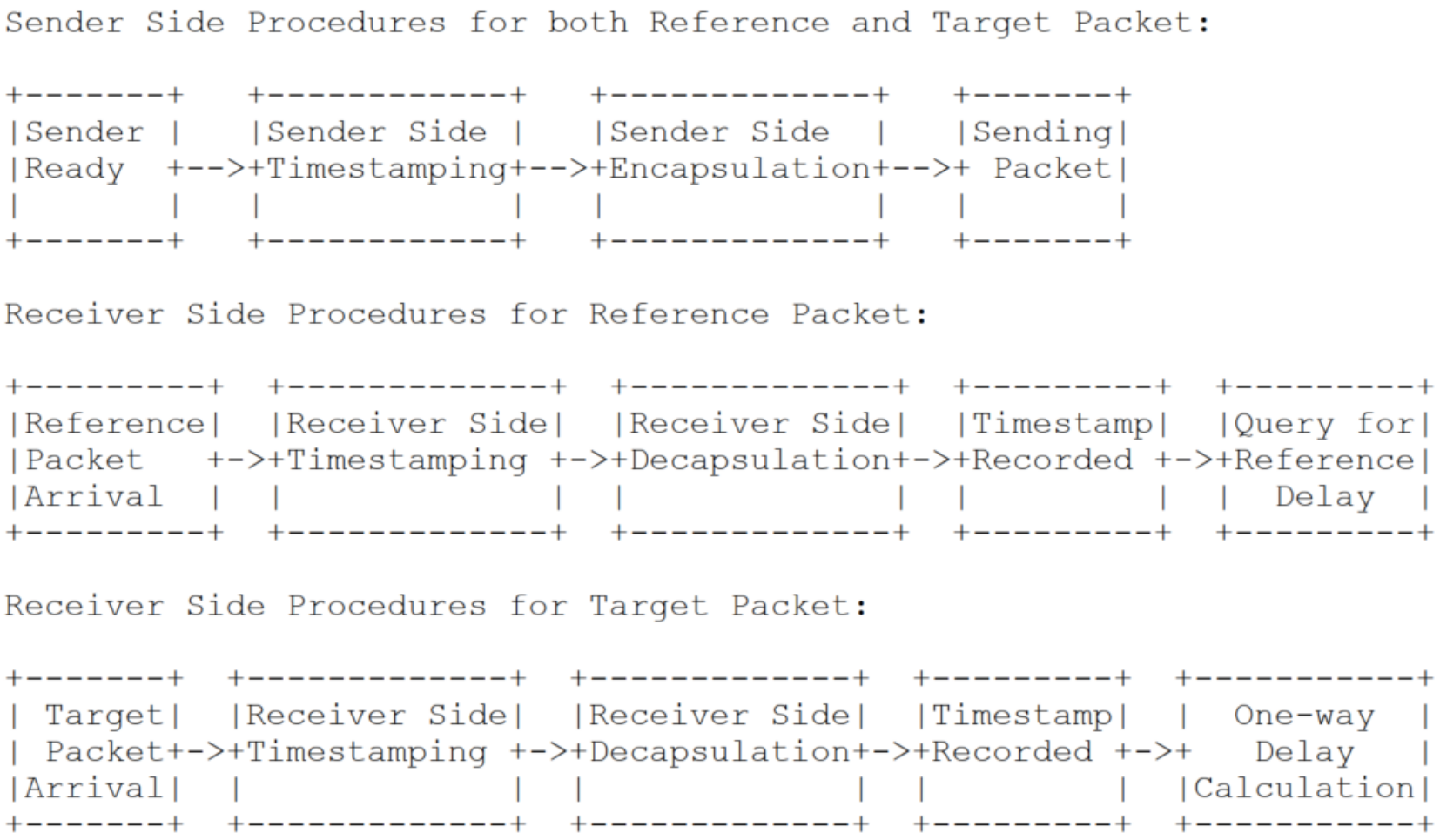

Figure 3: Measurement steps for Sender and Receiver Respectively

Packet Header Format

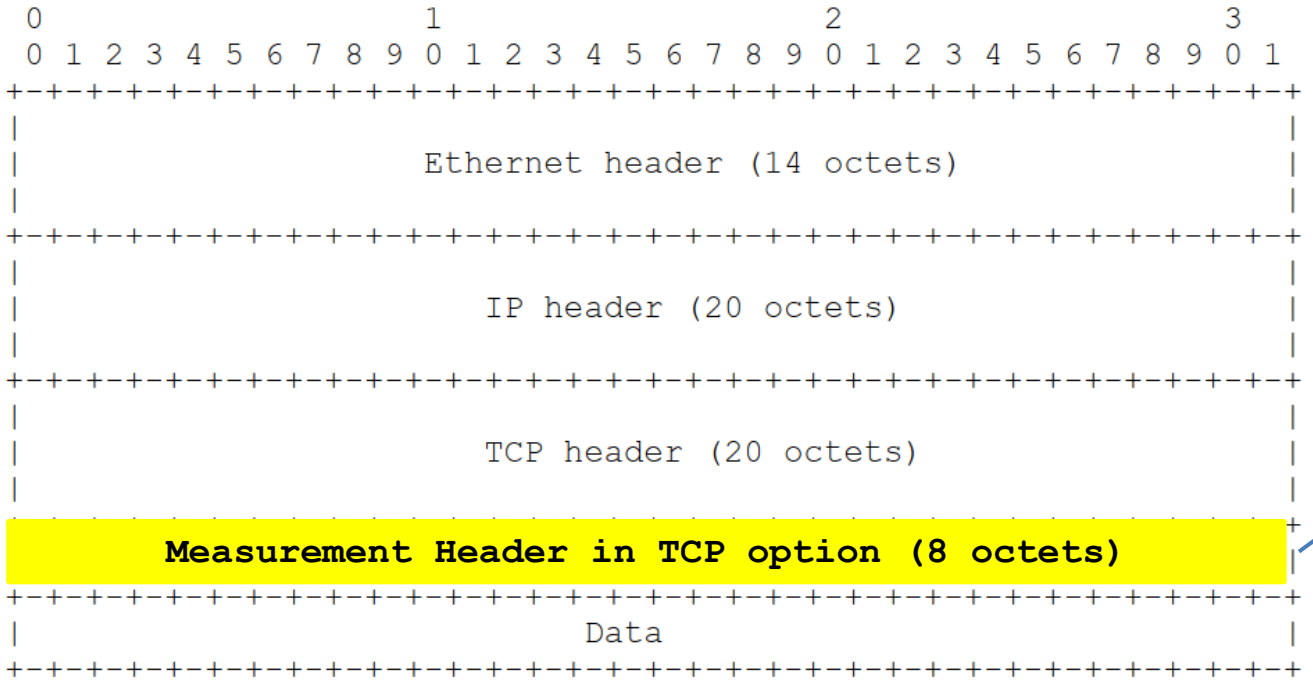

Figure 4: Format of Reference or Target Packet

- The sender encapsulates timestamp information and sender-receiver pair information in the Measurement Header of the sent packet.
- The position of the Measurement Header is in the option field of the TCP protocol header.

Measurement Header Format in Detail

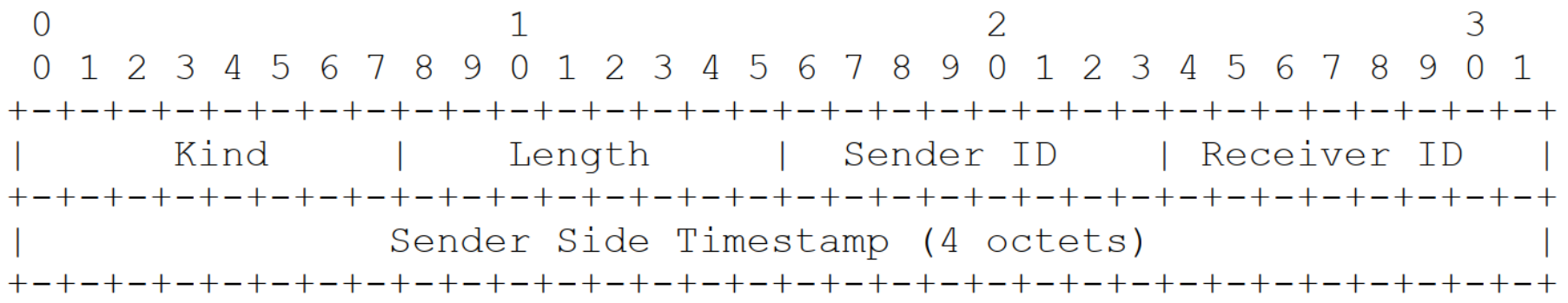

Figure 5: Detailed Measurement Header Format

- The Kind value can be 253 or 254, and the Length value is 8, which is in accordance with TCP option [RFC4727].
- The sender ID is one octet, and the receiver ID is also one octet.
- The sender side timestamp is 4 octets, which can store accurate timestamp information.

Advantages

- **No need to deploy time synchronization**
  - There is no need to deploy end-to-end accurate time synchronization, which reduces the deployment cost of accurate one-way delay measurement.
- **No impact on intermediate network devices**
  - Leveraging reference delay for assistance, only time stamping is required at the sender and receiver. So there is no extra configuration for intermediate network devices.

Next steps

- Detailed analysis on the acquisition of reference delay.
- Consider about security issues.
- More things to be done. You are also welcome to join our work!

Thanks!