Reporting Metrics: Different Points of View

(or: You Can Run with Scissors)

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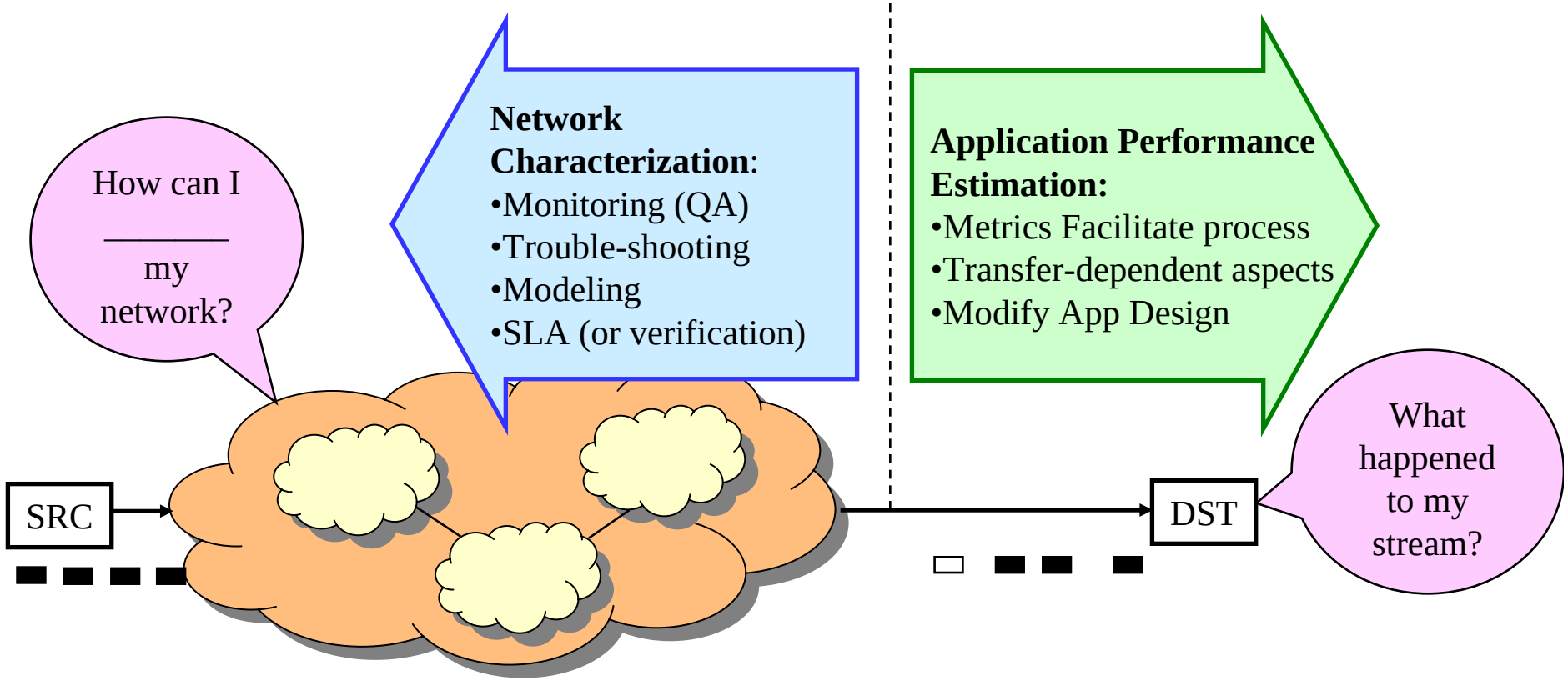
Background on this Discussion/Draft

- **Talk at IETF-65, comparing different ways to implement RFC 3393 on Delay Variation, ending with**
  - ➔ **"How do you want to use the DV Results?"**
  - ➔ **Two primary ways to measure within the options of 3393**
  - ➔ **Choices have profound implications, made clear in slides**
  - ➔ **Topic for a future draft…**
- **draft-shalunov-ippm-reporting**
  - ➔ **Real-time display of short-term network state, using only "on-the-fly" calculations**
  - ➔ **Stream and Metric parameters chosen for Loss, Delay, Delay Variation, Duplication, and Reordering**
  - ➔ **I would have made different choices for many parameters when reporting performance under other circumstances…**
- **Stas' comments on the Composition Framework**
- **Side point: Metric Parameters/Options make the IPPM Registry less-effective…**

Different Points of View (POV): 2 key ones

- **When designing measurements and reporting results, MUST know the Audience to be relevant**
- **Key question: "How will the results be used?"**



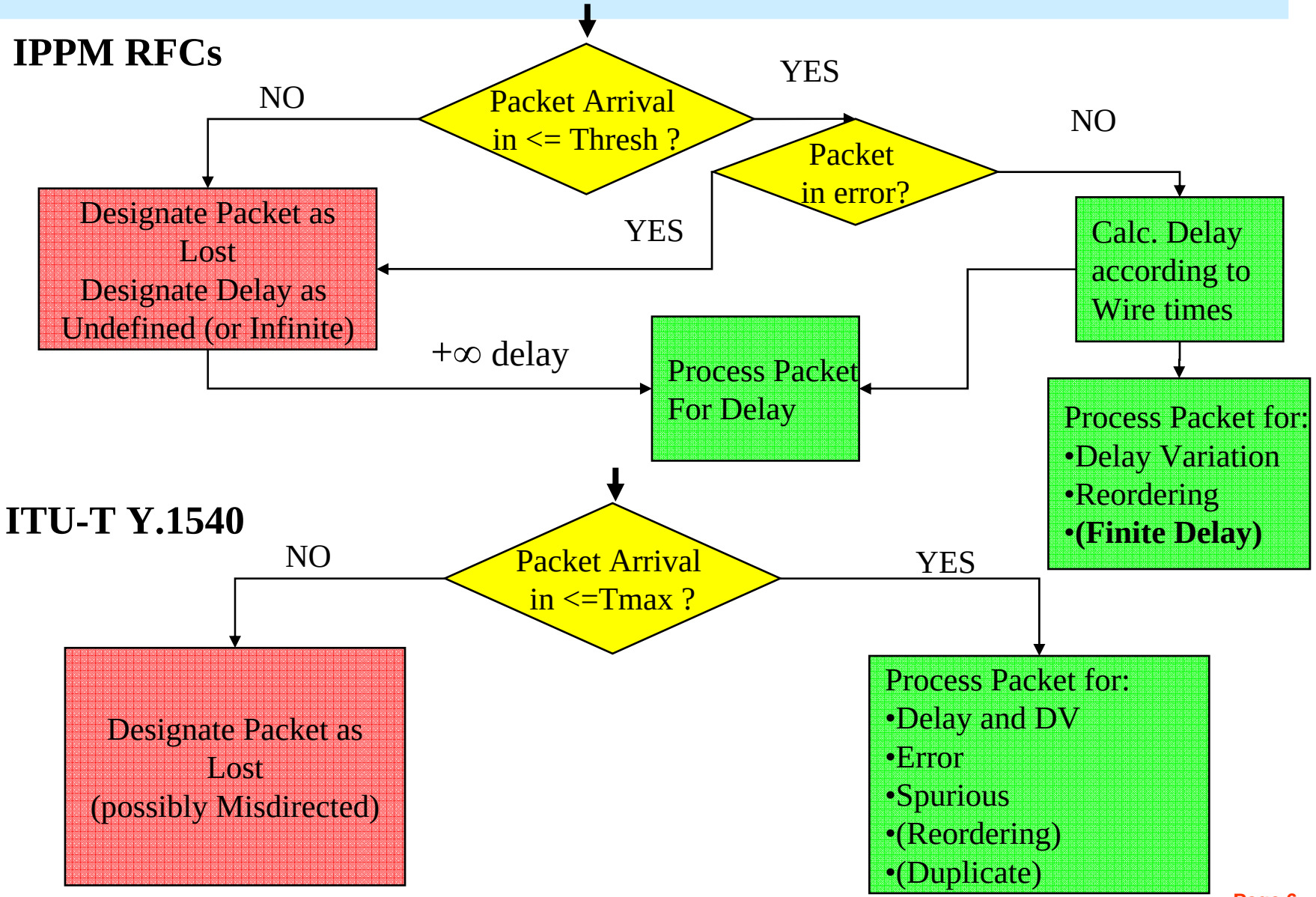
Outline

2. **Purpose and Scope**
   Delineate the 2 POV, and their effect on metric and stream params and the desirable statistics for reports.
3. **Effect of POV on the Loss Metric**
   - **3.1. Loss Threshold**
   - **3.2. Errored Packet Designation**
   - **3.3. Causes of Lost Packets**
4. **Effect of POV on the Delay Metric**
   - **4.1. Treatment of Lost Packets**
     - **4.1.1. Application Performance**
     - **4.1.2. Network Characterization**
     - **4.1.3. Delay Variation**
     - **4.1.4. Reordering**
   - **4.2. Preferred Statistics**
   - **4.3. Summary for Delay**
5. **Sampling: Test Stream Characteristics**
6. **Reporting Results**

Effect of POV on the Loss Metric

- **Loss Threshold – waiting time for each packet**
  - **Network Char – distinguish Loss and Long (Finite) Delay**
  - **RFC 2680 declines to recommend a value**
  - **"good engineering, including an understanding of packet lifetimes, will be needed in practice."**
  - **The methodology says to use "a reasonable value."**
  - **Routing Loops can cause long delays**
  - **Packet lifetime is still limited by hops traversed (TTL)**
  - **(100ms Link + 100ms Queue) x 255 hops = 51 seconds**
  - **Deliberate Packet Storage is a Replay Attack**
  - **Application Perf - long thresh. can be revised downward**
- **Errored Packet Designation**
  - **"If the packet arrives, but is corrupted, then it is counted as lost."**
- **Causes of Lost Packets (discard, corruption, failures)**

Comparison of Parameter Classifications



Effect of POV on the Delay Metric

One-way Delay RFC 2679

3.4. Definition:

For a real number dT, >>the *Type-P-One-way-Delay* from Src to Dst at T is dT<< means that Src sent the first bit of a Type-P packet to Dst at wire-time* T and that Dst received the last bit of that packet at wire-time T+dT.

>>The *Type-P-One-way-Delay* from Src to Dst at T is undefined (informally, infinite)<< means that Src sent the first bit of a Type-P packet to Dst at wire-time T and that Dst did not receive that packet.

- **How do these two different treatments align with the needs of the 2 main audiences for measurements?**
- **How have lost packets been treated in more recent metric definitions, such as delay variation and reordering?**

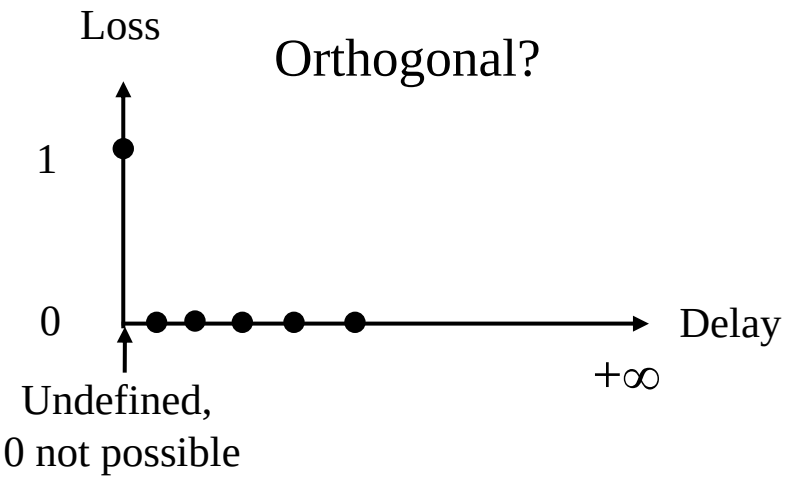
Effect of POV on the Delay Metric (2)

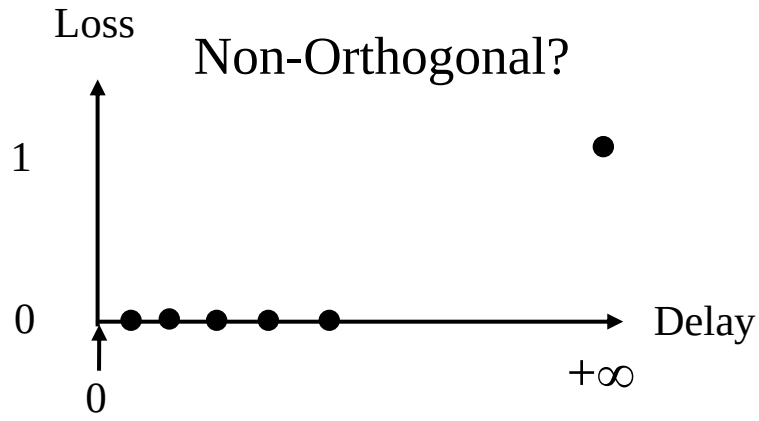
- **Application Performance**
  - ➔ **Receiver processing "forks" on arrival or time-out**
  - ➔ **Arrive within the time tolerance:**
    - ✦ **Check for errors**
    - ✦ **Remove headers**
    - ✦ **Restore order**
    - ✦ **Smooth delivery timing (de-jitter buffer)**
  - ➔ **Time-outs spawn other processes (recovery):**
    - ✦ **Re-transmission**
    - ✦ **Loss concealment**
    - ✦ **Forward Error Correction**
  - ➔ **Therefore: Maintain a distinction between packets that actually arrive within tolerance, and those that do not.**
  - ➔ **Measure Delay as a conditional distribution (conditioned on arrival within tolerance)**

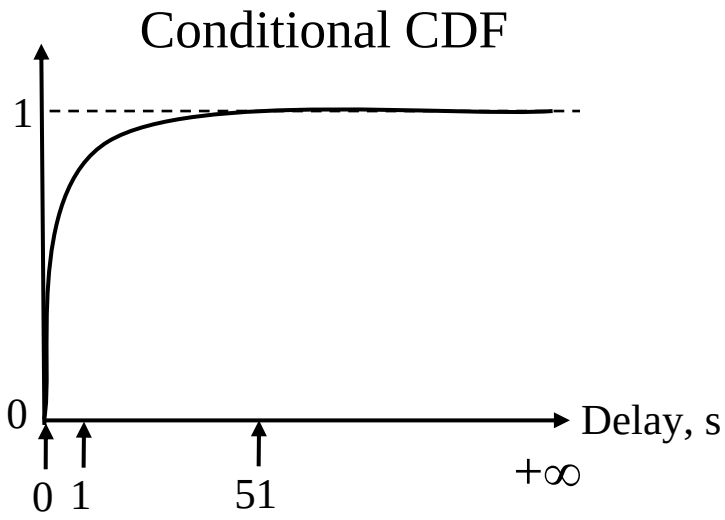
Effect of POV on the Delay Metric (3)

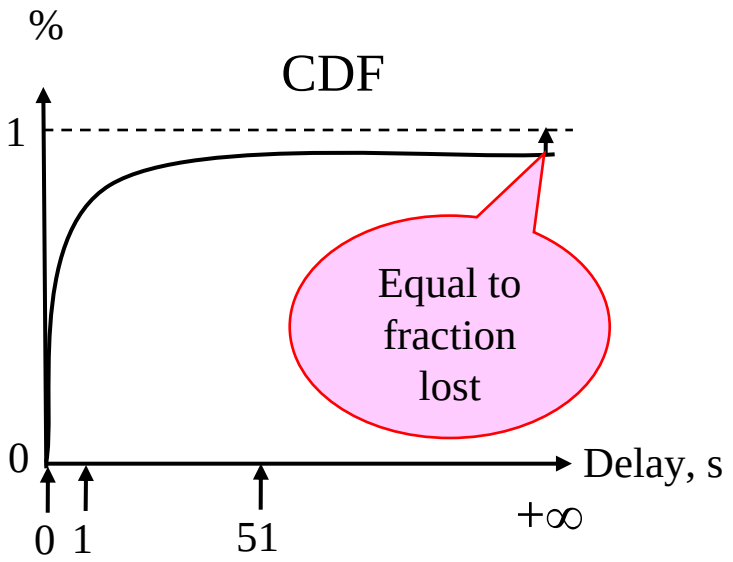
- **Network Characterization**
  - ➔ **Assume both Loss and Delay will be reported (at least)**
  - ➔ **Packets that do not arrive within the Loss Threshold are reported as Lost, AND**
  - ➔ **When they are assigned UNDEFINED delay, then the network's ability to deliver is captured only by the Loss metric**
  - ➔ **If we were to assign Infinite Delay to the Lost Packets, then:**
    - ✦ **Delay results are influenced by packets that arrive, and those that do not.**
    - ✦ **The delay and loss singletons do not appear orthogonal**
    - ✦ **The network is penalized in both Loss and Delay metrics**

Effect of POV on the Delay Metric (4)









Effect of POV on the Delay Metric (5)

- **Delay Variation**
  - ➔ **RFC 3393 excludes lost packets from samples (sec 4.1)**
  - ➔ **Reduces the event space by conditioning on arrival**
  - ➔ **Considers Conditional Statistics**
  - ➔ **Allowing packets with Infinite delay to be considered would influence the results in a non-useful way**
- **Reordering**
  - ➔ **The draft excludes lost packets based on a loss threshold, so maintains orthogonality to Loss**
  - ➔ **If we fail to distinguish between loss and delay, and assign lost packets some long delay value (e.g., infinity),**
  - ➔ **then the sequence numbers of packets assigned a long delay will surely be less than "Next Expected" value (if or when they arrive)**
  - ➔ **and they could be designated reordered.**

Status of IPPM Active Work in this area

- **New effort chartered on Metric Composition and Aggregation:**
  - **Framework Draft – common concepts and terminology**
  - **Temporal Aggregation – short-term meas. in long-term**
  - **Spatial Aggregation – summarize many paths across net**
  - **Spatial Composition – combine perf. of many sub-paths**
    - **Defined a "Finite Delay" Metric, enabling computation of the mean delay, and simple aggregation.**
    - **Avoids the informal assignment of "infinite" delay when a packet is lost – simply leave delay UNDEFINED.**
    - **This is consistent with the One-way Delay RFC 2679**
- **Future of this work will be influenced by the conclusions of this discussion**

Preferred Statistics on Delay

- **Sample Mean is Ubiquitous in Reporting (almost)**
  - ➔ **Usually based on a conditional distribution**
  - ➔ **Has some robustness to single errors in large sample**
    - ✦ **Vast crowds consider it useful (not harmful)**
    - ✦ **Robustness is both a strength and a weakness**
    - ✦ **Yes, you can run with scissors**
- **Median has different properties**
- **It can be informative to report BOTH Mean and Median**
  - ➔ **When they differ, there's information ...**
- **Delay Variation – See IETF-65 slides on Jitter Metric Comparison**

Summary: Suggestions

- **Set a LONG Loss threshold**
  - ➔ **Distinguish between Long Finite Delay and Loss**
  - ➔ **Avoid truncated distributions**
- **Delay of Lost Packets is UNDEFINED**
  - ➔ **Maintain orthogonality – avoid double-counting defects**
  - ➔ **Use conditional distributions and compute statistics**
- **Report BOTH Loss and Delay**
- **Report BOTH the Sample Mean and Median.**
  - ➔ **Comparison of the Mean and Median is informative**
  - ➔ **Means may be combined over time and space (when applicable)**
  - ➔ **Means come with a weighting function for each sample if needed, the sample Size, and Loss simply reduces the sample size**
  - ➔ **Means are more Robust to a single wonky measurement when the sample size is Large**
- **Move the Industry Away from "Average Jitter"**
  - ➔ **Use the 99.9%-ile minus minimum PDV**
  - ➔ **Portray this as a Delay Variation "Range"**