History of draft-duffield-ippm-burst-loss-metrics

- Aim: standardize burst loss probing methodology [SBDR08]
- Initial presentations IETF 72, 73
- -00 individual draft published prior to IETF 74
- IPR disclosures for -00 draft completed April 2009
- -01 draft published July 2009
Motivation Recap

- **Motivation**
  - One-way packet loss metrics
  - Current standards (mostly) concerned with average loss
  - Applications performance can be sensitive to patterns of loss

- **Develop Burst Loss Metrics**
  - Characterize packet burst loss patterns by two metrics
    - Average Loss Rate (as before)
    - Average Loss Episode Duration
    - Average Loss Episode Frequency (i.e. # of episodes per unit time)
  - Probing Methodology
    - Need more than usual Poisson probes to accurately measure burst loss

- **Build on Framework/Terms/Ideas from existing IPPM RFCs**
  - RFC 2680, RFC3357, RFC3393, RFC3611
Related IPPM Standards

- **RFC 2680: A One-way Packet Loss Metric for IPPM**
  - Average Loss Metric: Type-P-One-way-Packet-Loss
  - Samples: Type-P-One-way-Packet-Loss-Poisson-Stream

- **RFC 3393: IP Packet Delay Variation Metric for IPPM**
  - Focus on delay variation.
  - Useful Ingredient: selection function F specifies which packets used

- **RFC 3357: One-way Loss Pattern Sample Metrics**
  - Per packet detail on packet loss e.g.
    \{<T1,0>,<T2,1>,<T3,0>,<T4,0>,<T5,1>,<T6,0>,<T7,1>,<T8,0>,<T9,1>,<T10,1>\}

- **RFC 3611: RTP Control Protocol Extended Reports (RTCP XR)**
  - Burst Loss metrics for VoIP quality reporting
  - Burst and gap loss statistics on seqno of received packets
    - Related to parameters of 2-state Gilbert Model
**Burst Loss vs. Average Loss**

- **Example VoIP**
  - Frequent small glitches vs. local burst (at same average loss rate)

- **Suppose users don’t distinguish shorter from longer burst losses**
  - At least for burst lengths in some range

- **Relevant metric: # of loss bursts**

- **Other examples:**
  - MPEG video: compare burst loss duration to frame duration
  - TCP: compare burst loss duration to RTT
Methodology Idea

- **Loss Episode**
  - Defined as maximal sets of consecutive lost packets
  - Want to estimate duration of loss episodes

- **Probe pairs sample transitions into and out of loss episodes**
  - Loss Pair = a Bi-packet possible outcome from (0,0), (0,1), (1,0), (1,1)
  - 1 = loss, 0 = no loss

- **Poisson stream of bi-packet probes**
  - Only need to *sample* from set of possible loss pairs

- **Estimate loss episode frequencies and durations**
  - From measured frequencies of bi-packet outcomes
Organization of -01 draft

- Section 2: bi-packet loss singleton metrics
  - a loss pair

- Section 3: general definition of samples for bi-packet loss
  - sets of loss pairs

- Section 4: active probing methodologies
  - sets of loss pairs produced by Poisson loss pair probes

- Section 5: burst loss proto-metrics
  - express burst loss metrics in terms of generic sets of loss pairs

- Section 6: burst loss metrics
  - these result by applying burst loss proto metrics to Poisson loss pairs of Sec. 4

- New in -01 draft
  - Use of burst loss proto metrics + organization of Sections 4,5,6
  - (Hopefully) more intuitive burst loss metrics names (see later)
  - Filled in RFC 2680 template (explicitly or by reference) for metric definitions
-01 Draft: Metrics and Associated Quantities

- **Loss Pair**
  - Generic outcomes from a bi-packet probes

- **Type-P-One-way-Bi-Packet-Loss**
  - Loss pair resulting from a bi-packet probe

- **Type-P-One-way-Bi-Packet-Loss-Stream**
  - Loss pairs resulting from a set of bi-packet probes

- **Type-P-One-way-Bi-Packet-Loss-Geometric-Stream**
  - Loss pairs from a discrete Poisson bi-packet probe stream (samples)

- **Burst Loss Proto-Metrics**
  - **Loss-Pair-Counts**
    - Counts of different types of loss pair present in a sample
  - **Bi-Packet-Loss-Ratio**
    - Estimate of packet loss ratio from loss-pair-counts
  - **Bi-Packet-Loss-Episode-Duration**
    - Estimate of average loss episode duration from loss pair counts
  - **Bi-Packet-Loss-Episode-Frequency**
    - Estimate of loss episode frequency from loss pair counts

- **Type-P-One-way-Bi-Packet-Loss-Geometric-Stream-Ratio**
  - Packet loss ratio derived from loss counts of Type-P-One-way-Bi-Packet-Loss-Geometric-Stream

- **Type-P-One-way-Bi-Packet-Loss-Geometric-Stream-Episode-Duration**
  - Average burst duration derived loss counts of Type-P-One-way-Bi-Packet-Loss-Geometric-Stream

- **Type-P-One-way-Bi-Packet-Loss-Geometric-Stream-Episode-Frequency**
  - Average burst freq. derived from loss counts of Type-P-One-way-Bi-Packet-Loss-Geometric-Stream

**Final burst loss metrics: proto metrics acting on loss pairs of geometric probe stream**
Type-P-One-way-Bi-Packet-Loss (as in -00 draft)

- **Elementary 2 packet loss metric**
- **Parameters**
  - Src, Dst IP address
  - T1 = sending time of the first packet
  - T2 = sending time of the second packet
  - F = a selection function
  - P = the specification of the packet type
- **Metric Units**
  - Loss Pair
Loss pairs resulting from set of bi-packet probes

Parameters

- Src, Dst IP address
- \((T_{11},T_{12}), (T_{21},T_{22}),...,(T_{n1},T_{n2})\) a set of \(n\) times of sending times for packet pairs, with \(T_{11} < T_{12} \leq T_{21} < T_{22} \leq ... \leq T_{n1} < T_{n2}\)
- \(F\), a selection function
- \(P\), the specification of the packet type

Metric Units

- Resulting loss pairs \(L_1, L_2,...,L_n\)
Type-P-One-way-Bi-Packet-Loss-Geometric-Stream (as -00 draft)

- **(Discrete time) Poisson set of bi-packet probes**
  - Interval between probes = interval between packets within probe

- **Parameters**
  - Src, Dst, IP address
  - T time of first probe
  - d, time interval
  - n, number of possible probe launches
  - q, per probe launch probability
  - F, selection function
  - P, the specification of the packet type

- **Units**
  - Loss pairs L1, L2, ..., Lm for some m <= n
Burst Loss Proto Metrics

- Convert set of loss pairs into burst loss metrics
  - Input: set of n loss pairs L1,…,Ln

- Pair Counts
  - Output: \( N(i,j) = \#\{\text{loss pair type } (i,j)\} \) for \((i,j) = (0,0), (0,1), (1,0), (1,1)\)

- Bi-Packet Loss Ratio
  - Output: \( \frac{(N(1,0) + N(1,1))}{(2*n)} \)
    - Average of single packet loss
    - Formally equivalent to Type-P-One-way- Packet-Loss-Average / RFC 2680

- Bi-Packet-Loss-Episode-Duration
  - Output:
    - \( 2*(N(0,1) + N(1,0) + N(1,1) - (N(0,1)+N(1,0)) - 1 \) (when \( N(0,1) + N(1,0) > 0 \))
    - 0 if \( N(0,1) + N(1,0) + N(1,1) = 0 \) (no probes lost)
  - Mean number of probe packets in a loss episode

- Bi-Packet-Loss-Episode-Frequency
  - Output:
    - \( \frac{(N(1,0)+N(1,1)) * (N(0,1)+N(1,0))}{(2*N(1,1)+N(0,1)+N(1,0))} / n \) if \( N(0,1)+N(0,1) > 0 \)
    - 0 if \( N(0,1)+N(1,0) + N(1,1) = 0 \) (no loss), 1 if \( N(0,1) + N(1,0) + N(0,0) = 0 \) (all loss)
  - Average number of loss episodes per inter-probe time
Type-P-One-way-Bi-Packet-Loss-Geometric-Stream-Ratio

- Loss Ratio estimate from discrete Poisson set of bi-packet probes
- Parameters (as Type-P-One-way-Bi-Packet-Loss-Geometric-Stream)
  - Src, Dst, IP address
  - T time of first probe
  - d, time interval
  - n, number of possible probe launches
  - q, per probe launch probability
  - F, selection function
  - P, the specification of the packet type
- Units
  - A number in the interval [0,1]
Type-P-One-way-Bi-Packet-Loss-Geometric-Stream-Episode-Duration

- Loss episode duration estimate from set of discrete Poisson bi-packet probes
- Parameters (as Type-P-One-way-Bi-Packet-Loss-Geometric-Stream)
  - Src, Dst, IP address
  - T, time of first probe
  - d, time interval
  - n, number of possible probe launches
  - q, per probe launch probability
  - F, selection function
  - P, the specification of the packet type
- Units
  - A non-negative number
Loss episode frequency estimate from set of discrete Poisson bi-packet probes

Parameters (as Type-P-One-way-Bi-Packet-Loss-Geometric-Stream)
- Src, Dst, IP address
- T, time of first probe
- d, time interval
- n, number of possible probe launches
- q, per probe launch probability
- F, selection function
- P, the specification of the packet type

Units
- A non-negative number
Status and Next Steps

- Please read and comment
- Adoption as WG draft?