

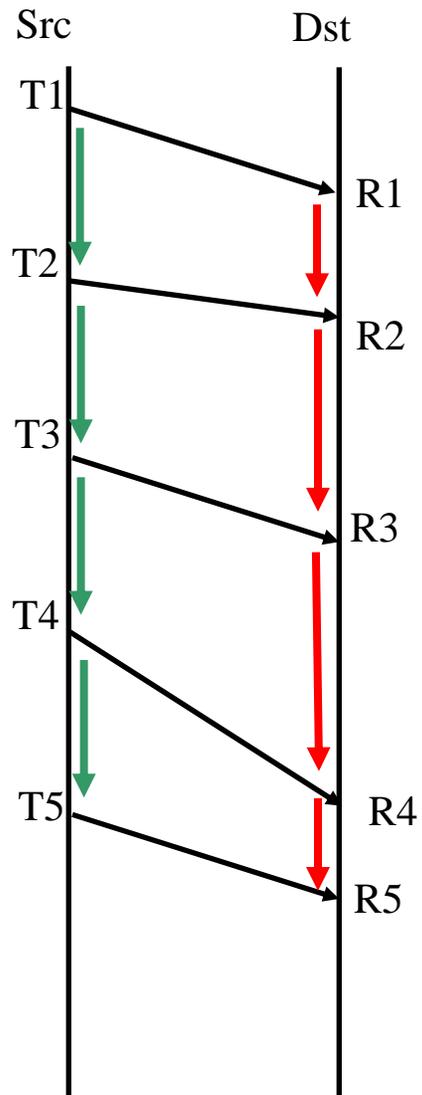
*A Brief Jitter Metrics Comparison,
and not the last word, by any means...*

March 21, 2006

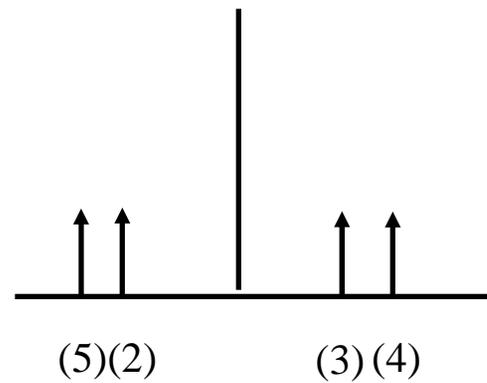
Al Morton

**(Remember, both metrics described here
are RFC 3393-compliant.)**

Inter-Packet Delay Variation

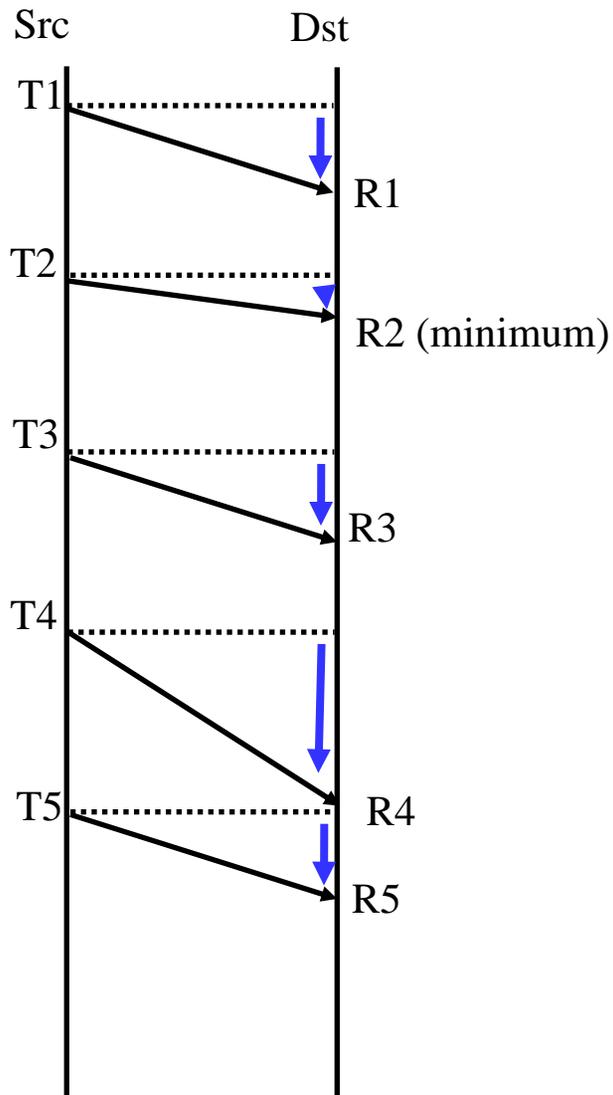


$$\text{IPDV}(2) = (R2-R1) - (T2-T1)$$

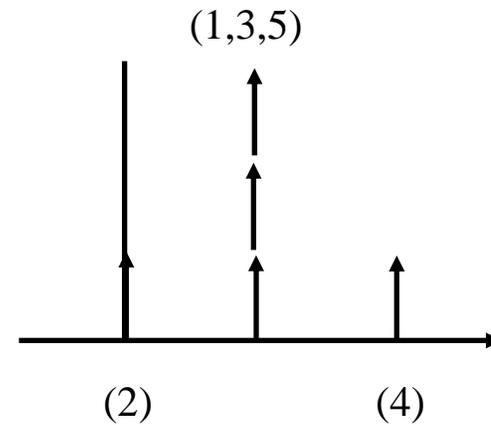


$$\text{IPDV}(4) = (R4-R3) - (T4-T3)$$

Packet Delay Distribution



$$PDV(3) = (R3 - T3) - (R2 - T2)$$



$$PDV(4) = (R4 - T4) - (R2 - T2)$$

IPDV (selection $f = \text{previous packet}$)

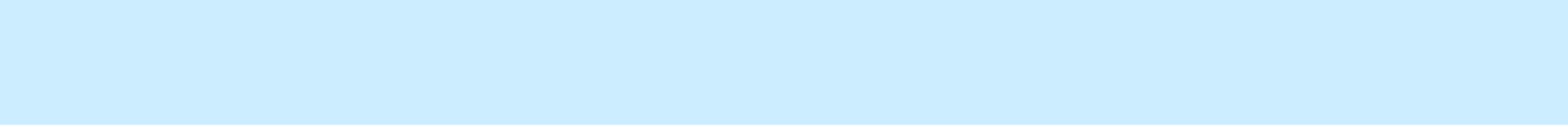
- **Dynamic Reference for assessing variation**
- **Possible to relate to RFC 3550 Jitter (smoothed est.)**
- **Minimal Dst Clock stability required**
- **Path Change WITH Loss is effectively IGNORED**
- **Path Change WITHOUT Loss affects 2 IPDV readings**

PDV (selection $f = \text{minimum delay pkt in stream}$)

- **Single, Fixed Reference, normalizes delay distrib.**
- **No clear relationship to RFC 3550 Jitter**
- **Dst Clock for 1-way delay, but in practice only stability matters over a longer evaluation interval**
- **Path Change WITH Loss causes Bi-Modal Distrib.**
 - ➔ **Practical fix: Could terminate a sub-interval after loss of x packets**
- **Path Change WITHOUT Loss -> Bi-Modal Distrib.**
 - ➔ **But that's what a de-jitter buffer would experience, too...**

HOW do YOU want to use the DV results?

- 1. Compare with Requirements/SLA/Maint. Threshold?**
-- but how are your customers using the Req/SLA/MainThresh?
- 2. Real-Time Application Planning: How big should my De-jitter buffer be?**
-- Note that even Adaptive DJB use a fixed reference between adjustments.
- 3. <insert your answer here>**
- 4. ACM 's answer:**
Doing (1.), to support (2.), with Composed Metrics (earlier talk),
in a multi-operator environment



Comparison of Jitter Concatenation Methods using Segmented Jitter Measurements

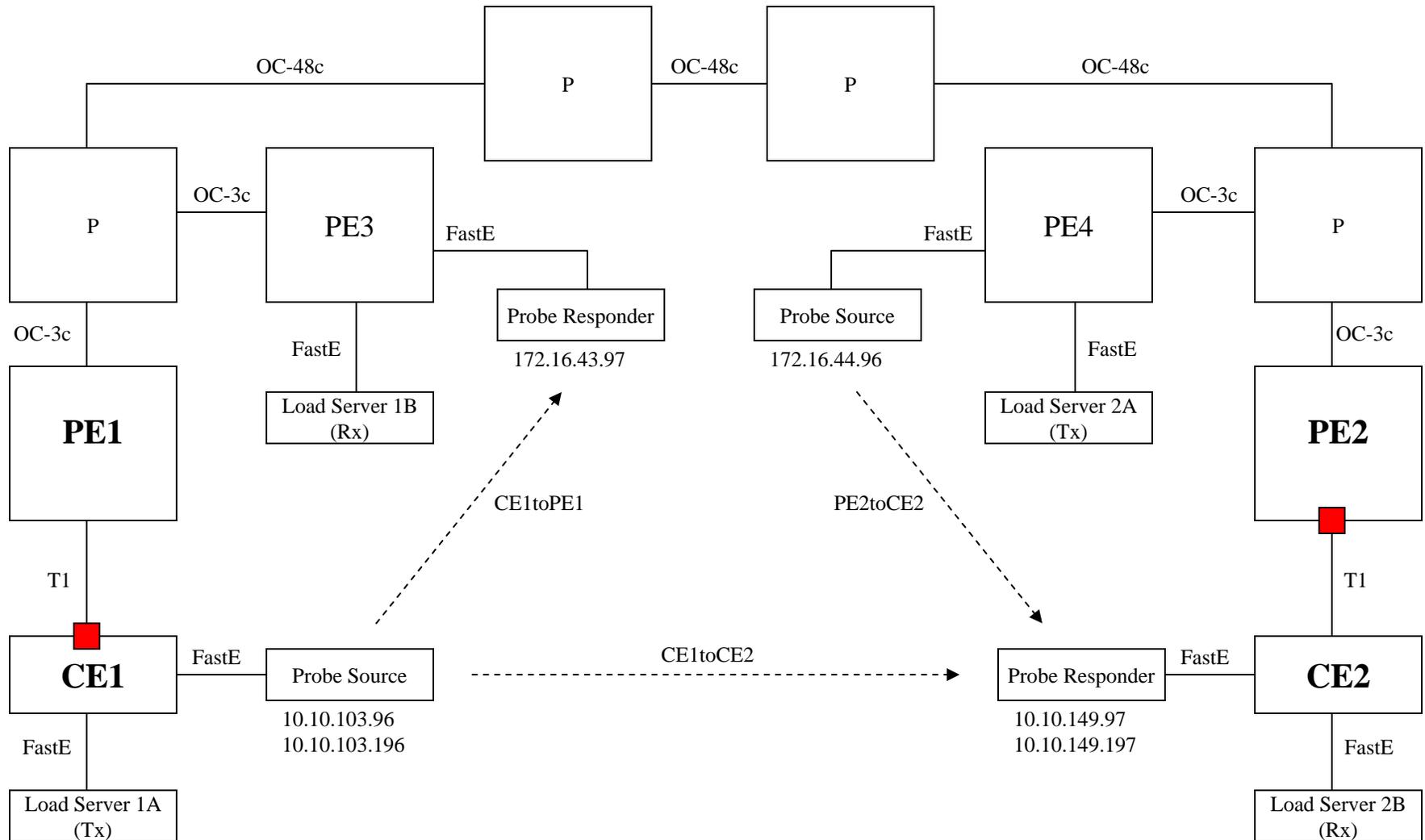
(Short summary of results)

**Len Ciavattone,
Al Morton, and Gomathi Ramachandran
(with contributions from Dave Hoeflin)**

Measurement Summary

- **Simultaneously measured jitter across two independently congested CE/PE T1 interfaces as well as end-to-end from CE to CE**
- **Generated all three sets of measurement probes from a single server (with multiple interfaces) to a second server acting as a responder (also with multiple interfaces)**
- **Generated unidirectional TCP background traffic from CE1 to PE1 and from PE2 to CE2 (no background traffic was sent between PEs)**
- **Probes were 60 byte (UDP) packets with 20 ms spacing**
- **All servers were running RedHat Linux 9.0**
- **All T1 queuing was configured as FIFO**

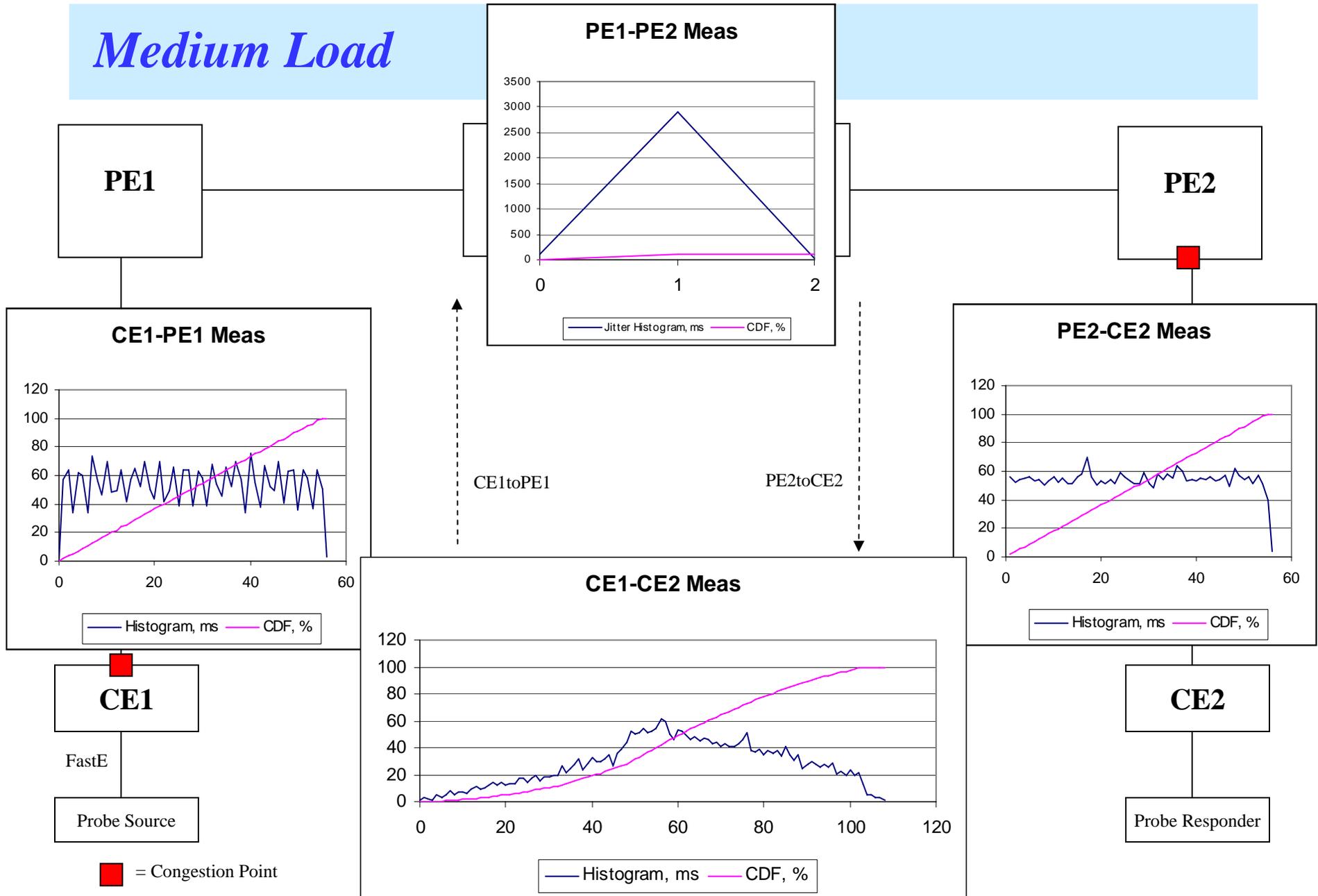
Lab Measurement Set-up



■ = Congestion Point

Note: "Probe Source" shown as two separate servers for clarity. Same for "Probe Responder".

Medium Load



Medium Load: Comparison of Estimation Methods

	CE-CE Meas.	Est. from mean, variance and segment %-iles	Collect/ Convolve 1 ms bin histogram (D.Hoefflin)	RMS Addition (an old approx)	Heuristic Addition of %-iles
99.9%-ile, ms	107	103.5	109	79.2	110 (95+95+99.9)
Error to Meas.	----	3.5 ms -3.3%	2 ms 1.9%	-27.8 ms -26.0%	3 ms 2.8%

Single repeating 10,000 byte TCP transfer (new connection setup for each)
Load Server Start Times: Simultaneous