

Metrics and Methods for IP Capacity

draft-morton-ippm-**capacity**-metric-method-01

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Define the Metric

- Maximum IP-Layer Capacity (incl header + payload)
- One of many metrics that could be defined
- Word Def. and an Equation (with variables explained)

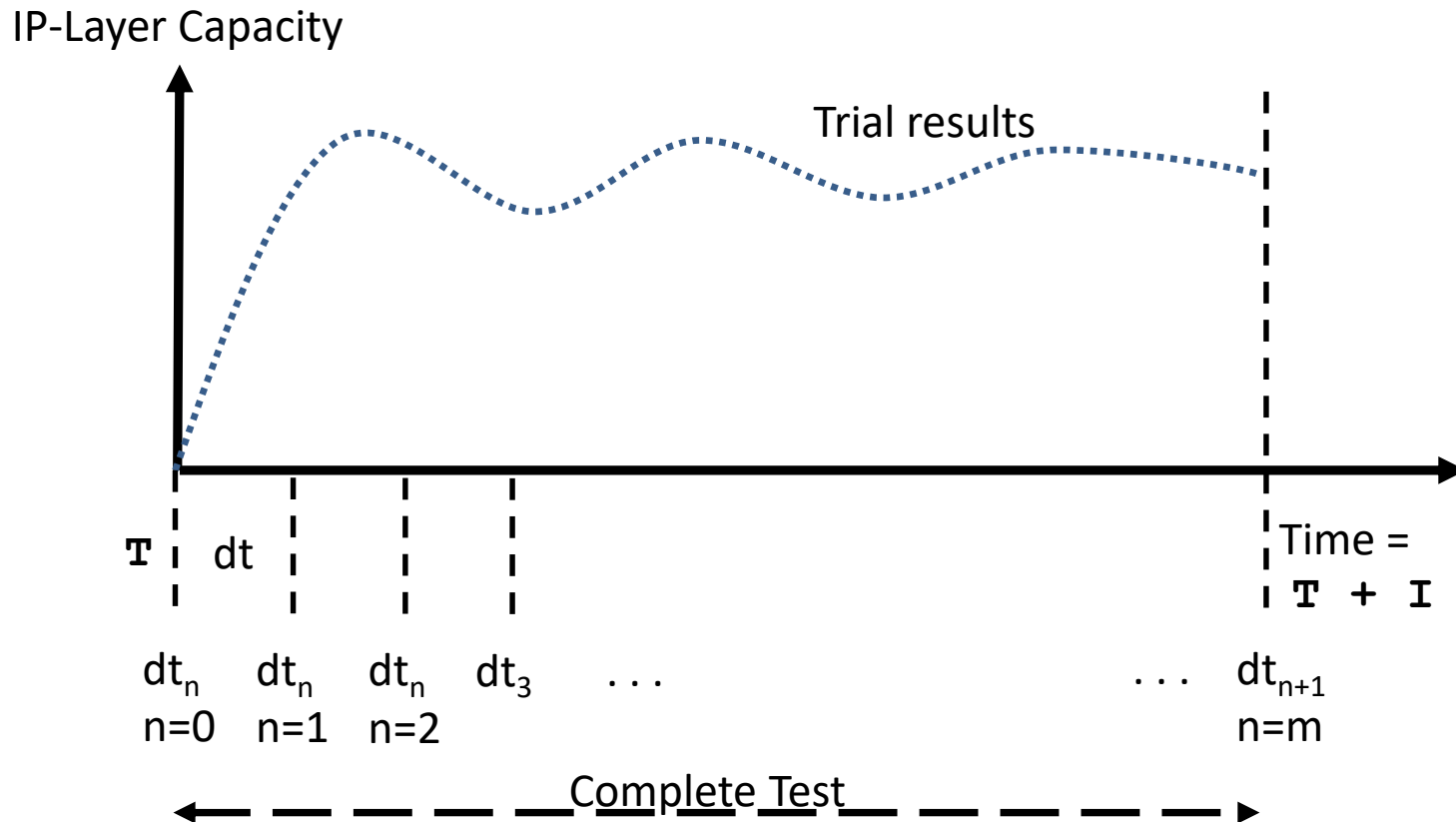
$$\text{Maximum_C}(T, I, \mathbf{PM}) = \frac{\max_{[T, T+I]} (n_0[\text{dtn}-1, \text{dtn}])}{dt}$$

where:

T < ----- Measurement Interval -----> T+I



Receiver Rate Measurement



IETF – Sept List Points raised (and addressed) -1

- @@@@ A clear take-away is that reporting must account for **bimodal** features, if/when measured.
- ++++ Covered in Section 6.6, reporting the Metric
- @@@@ Also, that wide-spread measurements will encounter wide-spread behaviors - testing should continue + expect some evolution.
- ++++ Covered in the Methods of Measurement Section
- @@@@ IMO, many of the above challenges fall on the measurement methodology: allow for traffic & time to initiate an on-demand access.
- @@@@ Also, results depend on the sending stream characteristics; we've known this for a long time, still need to keep it front of mind.
- ++++ both above covered in Methods of Measurement, Considerations.
- @@@@ Max IP-Layer Capacity and RFC 3148 BTC (goodput) **are different** metrics. Max IP-layer Capacity is like the theoretical goal for goodput.
- ++++ Section 1, Intro
- @@@@ This is a big one: when the path we measure is state-full based on many factors, the Parameter "Time of day" when a test starts is not enough info. We need to know the time from the beginning of a measured flow, and how the flow is constructed including how much traffic has already been sent on that flow, because state-change may be based on time or bytes sent or both. See RFC 7312.
- ++++ included in Measurement Considerations

IETF – Sept List Points raised (and addressed) -2

- @@@@ The **Singleton and Statistic** formulations of IPPM's framework RFC 2330 are still valuable in this context, possibly combined with results criteria ("stable" for X singletons, non-arbitrary threshold needed to define "stable").
- +++++ The Singleton, Sample and Statistic for IP Capacity are implemented.
- ---- "stable" needs more discussion, or may be resolved by Qualification below.
- @@@@ Measurements depend on the access network and the use case. Here, the use case is to assess the maximum capacity of the access network, with specific performance criteria used in the measurement.
- +++++ Covered in the Intro.
- @@@@ Goals made clearer in the next draft, if possible.
- +++++ Covered in the Intro.
- @@@@ A qualification measurement for the search result is a subsequent measurement, sending at a fixed 99.x % of the Max IP-layer Capacity for I, or an indefinite period. The same Max Capacity Metric is applied, and the Qualification for the result is a sample without packet loss or a growing minimum delay trend in subsequent singletons (or each dt of the measurement interval, I). Samples exhibiting losses or increasing queue occupation require a repeated search and/or test at reduced fixed sender rate for qualification.
- Here, as with any Active Capacity test, the test duration must be kept short. 10 second tests for each direction of transmission are common today. In combination with a fast search method and user-network coordination, the concerns raised in [RFC 6815] are alleviated.
- +++ covered in the method of measurement section, subsection on Measurement Qualification and Verification

<https://tools.ietf.org/html/draft-morton-ippm-capacity-metric-method-00>

October List Discussion: Matt, Rüdiger, acm (1)

- Summary: Matt is saying (? Subject to confirmation)
 - @@@@ RTT is a good singleton measurement interval (dt) to avoid “bursts & silence”
 - Use windowed Max of max_rate from BBR (but see our measurements)
 - Rüdiger: “Len and acm meas. results show convergence to an LTE receiver bandwidth meas. with limited queuing and no drops.”
 - Defaults of dt = 1 second, $\Delta t = 10$ sec
 - udpst tool sends feedback measurement at regular intervals = 50 ms
 - acm thinking: sub-second rate meas. are more susceptible to the cases described by Matt, and by Joachim Fabini (time-slot service with full link capacity play-out of the queue: LTE, others).
 - acm: But no assessment of loss with BBR, QUIC encrypt & aggregates
- ++++ We’ve added the defaults above with parameters when they appear, and more discussion in section 8.2
- ++++ Considerations for testing with parallel flows (sec 8).
- ++++ Default for the Sending rate measurement interval (sec 7, 0.05 s)

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Next Steps

There *IS* an active Metrics and Methods community in IPPM WG, among protocol devs:

- Many-many comments and reviews have resulted in a very complete draft.
- Authors believe it worthy of WG Adoption:
 - Harmonization: Keep-up with parallel efforts to ensure IPPM's expertise known elsewhere
 - Reach Consensus fast, start protocol support
- Do IPPM'ers Support Adoption?
 - Other opinions??
- Additional Volunteers for Review

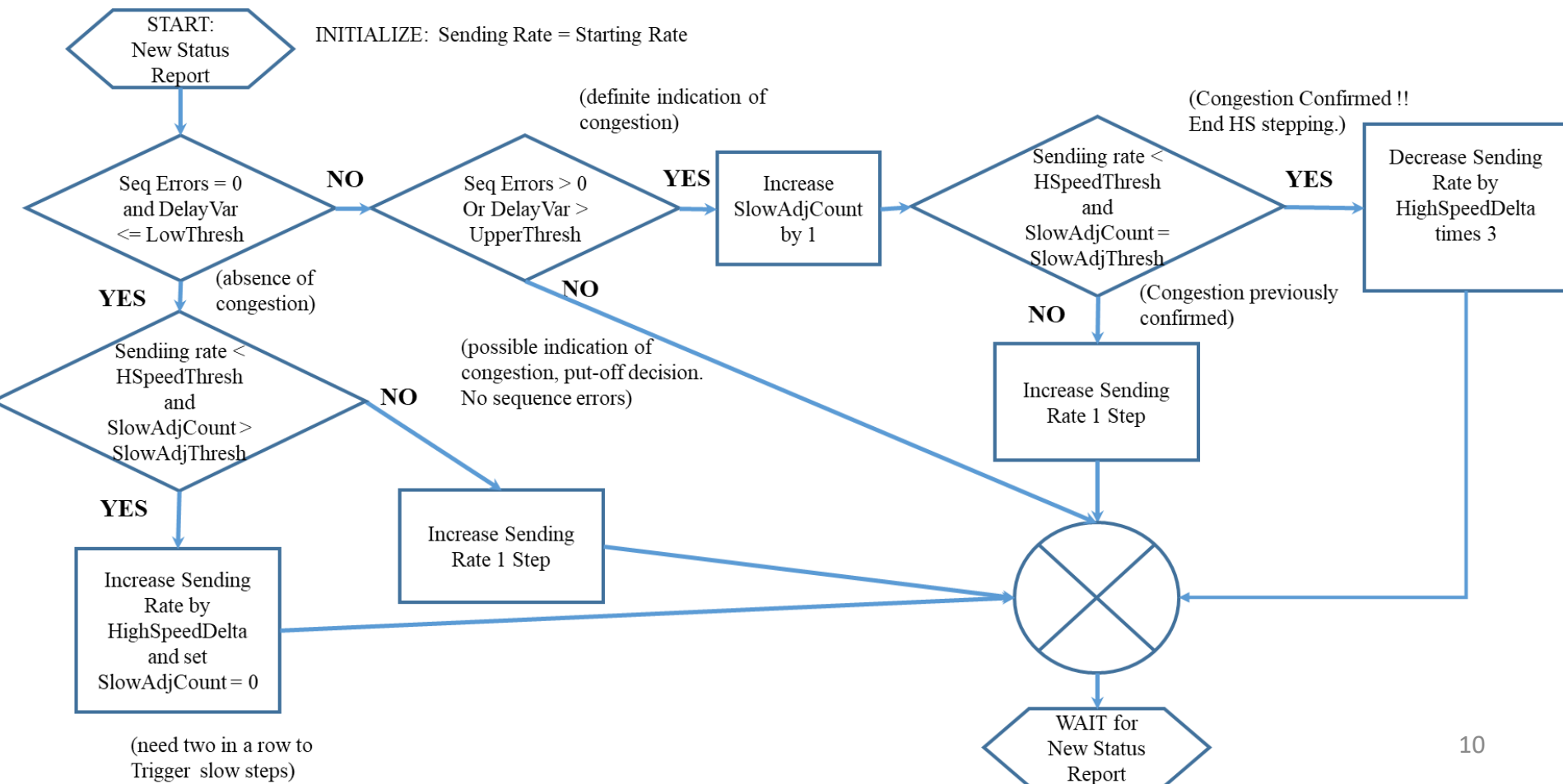
Background

- Hackfest 106 Slides:
- Hackfest 105 Slides: [Test Results](#)
- Liaisons from ITU-T SG 12 and ETSI TC STQ – see email for links, or
- <https://datatracker.ietf.org/liaison/1645/>
- <https://datatracker.ietf.org/liaison/1643/>
- <https://datatracker.ietf.org/liaison/1634/>
- <https://datatracker.ietf.org/liaison/1632/>
- More Test results in the Liaison attachments

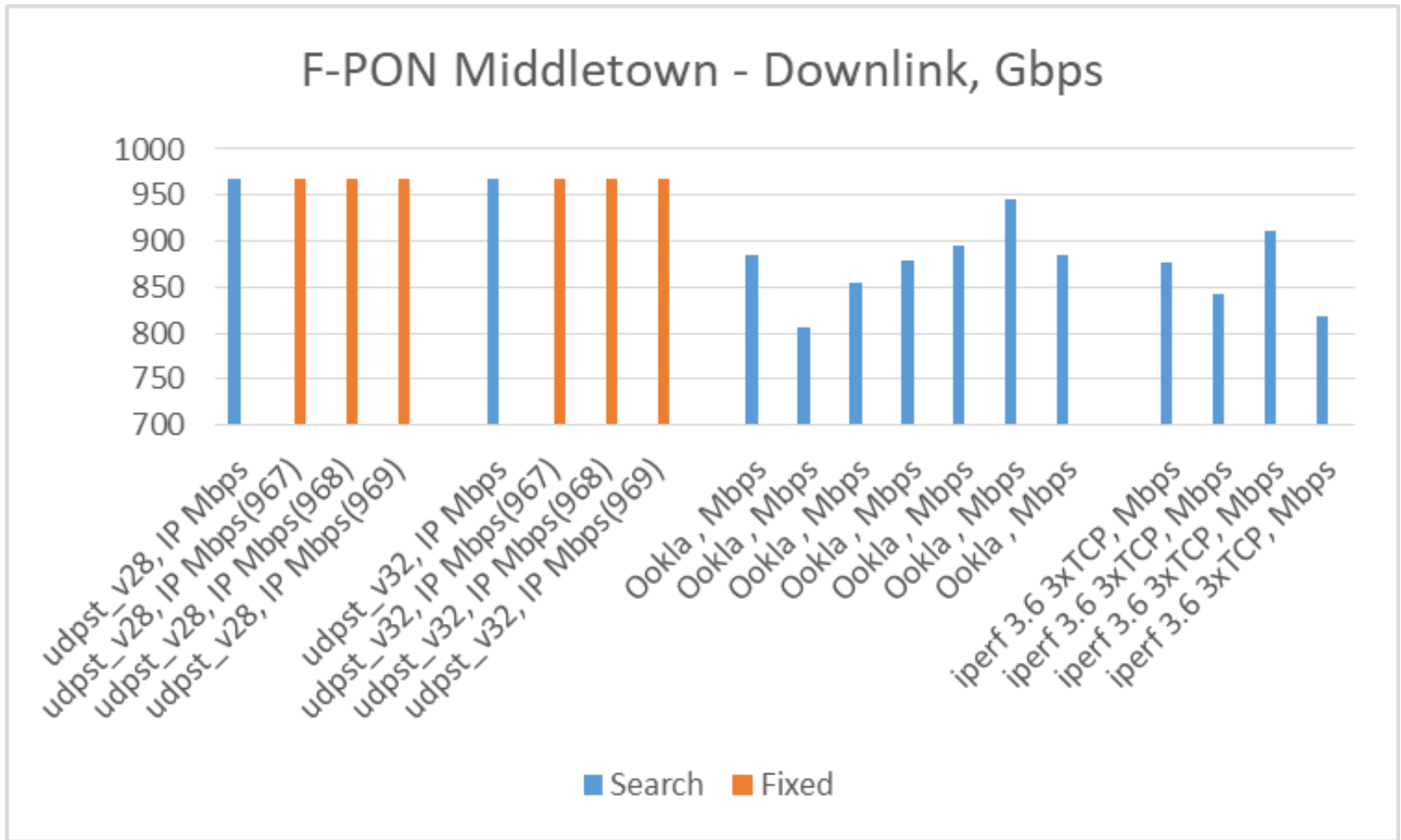
BACKUP

Define the Method

- “PM” is short-hand for the performance constraints on the Load Rate Adjustment Alg.:



Recent Test Results



Udpst and Ookla Web Sockets Clients

Udpst and Ookla Web Sockets Servers

UDP-Speedtest
Middletown, NJ



October List Discussion: Matt and Rüdiger

- It is fairly normal to see packets arrive in back to back packet trains, separated by periods of silence. Half- Duplex, Pkt Aggregation, ...
- MM: simplistic meas. of LTE receive rates often see modes at 1Gb/s.
- BBRv2 uses rate measurement per RTT:
 - $\text{rtt_sample} = \text{delta}(\text{timestamp}) \# 1 \text{ RTT}$
 - $\text{rate_sample} = \text{delta}(\text{total data ACKed})/\text{rtt_sample} \# \text{ one RTT's worth of data}$
- Effectively: $\text{Capacity}(t, \Delta t, n, \langle \text{no PM} \rangle) = n0[\text{dtn}-1, \text{dtn}]/(\text{dt} = \text{RTT}n)$
- min_rtt and max_rate (used by BBR congestion control) are the windowed (?) max and min of rtt_sample and rate_sample above
- MM: I predict that max of BBR's max_rate will be a more robust and more accurate measure of the short duration maximum rate than anything you can do with UDP (except perhaps QUIC, BBR over UDP).