broadband forum

MARKETING REPORT

MR-471.1: Maximum IP-Layer Capacity Metric and Measurement

Issue History

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Executive Summary

Many assumptions about Internet Access have changed over the last 5 years. While the state of the art and some future developments were fairly accurately captured by literature in 2013, some changes were unforeseen. For example, speed/capacity alone was the key performance measure until very recently, but now latency is just as critical. Also, Transmission Control Protocol (TCP) was the dominant reliable transport protocol; however User Datagram Protocol (UDP) and QUIC have a large role which continues to grow. Emphasis was on test paths with multiple operator networks from user to content servers, but now the content is moving closer to the user: Content Distribution Network (CDN) or Mobile Edge Computing servers will terminate connections within a single domain. Any one of these shifts in the network environment, along with needs of Internet Service Providers (ISPs), has significant repercussions on the network performance and therefore the metrics and measurements used to assess performance must follow quickly.

This document explores the motivation and gives an introduction to the new UDP-based IP Capacity metric and associated measurement methods under development in Broadband Forum in coordination with other global organizations. These methods aim to solve current TCP-based measurement issues encountered on today's highest-speed Internet access and provide a simple standardized metric and method where none previously existed.

1 Background

Many assumptions about Internet Access have changed over the last 5 years. *Improved Internet speed tests can enhance QoS and QoE* [1] captured the state of the art and future developments in 2013, but some changes were unforeseen, as indicated below.

5 years ago:	Today's trends:
User access was the bottleneck;	Mobile Carrier Aggregation & Gbps access
The main emphasis on Speed;	Latency also/more critical
TCP was *the*reliable transport;	UDP with QUIC large & growing
Measure multi-operator paths from user to content, and	Content moving to the user: CDNs, Mobile Edge Compute
Measure performance across Gateways between Tier 1 Ops	Content everywhere, Less traffic & less congestion at Gateways
You might not see ALL these trends happening in your region today, but arrival of any one changes the game!	

Figure 1: Designing Measurements: Today's clear trends, from [2]

Metrics and measurements of Access Performance should follow these trends, along with the needs of Internet Service Providers, their subscribers, and equipment suppliers.

2 Terminology

Term	Definition
QUIC	A new transport protocol under development in the IETF (work-in-progress)

2.1 References

The following references are of relevance to this Marketing Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Marketing Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document	Title	Source	Year
[1]	*Improved Internet speed tests can enhance QoS and QoE*	RAIM-2015 (PQS 2013)	2013
[2]	*Broadband QoS and QoE Assessment, 5-years-on: Major Changes!*	ITU Workshop	2018
[3]	*QUIC: A UDP-Based Multiplexed and Secure Transport (Work-in-progress)*	IETF	2019
[4]	*Using TLS to Secure QUIC (Work-in-progress)*	IETF	2019
[5]	*QUIC Loss Detection and Congestion Control (Work-in-progress)*	IETF	2019
[6]	*Hypertext Transfer Protocol Version 3 (HTTP/3) (Work-in-progress)*	IETF	2019

2.2 Abbreviations

This Marketing Report uses the following abbreviations:

AR	Augmented Reality
CDN	Content Distribution Network
CUBIC	A widespread form of congestion control for transport-layer protocols
GW	Gateway
IETF	Internet Engineering Task Force
QUIC	A new transport protocol under development in the IETF (work-in-progress)
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VR	Virtual Reality

3 Access Networks and Services Outrun TCP Speed Tests

As the speed of access links increase into the gigabit range for some technologies, the dominant methods of helping users test to discover their actual “Internet Speed” are showing their age. TCP-based methods, which react conservatively to loss and round-trip delay, produce a significant underestimate of Maximum IP-Layer Capacity.

Meanwhile, the Industry is seeing a transition to new protocols like QUIC [3,4,5,6], that will replace TCP for many applications. These new protocols use UDP as the Transport protocol and encrypt activity above the transport layer. Measuring the IP-Layer Capacity on a user’s access link should use the same Transport protocols as applications.

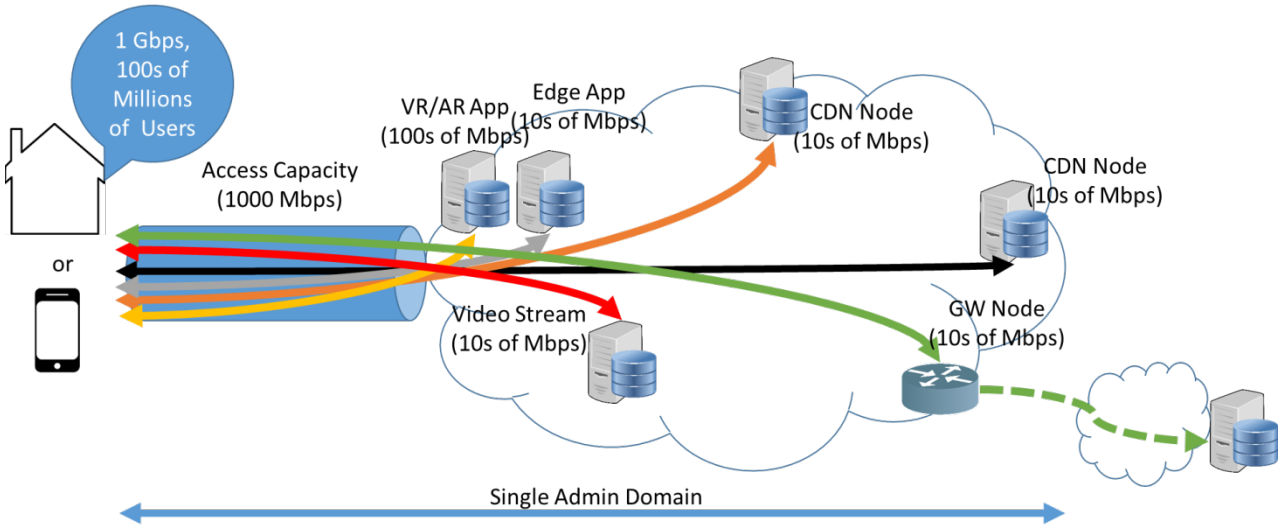

Figure 2: Service Capacity has Access Scope (user paths become diverse beyond), based on [1]

As Figure 2 shows, content is moving closer to users, but the user streams and content to/from servers frequently do not require the user’s full access rate. In such cases, latency and not speed becomes the critical issue for many applications (such as Augmented Reality (AR), Virtual Reality (VR), and Games). New metrics and methods of measurement need to reflect these realities.

4 IP Capacity Metric to the Rescue

The Broadband Forum is defining a new UDP-based IP Capacity metric and associated measurement methods in coordination with other global organizations. This project aims to solve current measurement issues with High-speed Internet access.

The Gigabit access services delivered by many service providers today have outstripped the ability of ad-hoc, TCP-based methods to measure their performance. The UDP-based IP Capacity metric and related measurement methods being specified in Broadband Forum can provide a much more accurate and consistent understanding of network performance, as shown in the figure below.

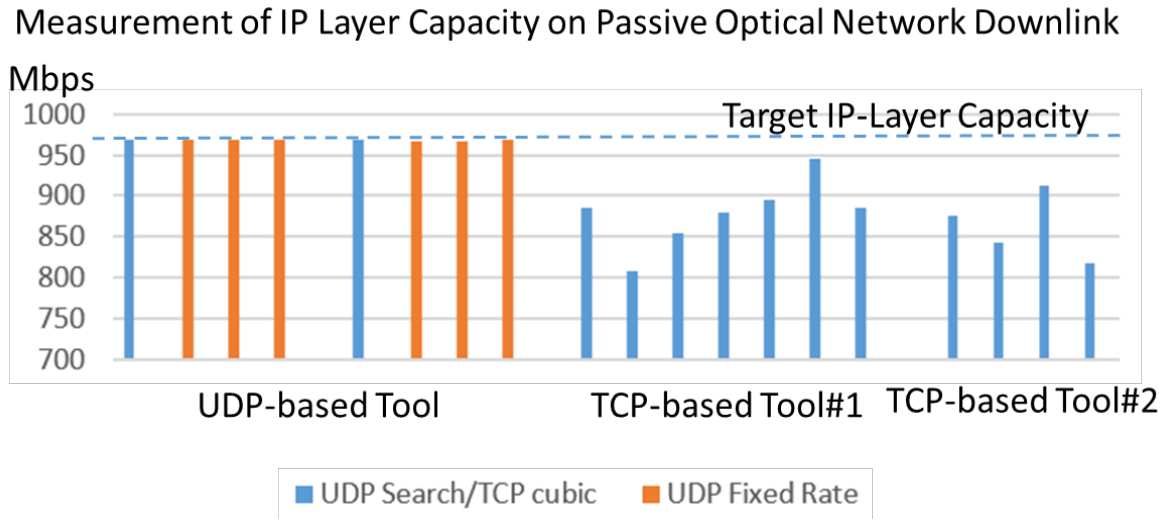

Figure 3: Recent 1Gbps Passive Optical Network Service test results

The metric and methods being developed apply to mobile as well as fixed access, with test measurements on an LTE network showing significantly more consistent results than their TCP-based counterparts.

The measurements can also provide consumer confidence in their service, and new dimensions for market messaging to specific user groups (e.g., Gamers emphasize Low Delay). The UDP-based measurement of Maximum IP Capacity simultaneously measures the packet loss, round-trip delay, delay variation, and reordering present. This is superior information to that provided by TCP and Ping measurements made separately.

5 Summary

The new Maximum IP-Layer Capacity Metric and Method(s) of Measurement based on UDP closes the gap between actual service rates and TCP's estimates under the measured conditions.

The new metric and method can measure the new Gigabit service without the confusing artifacts of TCP performance (such as its throughput sensitivity to packet loss, round-trip time, and its flow control details).

Choosing UDP transport helps make platform independence and equivalent implementations possible. It anticipates user transition from TCP to UDP and rate control to better take advantage of the Internet's scale in 2020, and it measures other important performance metrics when "speed" is not the only factor considered when choosing service.

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