Benchmarking Methodology Working Group
Internet-Draft
Intended status: Experimental
Expires: May 6, 2021

LM. Contreras
J. Rodriguez
L. Luque
Telefonica

November 2, 2020

5G transport network benchmarking

draft-contreras-bmwg-5g-02

Abstract

New 5G services are starting to be deployed in operational networks, leveraging in a number of novel technologies and architectural concepts. The purpose of this document is to overview the implications of 5G services in transport networks and to provide guidance on bechmarking of the infratructures supporting those services.

Table of Contents

1. Introduction

5G services are starting to be introduced in real operational networks. The challenges of 5G are multiple, impacting in different technological areas such as radio access, mobile core and transport network. Refer to [TMV] for a general overview of different aspects impacting 5G technology performance. From all those technological areas, the transport network is the focus of this document.

It is important for operators to have a good basis of benchmarking solutions, technologies and architectures before moving them into production. With such aim, this document intends to overview available guidelines to assist on the benchmarking of 5G transport networks, identifying gaps that could require further work and details.

As result, it is expected to provide guidance on benchmarking of 5G transport network infrastructures ready for experimentation in lab environments or real deployment in operational networks.

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC2119 [RFC2119].

3. 5G services

5G transport networks will need to accommodate different kind of services with very distinct needs and requirements leveraging on the same infrastructure. 5G services can be grouped in three main categories, namely enhanced Mobile Broadband (eMBB), ultra-Reliable and Low Latency Communications (URLLC), and massive Machine Type Communications (mMTC). Each of them presents different inherent characteristics spanning from ultra-low latency to high bandwidth and high reliability. For instance, eMMB services are expected to provide peak bit rates of up to 1 Gbps, uRRLC services will require latencies as lower as below microsecond delays, and mMTC will demand to support up to 100 times the number of current sessions. All these features impose great constraints to the networks deployed today in backhaul and aggregation, in terms of not only network capacity but also in terms of data processing, especially for guaranteeing very low latencies.

The impact in the transport network of those challenges is increased by some other additional challenges introduced by the emergence of two new technological paradigms: the network virtualization and the network programmability.

In one hand, virtualization will introduce uncertainty on the traffic patterns due to the flexibility and scalability in the deployment traffic sources in the transport network. On the other hand, programmability will potentially enable automated reconfiguration of the transport network which requires coordination mechanisms to avoid misconfigurations.

A final consideration is the introduction of the network slicing concept in 5G networks. According to that, the objective is to provide customized and tailored logical networks to different customers, allocating resources for the specific customer service request. With this respect the IETF has initiated the work in transport slicing (see [I-D.nsdt-teas-ietf-network-slice-definition]).

4. Benchmarking aspects of transport networks in 5G

The benchmarking aspects of 5G transport networks can be then structured in the following manner:

Data plane benchmarking: aspects to consider in data plane benchmarking refer to both hardware capabilities as well as to transport encapsulations. Examples of hardware capabilities are recent developments such as IEEE TSN, and example of encapsulation is SRv6 [I-D.ietf-spring-srv6-network-programming].

Control plane benchmarking: aspects to consider for control plane relates to transport infrastructure programmability. In this case some previous works exists such as RFC8456 [RFC8456].

Management plane benchmarking: one specific aspect of management benchmarking in 5G refers to the capability of managing the transport network slice lifecycle.

Architecture benchmarking: new architectural frameworks are being conceived to support advanced services like 5G. An example of these architectures is [I-D.ietf-detnet-architecture].

5. Key Performance Indicators

In order to define benchmarking criteria it is convenient to formalize Key Performance Indicators (KPIs) to assist on the assessment of the performance of the technologies under analysis.

5.1. Control and management plane KPIs KPIs

[I-D.nsdt-teas-ietf-network-slice-definition] introduces the concept of IETF Network Slice controller (NSC) as the element in charge of realizing, maintaining and monitor the IETF Network Slices as requested by higher level systems. The element itself can be assimilated to any other controller. From that perspective, it is possible to leverage on RFC8456 [RFC8456] to identify suitable KPIs. Thus, the following KPIs can be considered:

o Performance KPIs, including asynchronous message processing time and rate, proactive and reactive IETF network slice provisioning time, etc.

o Scalability KPIs, such as control sessions capacity, number of IETF network slices handled, etc.

o Security KPIs, like exception handling, denial-of-service attacks, etc.

- o Reliability KPIs, as failover time for the NSC.

Apart from that, other KPIs related to the monitoring and maintenance of the IETF network slices can be considered, as the ones related to telemetry.

5.2. Data plane KPIs

Data Plane KPIs will help to predict data plane performance under different measurement conditions. Existing metrics to consider are:

- o Bandwidth, considered as the maximum achievable throughput between two points. Those points can represent the ingress and egress ports of a equipment (e.g., to determine maximum throughput ofg a single element) or to an end-to-end setup. The througput could be differentieted in both directions of the link (i.e., upling and downlink).

- o Latency, considered as the network delay when transmitting between source and destination endpoints. This can apply to a single box (e.g., delay induced by a router implementing certain technology) or to a network scenario defined by a certain topology. RFC2681 [RFC2681] and RFC7679 [RFC7679] discuss about two-way (i.e., round trip time) and one-way delay metrics, respectively.

- o Jitter, understood as jitter the observable packet delay variation (PDV) as defined by RFC3393 [RFC3393], which is measured by the difference in the one-way.

- o Other general data-plane related issues affected for the usage of specific data plane technologies and/or encapsulations, such as MTU size, etc.

- o Other data-plane related issues specific to 5G such as e.g. the capability of isolation, understood as the avoidance of interference (i.e., affection) of traffic from different users in case of one of those user misbehaves or consumes more resources than expected.

6. Guidance on 5G transport benchmarking

To be completed.

6.1. Benchmarking topology

5G networks can be as complex as the one in Figure 1, from [I-D.rokui-5g-ietf-network-slice]. It comprises of fronthaul, midhaul, backhaul and even backbone segments, spanning end-to-end.

Each of those segments will have particularities, in terms of technologies used or routing solutions in place. In addition to that, because of the specific needs of the traffic to be supported, there will be different requirements applying to each of those segments. A clear example is the fronthaul segment, where protocols like CPRI or eCPRI will impose strict latency and bandwidth requirements, for instance.

```
     <--------------------- 5G E2E Network Slice  --------------------->
    <-------------- RS --------------->         <- CS ->
    <--- INS_3 --->    <-- INS_4 -->  <-- INS_1 -->     <--- INS_2 --->
 ......................................
 :  RAN                               :
 :       ......        ......        : ........          ......
 :|----|  :    : |----| :    : |----| : :      : |------| :    : |-----|
 :| RU |  : FN : | DU | : MN : | CU | : : TN1  : | Core | :TN2 : | App |
 :|----|  :    : |----| :    : |----| : :      : |------| :    : |-----|
 :       :....:        :....:        : :......:          :....:
 :                                   :
 :....................................:

Legend
  INS: 5G IETF Network Slice
  RS: RAN Slice
  CS: Core Slice
  FN: Fronthaul network
  MN: Midhaul network
  TN: Transport network
  DU: Distributed Unit
  CU: Central Unit
  RU: Radio Unit
  App: Mobile Application Servers
```

Figure 1: Transport segments in 5G networks

Since different restrictions apply, it will be necessary to consider specific topologies for each of thise segments, able to represent typical but meaningful deployment scenarios

6.2. IETF network slices

On top of the network above, thanks to the network slicing approach, it will be possible to build logical networks tailored to specific needs and services (e.g., eMBB, uRLLC, etc). As consequence, for the different topologies defined for the distinct transport network segments, it can be necessary to benchmark distinct kind of IETF network slices. The disctinction will come from the parametrization

used, expressed in base a number of parameters and attributes as described in [I-D.contreras-teas-slice-nbi].

An important aspect to test is the idea of isolation, or how a IETF network slice is not affected for a misbehavior on other IETF network slices supported by the same physical infrastructure. Different transport technologies can have distinct behaviors in this respect. For instance traffic policing or shaping mechanisms, hierarchical QoS, allocation of dedicated resources as FlexE calendar slots, etc. In this respect a common scenario can be solved follwoing different strategis according to the capabilities of each transport technology in place.

7. Security Considerations

This draft does not include any security considerations.

8. IANA Considerations

This draft does not include any IANA considerations

9. References

9.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

9.2. Informative References

[I-D.contreras-teas-slice-nbi]
Contreras, L., Homma, S., and J. Ordonez-Lucena, "IETF Network Slice use cases and attributes for Northbound Interface of controller", draft-contreras-teas-slice-nbi-03 (work in progress), October 2020.

[I-D.ietf-detnet-architecture]
Finn, N., Thubert, P., Varga, B., and J. Farkas, "Deterministic Networking Architecture", draft-ietf-detnet-architecture-13 (work in progress), May 2019.

[I-D.ietf-spring-srv6-network-programming]
Filsfils, C., Camarillo, P., Leddy, J., Voyer, D., Matsushima, S., and Z. Li, "SRv6 Network Programming", draft-ietf-spring-srv6-network-programming-24 (work in progress), October 2020.

[I-D.nsdt-teas-ietf-network-slice-definition]
Rokui, R., Homma, S., Makhijani, K., Contreras, L., and J. Tantsura, "Definition of IETF Network Slices", draft-nsdt-teas-ietf-network-slice-definition-00 (work in progress), October 2020.

[I-D.rokui-5g-ietf-network-slice]
Rokui, R., Homma, S., Foy, X., Contreras, L., Eardley, P., Makhijani, K., Flinck, H., Schatzmayr, R., Tizghadam, A., Janz, C., and H. Yu, "IETF Network Slice for 5G and its characteristics", draft-rokui-5g-ietf-network-slice-00 (work in progress), November 2020.

[RFC2681] Almes, G., Kalidindi, S., and M. Zekauskas, "A Round-trip Delay Metric for IPPM", RFC 2681, DOI 10.17487/RFC2681, September 1999, <https://www.rfc-editor.org/info/rfc2681>.

[RFC3393] Demichelis, C. and P. Chimento, "IP Packet Delay Variation Metric for IP Performance Metrics (IPPM)", RFC 3393, DOI 10.17487/RFC3393, November 2002, <https://www.rfc-editor.org/info/rfc3393>.

[RFC7679] Almes, G., Kalidindi, S., Zekauskas, M., and A. Morton, Ed., "A One-Way Delay Metric for IP Performance Metrics (IPPM)", STD 81, RFC 7679, DOI 10.17487/RFC7679, January 2016, <https://www.rfc-editor.org/info/rfc7679>.

[RFC8456] Bhuvaneswaran, V., Basil, A., Tassinari, M., Manral, V., and S. Banks, "Benchmarking Methodology for Software-Defined Networking (SDN) Controller Performance", RFC 8456, DOI 10.17487/RFC8456, October 2018, <https://www.rfc-editor.org/info/rfc8456>.

[TMV] "Validating 5G Technology Performance", 5G PPP TMV WG white paper , June 2019.

Acknowledgments

This work has been partly funded by the European Commission through the H2020 project 5G-EVE (Grant Agreement no. 815074).

Contributors

A. Florez and D. Artunedo (both from Telefonica) have also contributed to this document from their work in 5GENESIS project.

Authors' Addresses

Luis M. Contreras
Telefonica
Ronda de la Comunicacion, s/n
Sur-3 building, 3rd floor
Madrid 28050
Spain

Email: luismiguel.contrerasmurillo@telefonica.com
URI: http://lmcontreras.com/

Juan Rodriguez
Telefonica
Zurbaran, 12
Madrid 28010
Spain

Email: juan.rodriguezmartinez@telefonica.com

Lourdes Luque
Telefonica
Zurbaran, 12
Madrid 28010
Spain

Email: lourdes.luquecanto@telefonica.com