ETSI GS MEC-IEG 006 V1.1.1 (2017-01)

Mobile Edge Computing;
Market Acceleration;
MEC Metrics Best Practice and Guidelines

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Mobile Edge Computing (MEC).

Modal verbs terminology

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Introduction

Mobile Edge Computing is a new technology that provides an IT service environment and cloud-computing capabilities at the edge of the mobile network, in close proximity to mobile subscribers. In order to make MEC a success and encourage network operators to deploy Mobile Edge (ME) systems as well as to make MEC attractive to application developers and service providers, it is necessary to demonstrate the benefits of this technology for fulfilling various requirements. In order to make MEC an attractive proposition for service providers and applications developers to host their applications on a ME Host instead of in a centralized cloud, it is important to demonstrate a quantifiable performance increase.

The present document describes a number of performance metrics which can be used to demonstrate the benefits of deploying services and applications on a ME Host compared to a centralized cloud or server. Examples of how these metrics can be measured are also described.

Examples of such metrics KPIs are reducing latency, increasing end-to-end energy efficiency and increasing network throughput.

1 Scope

The present document describes various metrics which can potentially be improved through deploying a service on a MEC platform. Example use cases are used to demonstrate where improvements to a number of key performance indicators can be identified in order to highlight the benefits of deploying MEC for various services and applications. Furthermore, the present document describes best practices for measuring such performance metrics and these techniques are further exemplified with use cases.

Metrics described in the present document can be taken from service requirements defined by various organizations (e.g. 5G service requirements defined by Next Generation Mobile Networks (NGMN) or 3rd Generation Partnership Project (3GPP)). An informative annex is used to document such desired and/or achieved ranges of performance which could be referenced from the main body of the present document.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI ES 202 706 (V1.4.1): "Environmental Engineering (EE); Measurement method for power consumption and energy efficiency of wireless access network equipment".

[2] ETSI ES 203 228 (V1.1.1): "Environmental Engineering (EE); Assessment of mobile network energy efficiency".

[3] ETSI GS MEC 002: "Mobile Edge Computing (MEC); Technical Requirements".

[4] ETSI GS MEC 001: "Mobile Edge Computing (MEC); Terminology".

[5] ETSI ES 202 336-12: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (power, cooling and building environment systems used in telecommunication networks); Part 12: ICT equipment power, energy and environmental parameters monitoring information model".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IETF RFC 4656: "One way active measurement protocol".

[i.2] IETF RFC 5357: "A two-way active measurement protocol".

[i.3] IETF IP Performance Metrics Working Group: IPPM status pages.

NOTE: Available at https://tools.ietf.org/wg/ippm/.

[i.4] IETF IP Performance Metrics Working Group: Charter.

NOTE: Available at https://tools.ietf.org/wg/ippm/charters.

[i.5] NGMN Alliance 5G White Paper version 1.0 (17 February 2015): "NGMN 5G White Paper".

NOTE: Available at https://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf.

[i.6] J. S. Milton, J. Arnold, "Introduction to Probability and Statistics", McGraw-Hill Education, 4th Edition.

[i.7] P. Serrano, M. Zink, J. Kurose, "Assessing the fidelity of COTS 802.11 sniffers", IEEE INFOCOM 2009, Rio de Janeiro, Brazil, April 2009.

[i.8] P. Serrano, A. Garcia-Saavedra, G. Bianchi, A. Banchs, A. Azcorra, "Per-frame Energy Consumption in 802.11 Devices and its Implication on Modeling and Design," IEEE/ACM Transactions on Networking, vol.23, no.4, pp.1243-1256, Aug. 2015.

[i.9] N Vallina-Rodriguez, J Crowcroft, "Energy Management Techniques in Modern Mobile Handsets," IEEE Communications Surveys & Tutorials, 1-20.

[i.10] ETSI MEC PoC#3 RAVEN: "Radio aware video optimization in a fully virtualized network".

NOTE: Available at http://mecwiki.etsi.org/index.php?title=PoC_3_Radio_aware_video_optimization_in_a_fully_virtualized_network.

[i.11] ETSI GS MEC 015: "Mobile Edge Computing (MEC) Bandwidth Management API".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI GS MEC 001 [4], ETSI ES 203 228 [2] and the following apply:

NOTE: For some background definitions for network level energy efficiency, see ETSI ES 203 228 [2].

Energy Efficiency (EE): relation between the useful output and energy/power consumption

mobile network coverage Energy Efficiency: ratio between the area covered by the network in the Mobile Network under investigation and the energy consumption

mobile network data Energy Efficiency: ratio between the performance indicator based on Data Volume and the energy consumption when assessed during the same time frame

mobile network energy consumption: overall energy consumption of equipment included in the MN under investigation

system resources: any kinds of entities to be shared to compose services including computing power, processor and accelerator loads, memory usage, storage, network, database and applications

NOTE: System resources can be considered as a set of coherent functions, network data objects or services, accessible through a server where such system resources reside on a single host or multiple hosts and are clearly identifiable.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
API	Application Programming Interface
BER	Bit Error Rate
CN	Core Network
CPU	Central Processing Unit
DC	Direct Current
EE	Energy Efficiency
eNB	eNodeB
GPS	Global Positioning System
ICMP	Internet Control Message Protocol
IDT	Inter Departure Time
IP	Internet Protocol
IPPM	IP Performance Metrics
KPI	Key Performance Indicator
ME	Mobile Equipment
MN	Mobile Network
MOS	Mean Opinion Score
MSL	MEC-Specific Latency
MSS	Maximum Segment Size
MTU	Maximum Transmission Unit
NGMN	Next Generation Mobile Networks
NRQA	No Reference Quality Assessment
NRT	Non Real-Time
NTP	Network Time Protocol
OS	Operating System
OWD	One-Way Delay
PA	Power Amplifier
PEAQ	Perceptual Evaluation of Audio Quality
PEVQ	Perceptual Evaluation of Video Quality
PLR	Packet Loss Rate
POC	Proof Of Concept
POLQA	Perceptual Objective Listening Quality Assessment
PSNR	Peak Signal-to-Noise Ratio
PSS	Proportional Set Size
PTP	Precision Time Protocol
QoS	Quality of Service
RAN	Radio Access Network
RAVEN	Radio Aware Video optimization in a fully virtualized network
RSS	Resident Set Size
RT	Real-Time
RTT	Round-Trip Time
SDT	Service Delivery Time
SGW	Service GW
SPT	Service Processing Time
SUT	Set-Up Time
TCP	Transmission Control Protocol
UD	Update delay
UDP	User Datagram Protocol
UE	User Equipment
USS	Unique Set Size
VSS	Virtual Set Size

4 Metrics

4.1 General

This clause introduces the metrics considered by ETSI ISG MEC for the evaluation of improvements introduced by Mobile Edge Computing technologies. While clause 4 is describing all the different metrics considered (in separated clauses), clause 5 is organized similarly (with one clause corresponding to each metric in clause 4) in order to introduce the related measurement methodologies.

Generally MEC metrics are introduced with different purposes: evaluating the improvement given by MEC (as perceived by the end user), and assessing the benefits of different MEC deployment options (thus giving insights from a technologic point of view).

All metrics introduced in the present document can demonstrate the improvements of MEC solutions at least in the two following ways:

1) comparison between MEC and non-MEC solutions;

2) assessment of MEC deployments: comparison between different ME host positions within the network.

In both cases, the goal is not to compare different vendors or solution providers, but to assess the improvement of MEC introduction with respect to a traditional system (without MEC), e.g. in order to understand the different deployment options against the different use cases (e.g. by minimizing costs, maximizing benefits or flexibility).

For this reason, MEC metrics can be classified into two main groups: functional and non-functional metrics. For both categories (defined here below), metrics can be referred to different MEC use cases, as listed in IETF RFC 4656 [i.1], and the actual assessment of these metrics can depend on the particular service and/or application utilization:

1) Functional metrics are related to MEC performances impacting on user perception (often called also KPIs, key performances indicators):

   - Examples of functional service performance KPIs include: latency (both end-to-end, and one-way), energy efficiency, throughput, goodput, loss rate (number of dropped packets), jitter, number of out-of-order delivery packets, QoS, and MOS. Each of the functional metrics should be defined on per service basis. Note that the latency in localization (time to fix the position) is different from latency in content delivery.

2) Non-functional metrics are related to the performance of the service in terms of deployment and management:

   - Examples of non-functional metrics include: service lifecycle (instantiation, service deployment, service provisioning, service update (e.g. service scalability and elasticity), service disposal), service availability and fault tolerance (aka reliability), service processing/computational load, global ME host load, number of API request (more generally number of events) processed/second on ME host, delay to process API request (north and south), number of failed API request. The sum of service instantiation, service deployment, and service provisioning provide service boot-time.

In both cases, one could measure all the statistics over the above metrics. In fact, all metrics are in principle time-variable, and could be measured in a defined time interval and described by a profile over time or summarized through:

- the maximum value;
- mean and minimum value;
- standard deviation;
- the value of a given percentile;
- etc.

All MEC metrics assessments can be done by considering the overall system, or portions of that, according to the purpose of the measurement itself. An example below (figure 1) shows a mobile network system with ME host, and the different entities potentially involved in the assessment.

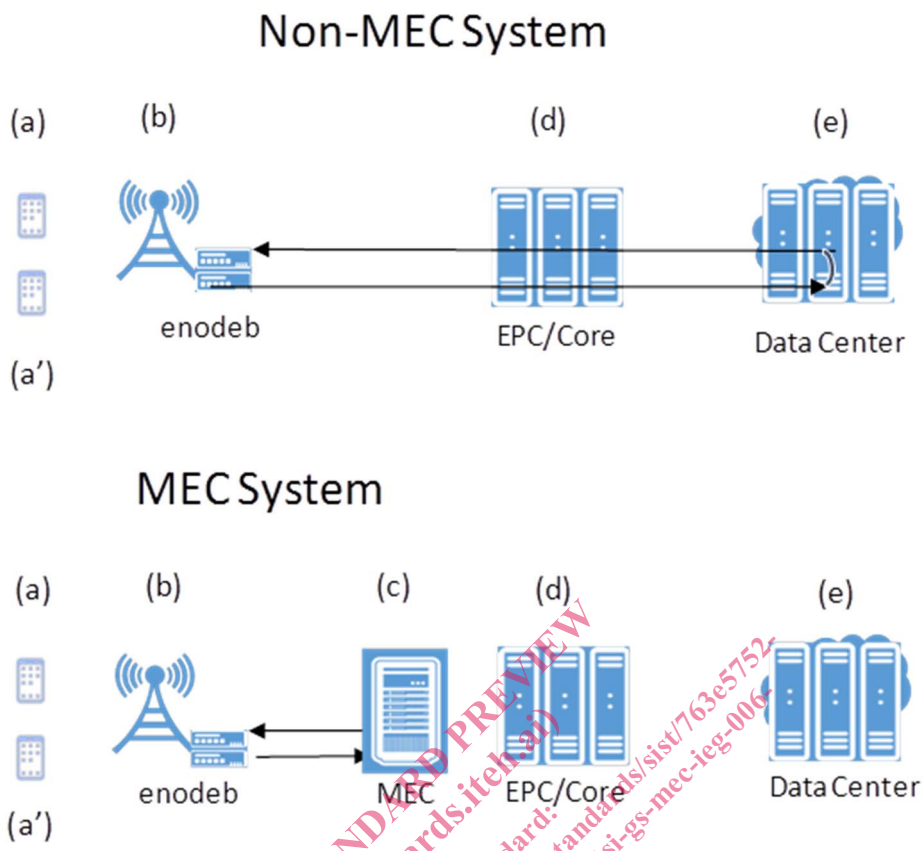

Figure 1: Measuring MEC metrics

4.2 Latency

4.2.1 General

The concept of latency is wide and encompasses manifolds metrics: in communications, latency refers to a time-interval whose measurement quantifies the delay elapsed between any event and a consequent target effect. Even more, still in the communication domain, latency is useful to measure phenomena both in the control plane (e.g. set-up time or hand-over time) and in the data plane (e.g. transfer delay). The purpose of this clause is not to define all the latency metrics potentially relevant to the MEC solutions, but rather to highlight what type of latency metrics can be adopted (or newly defined) and their potential roles.

Referring to all the latency metrics in the clauses 4.2.2 to 4.2.6, it is assumed that an ideal synchronization holds across the nodes under test for measurements purposes.

Note that different Latency measurements have been specified in IETF RFC 4656 [i.1] and IETF RFC 5357 [i.2]. However, the latency definitions within the subsequent clauses are referring to latency measured on application level.

4.2.2 Round-Trip Time

Round-Trip Time (RTT): by referring to figure 1, it is defined as the time taken for a request (e.g. packet) generated from a terminal (a) to go to the destination, be updated or replied and travel back to (a), in conditions of ideal service capabilities (i.e. the server and/or terminal response time is supposed to be fixed and the RTT does not depend on the server/terminal computational load). Characteristics of RTT include:

1) Depending on the service type, the RTT might include very heterogeneous paths. Referring to figure 1:
   - (a)-(c)-(a) in case of MEC client-server applications;
   - (a)-(e)-(a) in case of non-MEC client-server applications;