**3GPP TSG-SA5 Meeting #139e *S5-215375rev1***

**11 Oct to 20 Oct 2021, E-meeting**

**Source: China Telecom**

**Title: Add conclusion to Key Issue #2a**

**Document for: Approval**

**Agenda Item: 6.5.1**

# 1 Decision/action requested

***The group is asked to discuss and agree on the proposal.***

# 2 References

[1] 3GPP TR 28.813: "Study on new aspects of Energy Efficiency (EE) for 5G "

# 3 Rationale

This pCR is to add conclusion to key issue #2a.

# 4 Detailed proposal

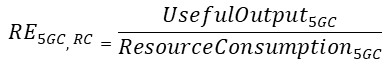
This document proposes the following changes in TR 28.813 [1].

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| **1st change** |

4.2a Key Issue #2a: Resource Efficiency KPI for 5GC

4.2a.1 Description

With Network Functions Virtualisation (NFV), physical equipment in the telecom network architecture can be replaced by virtual network functions running on standard server platform. Since the 5GC can be fully virtualized, and the 5GC NF can be composed of VNF(s), the 5GC Resource Efficiency KPI is introduced as:



The term Useful Output was introduced in the ES 203 539 [21] as the maximum capacity of the system under test which is depending on the different functions in both data plane / user plane or control plane. As the Useful Output can be defined for both data plane and control plane network functions, it can be expressed as the number of Erlang (Erl), Packets/s (PPS), Subscribers (Sub) or Simultaneously Attached Users (AU). And within [x], the Useful Output is also expressed as bits/s (bps) or the number of sessions.

When the Useful Output is expressed as Packets/s (PPS) or bps, it can be used as metric for throughput of data plane or user plane network function. And when the Useful Output is expressed as Subscribers (Sub) or Simultaneously Attached Users (AU) or number of sessions, it can be used as the metric for control plane network function.

The Useful Output of 5GC is denoted as UsefulOutput5GC, it can be defined for both data plane and control plane network functions.

In ES 203 539 [21], the measurement of Resource Consumption of VNF under test which solely running on NFVI platform was introduced as a method for energy consumption measurement of VNF indirectly.

As the 5GC can be fully virtualized, the Resource Consumption of 5GC is denoted as ResourceConsumption5GC.

The ES 203 539 [21] is intended to be used in laboratory environment. For the environment of the operational network, such as the one studied within the scope of the present document, the measurement or estimation of the Useful Output of 5GC and Resource Consumption of 5GC needs to be studied.

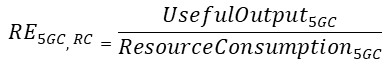
Depending on the solution, new measurements may have to be defined in TS 28.552 [4].

4.2a.2 Potential solutions

4.2a.2.1 Potential solution #1 for ResourceConsumption5GC Estimation

4.2a.2.1.1 Introduction

This potential solution focuses on the definition of ResourceConsumption5GC appeared in:



4.2a.2.1.2 Description

The ResourceConsumption5GC (which is also denoted as R5GC) is defined as the resource allocated to all 5GC NF.



where RNF represents the resource allocated to a 5GC NF.

Since the 5GC NF is composed of 1 to many VNFs, the resource allocated to 5GC NF is the sum of the resource allocated to the VNFs composing the 5GC NF.



where RVNF represents ResourceConsumption.

The resource considered are Virtualization Container (VC) resources and Virtual Network resources. Therefore, ***R5GC*** can be further denoted as {***R5GC, cpu, R5GC, memory***, ***R5GC, storage***}. Moreover, as 5GC NF is composed of 1 to many VNFs, we have the following definitions:

* ***RNF, cpu*** is CPU resource consumption, defined as the sum of the used CPU capacity of the underlying VCs allocated to each of the VNFs composing the 5GC NF.
* ***RNF, memory*** is memory resource consumption, defined as the sum of the total memory used of the underlying VCs allocated to each of the VNFs composing the 5GC NF.
* ***RNF, storage*** is storage resource consumption, defined as the sum of the total storage used of the underlying VCs allocated to each of the VNFs composing the 5GC NF.

NOTE 1: NF is composed of VNF(s). VNFs are composed of VNFC(s). VNFC is deployed on Virtualization Container(s). Therefore, the summation of the resource used by the VNFs composing the 5GC NF is based on the measurement of the corresponding VNFCs' resource consumption on the VCs. And this can be expressed as the following:



NOTE 2: The consumption of the resource of different kinds may not be able to be added together. But the consumption of the resource of the same kind will be added together. Therefore, for each VNF, there will be a summation of resource consumption for each kind of resource, e.g. the total CPU resource consumption, the total memory resource consumption, etc. And they will be used or considered separately. And similarly, for each NF, there will be a summation of resource consumption for each kind of resource, based on the resource consumption of the VNFs. And they also will be used or considered separately. And so is for the 5GC.

Since each of the VNFs composing the 5GC NF may not be the only VNF running on a NFVI, the virtual resource consumption of the each VNF needs to be measured separately.

In this version of the present document, it is assumed that:

- the resource allocated to a NF/VNF/VNFC other than CPU and Memory are not included.

- each VNFC instance pertains to one and only one VNF instance,

- each VNF instance pertains to one and only one Network Function,

- each VNFC instance utilizes virtual CPUs pertaining to one and only one NFVI node.

Resource consumption can be measured through performance monitoring, which could be external monitoring tools or monitoring functions provided by NFV infrastructure.

The CPU resource consumption of the VNFC is denoted as ***RVNFC,CPU*** and it can be derived based on all the vCPUs allocated to it as the following:



For each vCPU allocated to the VNFC instance, the vCPU Resource Usage is calculated as the average Processor Utilization of the VNFC instance during a given time period multiplied by cpu clock speed and number of cores of the underlying VC where the VNFC is located, and its unit is MegaHertz (MHz)**.**

Processor Utilization is defined in [14] clause 6.6 as the ratio of the total time that one or more compute resources (according to the defined scope) execute instructions in the specified execution context during the measurement interval to the time in the measurement interval, expressed as a percentage.

NOTE 3: Virtual Machine and OS Container are examples of Virtualisation Container [10].

The measurement of the memory resource consumption of the VNFC is denoted ***RVNFC, memory*** and itcan be derived as the amount of memory used by VNFC (see the metric 'Memory Used' defined in ETSI GS NFV-TST 008 clause 8.6).

The storage usage of the VNFC is denoted as ***RVNFC, storage***. As the methods of measurement for storage systems vary widely and depend on the implementation, the measurement of the ***RVNFC, storage*** may not be defined in this version of the present document.

Based on the CPU resource consumption of the VNFC, the CPU resource consumption of the VNF can be estimated as the following:



And the CPU resource consumption of the NF and the 5GC can be estimated accordingly:





Similarly, the memory resource consumption of the VNF, NF, and 5GC can be estimated:







And the estimation of the resource consumption of the NF and 5GC can be derived based on CPU resource consumption only:





Or they can be derived based on memory resource consumption only:





Or they can be derived as the couple with two dimensions based on CPU resource consumption and memory resource consumption:





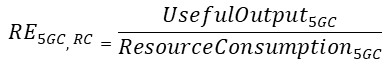
NOTE 4: The estimation of the resource consumption of the NF and 5GC based on memory resource consumption only is for information only.

NOTE 5: The estimation of the resource consumption of the NF and 5GC as the couple with two dimensions based on CPU resource consumption and memory resource consumption is for information only and a Euler distance between a vector with 2 dimensions and the origin can be used as metric for this estimation.

4.2a.2.2 Potential solution #2 for measuring UsefulOutput5GC

4.2a.2.2.1 Introduction

This potential solution focuses on the definition of UsefulOuput5GC appeared in:



For this proposed solution, it can be applied to both User Plane Function (UPF) and Control Plane network functions that constitute the 5GC. And it is assumed that the definition of the useful output for UPF and control plane network function are different.

4.2a.2.2.2 Description

The useful output of a 5GC NF is defined as the capacity of the 5GC NF, and depending on the different type of 5GC NFs, it may be:

* throughput (e.g. bps) for 5GC User Plane network functions
* capacity (e.g. subscribers, sessions) for 5GC Control Plane network functions.

The UsefulOuput5GC is composed of the useful output of all the 5GC NFs that constitute the 5GC. Therefore, the UsefulOuput5GC can be divided into:

- UsefulOutput5GC,UP, when only User Plane (UP) network functions are considered,

- UsefulOutput5GC,CP, when only Control Plane (CP) functions are considered, and which can be further divided into:

- UsefulOuput5GC,CP,subscribers

- UsefulOuput5GC,CP,sessions.

Since each type of the useful output is one dimension used to describe the UsefulOuput5GC, when one or multiple types of useful output are used for calculation, such as the calculation of resource efficiency ratio, the calculation is made with respect to each type of useful output, i.e. the useful output of the same kind can be added together, while the useful output of different kinds cannot be added together.

In this proposed solution, the following network functions may be considered (see clause 4.2.2 of TS 23.501 [2]):

- Access and Mobility Management Function (AMF)

- Session Management Function (SMF)

- User Plane Function (UPF)

The UsefulOuput5GC,UP can be taken as the measurement of the Useful Output of the UPF(s) that constitute the 5GC. Therefore, the UsefulOuput5GC, UP is equivalent to the Data Volume of UPF(s) that constitute the 5GC, defined in TS 28.552 [4] clause 5.4.1. See also clause 4.2.2.1.2 of the present document.

The Useful Output of the AMF can be measured by the mean number of the registered subscribers defined in TS 28.552 [4] clause 5.2.1. The UsefulOutput5GC,CP,subscribers is taken as the measurement of the Useful Output of the AMF(s) that constitute the 5GC. Therefore, the UsefulOutput5GC,CP,subscribers is equivalent to the mean number of the registered subscribers of the AMF(s) that constitute the 5GC.

Considering the mean number of the registered subscriber defined in TS 28.552 [4] clause 5.2.1, the UsefulOuput5GC, CP, subscribers can be expressed as follows:



where:

- RM.RegisteredSubNbrMean.SNSSAI is the mean number of registered state subscribers per S-NSSAI per AMF, as defined in TS 28.552 [4] clause 5.2.1.

The Useful Output of the SMF can be measured by the mean number of the PDU sessions defined in TS 28.552 [4] clause 5.3.1. The UsefulOutput5GC,CP,sessions is taken as the measurement of the Useful Output of the SMF. Therefore, the UsefulOutput5GC,CP,sessions is equivalent to the mean of the number of PDU Sessions of SMF.

Considering the mean number of the PDU sessions defined in TS 28.552 [4] clause 5.3.1, the UsefulOuput5GC, CP, sessions can be expressed as follows:



where:

- SM.SessionNbrMean.SNSSAI is the mean number of PDU sessions per S-NSSAI per SMF, as defined in TS 28.552 [4] clause 5.3.1.

### 4.2a.3 Conclusion

There are two solutions being discussed. The potential solution #1 is for ResourceConsumption5GC estimation, and the potential solution #2 is for UsefulOuput5GC measurement. The ResourceConsumption5GC and UsefulOuput5GC can be used for defining the RE5GC, RC.

In the potential solution #1, ResourceConsumption5GC is defined based on the resources allocated to all 5GC NFs. The resources considered are Virtualization Container (VC) resources and Virtual Network resources, which can be further denoted as virtual CPU resource and virtual memory resource. With regard to virtual CPU resource usage, the CPU core number and the CPU clock speed used by the potential solution are maintained by VIM and it is not clear whether they are or will be made available by ETSI NFV MANO to 3GPP management system. This issue had been discussed within SA5 and the LS asking ETSI NFV to feedback further information was sent.

In the potential solution #2, UsefulOuput5GC is defined as the useful output of the 5GC NFs. In this solution, the definitions of Useful Output of AMF, SMF and UPF are provided.

Consequently, the conclusion is proposed as follows:

- The estimation of ResourceConsumption5GC is still open and the potential solution #1 needs further study in upcoming Rel-18 work;

- The potential solution #2 may move to the normative phase as solutions for measuring the Useful Output of AMF, SMF and UPF;

- Key Issue #2a: Resource Efficiency KPI for 5GC is still open and the study may continue in the Rel-18 EE study within SA5.

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| **End of changes** |