**3GPP TSG-SA5 Meeting #157 *S5-246049***

Hyderabad, India 14 - 18 October 2024 revision of S5-245459

**Source: Huawei, China Mobile**

**Title: Add evaluation for signaling storm analysis**

**Document for: Approval**

**Agenda Item: 6.19.5**

# 1 Decision/action requested

***The group is asked to discuss and approval.***

# 2 References

[1] 3GPP draft TR 28.915: “Management and orchestration; Study on management aspects of Network Digital Twin v1.0.0”.

[2] SP-231727 "New Study on management aspects of Network Digital Twin"

# 3 Rationale

There are three potential solutions proposed for use case 2 signaling storm analysis, this contribution provides the comparsion and evalution of the 3 potential solution for TR 28.915 based on [1].

# 4 Detailed proposal

It proposes to make the following changes to TR 28.915[1].

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| **1st Change** |

## 5.2 Use case 2: Signaling storm analysis

### 5.2.1 Description

Signaling storm refers to the situation where a large number of signaling messages suddenly surge in the mobile communication network, resulting in the network processing capacity overload, thus affecting the network performance and stability. Signaling storm may be caused because of big event happened that too many users request service at the same time, or by network failure, configuration error or malicious attacks. During this period, users will repeatedly try to establish the connection until reconnected, thus generating a large number of signaling messages surge suddenly, causing signaling storm. By using NDT to model (either simulation or emulation) various network scenarios such as network failure or surge of requests, the network operator can determine whether the current network can defend against. a possible future signaling storm.

Also, if an actual signalling storm occurs on the network (e.g. by checking network performance data), to prevent potential impacts caused by signaling storm, the operator needs to effectively control the flow of each signaling control node on the network to avoid nodes working improperly caused by signaling storm. For example, as depicted in figure 5.2.1-1, AMF, SMF, and UDM in the 5G network might be all potential signaling storm impact points when network signaling storm happens. The NDT can be used to model the network behaviors and help find the optimal flow control parameters of each signaling impact point to avoid serious damage to the 5G network when it is affected by signaling storm.



Figure 5.2.1-1

### 5.2.2 Potential requirements

**REQ-SIMULATION\_NDT-01:** NDT should have the capability to model (either using emulation method or simulation method) the behaviour of signaling storm.

**REQ-SIMULATION\_NDT-02:** NDT should have a capability enabling the MnS consumer to define a network configuration to be modelled for checking the network response to a signaling storm.

**REQ-SIMULATION\_NDT-03:** NDT should have the capability to report the results for signaling storm analysis.

### 5.2.3 Potential solutions

#### 5.2.3.1 Solution 1: NDT for signaling storm simulation and solution validation

This solution addresses the following issues of use case 2. When a signaling storm occurs on the network (e.g. identified by MDA, see MDA type for 5GC control plane congestion analysis), NDT is used to evaluate whether the suggested solution can resolve the signaling storm issue. The NDT utilizes network related information on signaling storms from the MnS producer to generate a report of simulation and validation results with the following approach.



Figure 5.2.3.1-1: NDT for signaling storm simulation and validation

1. The MnS consumer sends a request to NDT as the MnS provider for signaling storm simulation, including the simulated network objects(e.g. network functions, S-NSSAI, etc.) and optional network optimization actions to resolve the issue caused by signaling storm (e.g. setting the maximum rate of traffic received at a network node, flow control rules).

2. The NDT as the MnS provider provides a response to MnS consumer indicating the status of the request based on a feasibility check (success or failure).

3. The NDT as the MnS consumer synchronizes the network objects related information from MnS providers for network simulation and validation. The network related information may include network capability related information, network slicing information regarding the resource aspects and/or other relevant data (e.g. the number of current subscribers, traffic collected in recent and historical periods) for simulation and validation of the behaviour of signaling storm.

4. The NDT executes the network simulation and validation for signaling storm and generates the report.

5. The NDT as the MnS provider sends the report including the results to MnS consumer. The report can include:

- Simulated behavior: Use of network simulation to analyse the behavior and impacts of signaling storms based on current and historical data.

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#### 5.2.3.2 Solution 2: NDT for replicating signaling storm scenario

This solution aims to resolve REQ-SIMULATION\_NDT-02 and 03 of issue#2, a NDT is created to model (either using emulation method or simulation method) a specific network scenario and its possible impact on the network. It is used to determine whether the current network can defend against a possible future signaling storm when such network scenario happens.



Figure 5.2.3.2-1: Procedure of NDT for sinaling storm analysis

1. MnS consumer requests MnS producer (the entity who provides the NDT management service) to create an NDT instance (i.e. a new IOC, may be called NetworkDigitalTwin, is required. It may be name contained in a subnetwork or managed function) with modeling requirements. The modeling requirements are used to specify the scope of the network to be modelled and the to be modelled network scenario, which may include,

- NDT scope: the area of actual mobile network or the managed object that needs to be simulated or emulated in NDT. For instance, a geography area, a network slice, etc.

- Modeling scenario: the network scenario required to be modelled, e.g. the number of PDU session received by AMF increases to 10 times.

- Modeling data: the selected data to be modelled by NDT, e.g. 5GC related PM data as defined in 3GPP TS 28.552 [7] and 3GPP TS 28.554 [8], CM data as defined in 3GPP TS 28.541 [6] and 3GPP TS 28.622 [10], etc.

2. Based on the modeling requirements given in step 1, the MnS producer collects the data from the network and creates a NDT instance.

3. MnS producer notifies MnS consumer that the NDT instance is created.

4. MnS consumer requests NDT to output the impact on the network (e.g. whether a signalling storm occurs). The request parameters may include:

- Identified event: in this use case, a signalling storm is identified possibly be occurred in the future.

- Impact detectors: specified performance metrics and/or alarm types that needs to be collected and reported by NDT after the behaviour happens in NDT.

5. NDT simulates/emulates the network behaviour and generate network performance data and/or alarm data from the NDT.

6. MnS producer reports the result to MnS consumer. The report content may include the result of the evaluation and impact which is a key-value list where the keys contain the impact detectors specified in step 4. Alarms are reported if any raised.

#### 5.2.3.3 Solution 3

Introduce an IOC for an NDT, which may be called NDT. This may be name contained in a subnetwork or managed function to respectively represent a standalone NDT and an NDT contained in another function, e.g. in a SON function.

The consumer can configure on to the NDT instance the network scenario to be modelled. The scenario can include the scope to be considered for evaluating a signaling storm:

- Introduce a data type and an attribute on the NDT of the scope to be modelled or simulated by the NDT instance. This may be called nDTSimulationScope.

The consumer can configure the parameters of the NDT instance, including the configurations indicating a signaling storm:

- Introduce a data type and an attribute on the NDT configuration plan. The datatype which may be called nDTConfigurationPlan indicates the parameter values to be applied by the NDT instance.

NOTE 1: The specific characteristics of Signaling storm analysis can be added as an attribute of the nDTSimulationScope and nDTConfigurationPlan.

The NDT can provide output to the MnS consumer, the output including values on PMs, KPIs and alarms of all the objects that have been modelled by the NDT instance. These include the values indicating the impact of the signaling storm:

- Introduce a data type and an attribute on the NDT to represent the output of the NDT instance. This may be called nDTOutput and will contain attributes similar to those of existing network objects like cells

NOTE 2: The specific characteristics of reports for Signaling storm analysis can be added as an attribute of the nDTOutput.

### 5.2.4 Evaluation of potential solutions

The solution 1 provides the NRM extension and procedure needed for NDT to do signaling storm simulation and solution validation.

The solution 2 provides the NRM extension and procedure needed for NDT to do signaling storm scenario replicating.

The solution 3 provides the NRM extension needed for the NDT to provide modelling of network behavior that supports sinaling storm analysis.

There are common part of NRM extension proposed in solution 1, solution 2 and solution 3:

1. nDTSimulationScope in solution 3, which represents the scope to be modelled or simulated by the NDT instance, is similar with simulated network objects given in solution 1 and NDT scope given in solution 2.

2. nDTConfigurationPlan in solution 3, which indicates the configurations to be verified by NDT, can be specialized by network optimization actions to resolve the issue caused by signaling storm given in solution 1 and Modeling scenario given in solution 2.

3. nDTOutput in solution 3, which represents the output of the verification service, is similar with report given in solution 1 and solution 2.

Regarding signaling storm scenario replicating scenario resolved in solution 2, the following specific perameters are required to be added in the NRM solution::

1. Modeling data can be further focus on signaling storm, e.g. 5GC related PM data as defined in TS 28.552[7]/28.554[8], CM data as defined in TS 28.541[6]/28.622[10], etc.

2. Impact detectors: specified performance metrics and/or alarm types that needs to be collected and reported by NDT after the behaviour happens in NDT.

Solution1, 2 and 3 statify the requirements, they can be conbined to provide a complete solution for signaling storm analysis it’s recommended to keep common attributes as the NDT NRM solution framework, based on which the use case specific attributes are defined case by case.

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| **End of Changes** |