**3GPP TSG-SA5 Meeting #156 *S5-244198***

Maastricht, Netherland, 19 Aug - 23 Aug 2024

**Source: Samsung, Nokia, NTT Docomo**

**Title: Network issue inducement**

**Document for: Approval**

**Agenda Item: 6.19.5**

# 1 Decision/action requested

***Group is requested to discuss and agree this document`***

# 2 References

None

# 3 Rationale

In order to develop a resilient network, the behavior and performance of the network should be monitored during certain network failure issue e.g node/functionality failure, service degradation etc. In order to plan for the optimal network configuration in case of such network failure issue, the scenario itself need to be induced in the network. It is desirable, to use NDT for such an inducement process. A particular issue can be induced in the NDT instead of real network. After a particular issue is induced, the performance of the network can be monitored, other degradation/faults/failure can be identified and the mitigation actions can be decided and reported.

Same concept can be applied to use case of Network failure and risk prediction.

# 4 Detailed proposal

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| **First Change** |

## 5.x Use case4: Network issue inducement

### 5.x.1 Description

This use case describes how a network issue can be induced using NDT. In order to develop a resilient network, the behavior and performance of the network should be monitored during certain network failure issue e.g node/functionality failure, service degradation etc. In order to plan for the optimal network configuration in case of such network failure issue, the scenario itself need to be induced in the network. It is desirable, to use NDT for such an inducement process. A particular issue can be induced in the NDT instead of real network. After a particular issue is induced, the performance of the network can be monitored, other degradation/faults/failure can be identified and the mitigation actions can be decided and reported. The following are some of the example of the issues that can be induced.

The network slice performance degradation in terms of low PDU session establishment success rate or in terms of high latency can be induced, in a NDT, to see how the related network functions will behave when the PDU session establishment success rate is degraded. The remedial actions can be decided to mitigate the problem.

The coverage hole can be induced, in a NDT, to see how the related services are getting effected. The remedial actions can be decided to mitigate the problems arising due to the induced coverage hole.

NDT can be used for fault injection experiments avoiding impact on the physical network while measuring and monitoring the impact of each injected fault in the NDT simulation. This could be leveraged, to build a training dataset for enhancing and enriching detection and diagnosing systems capabilities. In addition, NDT could be leveraged for improving root causes analysis.

Mobile network has become crucial infrastructure and the impact of network failures on society can be substantial. Therefore, it is important to consider measures against potential future network failures. To this end, it is useful to proactively analyse potential future network failures (e.g., analyse potential network failures caused by component failures like VMs or containers turned down). It is impossible to cause issues in actual commercial networks because it would affect users. Therefore, the use of Digital Twin can be investigated for this purpose.

NDT fault injection analysis is described in ETSI GR ZSM 015 clause 5.13 [1]. In this use case, it is described as non-disruptive way of doing fault injection studies. Network digital twin simulates potential fault scenarios and provide results. This enables operator to learn network anomaly patterns of different faults.

For example, mobile networks are built on physical resources and can be built on virtualization technologies. Predicting the impacts on the network induced by the failures on physical resources (e.g., CPU, memory, storage failure of physical servers or port and transmission error of physical networks) or virtual resources (e.g., stopping of VMs or containers, host OS failures) can be challenging. Additionally, with the introduction of technologies like containers, the number of components in a mobile network increase, making it difficult to analyse the network-wide impacts of a single component failure. In the increasingly complex modern networks, it can also be difficult to ascertain the effectiveness of the countermeasures to those failures.

Furthermore, to allow verification of countermeasures, operator can repeat simulation of a failure on the network within NDT after applying the countermeasures, and observe the results, which can confirm the effectiveness of the countermeasures.

The consumer can request NDT to simulate failures and receive the simulation results regarding the impact on the network.

Moreover, network failures can sometimes cause issues originating in a part of the network to propagate throughout the entire network. In such cases, it is necessary to simulate not just individual components, but the entire network or a significant part as network digital twin. Additionally, as networks are structured in layers, an issue in one layer can impact other layers. Therefore, to accurately reproduce the entire network or its parts, it is crucial that 3GPP management system provide the network topology including how network elements are interconnected and elements/connection capability.

### 5.x.2 Potential requirements

**REQ-NDTN\_Induce-1:** The NDT should support a capability enabling a network issue (e.g fault/failure) to be induced.

**REQ-NDTN\_Induce-2**: NDT should have a capability enabling the MnS consumer to measure and monitor the impact of the injected issue in a simulation environment.

**REQ-NDTN\_Induce-3:** NDT should have a capability enabling the MnS consumer to perform root cause analysis over the injected issues.

**REQ-NDTN\_Induce-5:** The management system should have a capability to provide topology data for simulating and/or emulating network failures in NDT.

### 5.x.3 Potential solutions

In order to induce a particular network scenario the consumer need to voluntarily update management data (including performance and configuration data) in a way that may result in a particular network issue. The solution requires consumer to indicate details on which management data is to be updated and how.

Introduce a data type and an attribute on the NDT of the fault to be injected or simulated by the NDT instance. This may be called nDTFaultInject. This may include the following infomrations:- Information related with simulation data that need to be voluntarily updated to inject a particular issue

* Data: This will define which management data is to be updated artificially in order to induce a particular network issue. The management data includes:
	+ Performance data: The name of the performance measurement or the KPI as defined in 3GPP TS 28.552 and TS 28.554
	+ MDT/Trace data: The name of MDT measurements as defined in 3GPP TS 32.422
	+ Configuration data: The name of the attribute from any of the available MOIs.
* Threshold: This will define the threshold for a particular management data. Once the threshold is reached the simulation data will be updated.
* Condition: This will define the condition that has to be satisfied in order to update the simulation data. This can be defined in terms of location and time
* Updates: This will define the induced values for the simulation data.
* Mitigation: This will defined the mitigation actions in terms of network reconfiguration to handle the simulated network failure scenario.

Configuration date:

- Type of failure (e.g., CPU, memory, storage failure of physical servers or port and transmission error of physical networks, stopping of VMs or containers, host OS failures).

- Reference to node where failure to be induced.

- Information representing the evaluation of the injected issues. This may be called nDTFaultSignature and will contain information about the impacts of the fault e.g node performance data, node fault data



1. NDT consumer request to create an NDT providing details of NDT including information related to simulation data.
2. The NDT is created.
3. Producer send a response to consumer.
4. Producer then activates the NDT and monitor the same for performance.
5. Producer check the simulation data information, received in step 1, to confirm whether the indicated simulation data need to be updated.
6. Producer updates the simulation data internally.
7. Producer monitor the NST for performance degradation and failures. Based on the issues identified producer decides the mitigation actions and update the NDT with the same.
8. Producer notifies consumer about the updating of NDT characteristics related with mitigation actions.

### 5.x.4 Evaluation of potential solutions

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| **Next Change** |

### 5.4.3.1 solution 1

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 Network failures and risks.

* 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 the Network failure

* 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: the specific characteristics of Network failure and risk prediction can be added as an attribute of the nDTSimulationScope and nDTConfigurationPlan

The consumer can configure the PM data that needs to modified for the NDT in order to induce the potential network failure.

* Introduce a data type and an attribute on the NDT simulation data. The datatype which may be called nDTSimulationData indicates the PM data and KPI that need to be modified. The predicted values of data is required when simulating a potential failure. The prediction of the some of the data can be requested from MDAS using MDT type “Predictions.PMData” as defined in 28.104.

The NDT can provide output to the MnS consumer, the output including values on PMs and KPIs of all the objects that have been modelled by the NDT instance. These include the values indicating the impact of the Network failure which included the expected risks.

* 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 existining network objects like cells

Note: the specific characteristics of reports for Network failure and risk prediction can be added as an attribute of the nDTOutput