**3GPP TSG-SA5 Meeting #155S5-243180**

**27 - 31 May 2024, Jeju, South Korea**

**Source: Nokia**

**Title:** **pCR 28.915 NDT requirements and solutions**

**Document for: Approval**

**Agenda Item: 6.19.5**

# 1 Decision/action requested

***In this box give a very clear / short /concise statement of what is wanted.***

# 2 References

[1] 3GPP TR 28.915-010 “Study on management aspect of Network Digital Twin”.

# 3 Rationale

.Network digital twins are supposed to provide modelling capabilities that may be used to accomplish network related automation operations. This pCR introduces the scope of network digital twins and their relations to network automation functions.

# 4 Detailed proposal

***Start of First change***

# 5 Use cases

## 5.1 Use case 1: RAN energy saving policy verification

### 5.1.1 Description

When configuring the energy saving for RAN, normally the policy is applied in execution with monitoring and optimization loop to minimize the influence on network service quality. That’s to say, there could be multiple ES policies executed iteratively in actual mobile network until the network performance, e.g., energy efficiency of NG-RAN, UE throughput in gNB, etc., meets certain requirements from operators.

This may bring two problems from network management perspective:

- Redundant ES policies configurations due to conservative adjustment on ES policy for each iteration.

- Risk of unexpected deterioration in actual mobile network performance.

The digital twin technology may be used to evaluate the impact of RAN ES policy while satisfying simulation performance requirements (e.g., precision, maximum run time, etc).

The consumer could request the NDT to verify the impact of behaviour (e.g., the configuration of RAN energy saving policies) and receive the report of simulated impact generated by NDT.

### 5.1.2 Potential requirements

**REQ-NDT-FUN-01** The NDT shall have the capability to estimate the impact of RAN energy saving policies.

**REQ-NDT-FUN-02** The NDT shall have the capability allowing the consumer to configure the RAN energy saving policies.

**REQ-NDT-FUN-03** The NDT shall have the capability to report the simulated impact of RAN energy saving policies.

Editor’s Note: This UC currently only focuses on RAN. The energy saving policy verification for other part of the network is FFS.

### 5.1.3 Potential solutions

5.1.3.X Potential solution X

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 ES policies.

* 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 ES policy

* Introduce a data type and an attribute on the NDT to represent a 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 RAN energy saving policy 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 and KPIs of all the objects that have been modelled by the NDT instance. These include the values indicating the impact of the configured ES policies.

* 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

## 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 simulating various network scenarios such as network failure or large amount of user subscribes at the same time because of big event. In this way, the network operator can determine whether the current network can defend against if signaling storm happened.

### 5.2.2 Potential requirements

**REQ-SIMULATION\_NDT-01:** NDT should have a capability enabling the MnS consumer to configure the network scenario to be modelled for a signaling storm

**REQ-SIMULATION\_NDT-02:** NDT should have a capability to provide the results of network simulation for signaling storm analysis.

**REQ-SIMULATION\_NDT-03:** NDT should have a capability enabling the MnS consumer to configure the parameters of the NDT instance of the objects to be modelled for a signaling storm

### 5.2.3 Potential solutions

5.1.3.X Potential solution X

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 to 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: 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 existining network objects like cells

## 5.3 Use case 3: Emergency preparedness

### 5.3.1 Description

A natural disaster (e.g. earthquake, tsunami) can cause major impacts to the services provided by a mobile network. The disaster may directly impact the network by causing loss of connectivity, and can also cause indirect effects such as a flood of calls to emergency services. It is important for a network operator to be able to estimate how the mobile network will be impacted by a natural disaster, and to optimize the network configuration (e.g. redundancy and routing) to reduce the impact to services.

Network Digital Twin allows the possibility to apply the effects of a natural disaster in a replica network without risk of impacts to the mobile network. This allows the network operator to evaluate how the replica network responds to the natural disaster. If the response is not acceptable, the network operator may repeatedly reconfigure the replica network and replay the natural disaster until the response is acceptable. The network operator may then decide to apply the best-performing configuration to the mobile network.

As an example, the impact evaluation of a natural disaster (e.g. earthquake, tsunami) is explored in more detail as follows:

1. The network operator wishes to check how a proposed network configuration will react to a natural disaster.

2. The network operator synchronizes the replica network with the mobile network to ensure that the replica network is up to date.

3. The network operator applies the proposed network configuration to the replica network.

4. The network operator applies the effects of the natural disaster (e.g. loss of connectivity, flood of calls to emergency services) to the replica network.

5. The replica network simulates the behaviour of the mobile network.

6. The network operator measures the reaction of the replica network, by observing performance measurements and alarms from the replica network.

7. The network operator may optionally decide to apply the reconfigured parameters to the mobile network.

By using the replica network as described above, the network operator may proactively check how a proposed network configuration will react to a natural disaster.

### 5.3.2 Potential requirements

**REQ-NDT-01:** NDT should have a capability enabling the MnS consumer to configure the network scenario to be modelled for evaluating emergency preparedness

**REQ-NDT-03:** NDT should have a capability enabling the MnS consumer to configure the parameters of the NDT instance of the objects to be modelled for evaluating emergency preparedness

**REQ-NDT-02:** NDT should have a capability to provide the results of network simulation for evaluating emergency preparedness.

### 5.3.3 Potential solutions

5.1.3.X Potential solution X

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 to scope to be considered for evaluating Emergency preparedness.

* 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 actions of a natural disaster.

* 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 Emergency preparedness 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 and KPIs of all the objects that have been modelled by the NDT instance. These include the values indicating the impact of the actions of a natural disaster.

* 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

### 5.3.4 Evaluation of potential solutions

## 5.4 Use case4: Network failure and risk prediction

### 5.4.1 Description

Each operations for network optimization and maintenance on mobile network may cause potential network failures and risks, especially high-risk operations, such as potentially dangerous configuration modification, policy modification, software version upgrade, and board switching, which may cause network congestion and network breakdown. To avoid any impact on the physical network, we can’t carry out the potential high-risk network operations in the physical network directly without concerning any consequences, and we can’t use the physical network to evaluate possible network optimization strategy and solution directly. Therefore, it is the better way that these network operations and possible network optimization solutions can be simulated and evaluated using network digital twin.

Using NDT, high-risk operations can identify whether these operations may cause potential network failures and risks by performing necessary digital twin related operations, e.g. simulation, verification and evaluation. The NDT can also optimize, verify and evaluate possible network policies and solutions for the further risk avoidance. After simulating and evaluating by the NDT, the results of high-risk operations prediction and evaluation should be notified back to 3GPP network system.

In addition, SLA degradation and failure of single node in mobile network can also be predicted using the NDT. When it is predicted that the network resources in the network domain are not enough to maintain the SLA or hardware resources failure at some time in the future, the NDT should warn 3GPP management system to take actions for network failure and risk avoidance.

Another scenario of network slice risk prediction is described in clause 5.2[1]. Using the NDT to predict risks, the ZSM framework can identify risks of specific service or network slice profile parameters not being met due to changing traffic and network conditions (e.g. a MD not being able to provide the network slice latency it committed for) and the NDT supports the ZSM framework to take actions before these risks materialize and therefore before the committed SLA/SLS are broken.

Therefore, 3GPP network system has needs to use network digital twin to predict and evaluate potential network failures and risks based on operator’s requirements, such as predict possible network failures and risks posed by the high-risk operation. 3GPP management system can also use the NDT to evaluate and verify possible network policies and solutions to minimize the impact of high-risk operations.

### 5.4.2 Potential requirements

**REQ-NDTN\_Failurerisk-1:** The NDT should have the capability allowing the consumer to request evaluation of the risk level for high-risk operations.

**REQ-NDTN\_ Failurerisk-2:** The NDT should have the capability to provide the results of a simulation, including evaluation of risk level for high-risk operations.

**REQ-NDT-01:** NDT should have a capability enabling the MnS consumer to configure the network scenario to be modelled for evaluating a Network failure

**REQ-NDT-02:** NDT should have a capability enabling the MnS consumer to configure the parameters of the NDT instance of the objects to be modelled for evaluating a Network failure

### 5.4.3 Potential solutions

5.1.3.X Potential solution X

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 to 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 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

### 5.4.4 Evaluation of potential solutions

Annex <X> (informative):
Change history

|  |
| --- |
| **Change history** |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2024-01 | SA5#153 | 1.S5-240475 |  |  |  | 1.TR 28.915\_000 | 0.0.0 |
| 2024-02 | SA5#153 | 1.S5-2410482.S5-241049 |  |  |  | 1.Add skeleton for TR 28.9152.Add scope for TR 28.915 | 0.1.0 |
| 2024-04 | SA5#154 | 1.S5-2420122.S5-2420163.S5-2420174.S5-2420185.S5-2418926.S5-2420217.S5-242138 |  |  |  | 1.pCR 28.915 Add use case for disaster planning2.Rel-19 pCR TR28.915 Overview on NDTs3.pCR Add terms of NDT for TR 28.9154.pCR Add concepts for TR 28.9155.pCR Add use case of Signaling storm analysis for TR 28.9156.pCR TR 28.915 Use case on network failure and risk prediction7.pCR TR 28.915 New use case on RAN energy saving policy verification | 0.2.0 |