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**Network Functions Virtualisation (NFV);
Management and Orchestration;
Report on the support of real-time/ultra-low latency aspects in NFV related to service and network handling**

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Network Functions Virtualisation (NFV).

Modal verbs terminology

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1 Scope

The present document analyses the impact on management and orchestration of Network Service (NS) instance(s) supporting low latency services from the perspective of the NFV-MANO architectural framework. The following topics are handled:

- Definition of relevant NFV-MANO use cases.
- Analysis of the use-cases and deriving potential requirements.
- Providing relevant recommendations.

The content of the present document is informative.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

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] ETSI GR NFV-IFA 012 (V3.1.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Report on Os-Ma-Nfvo reference point - Application and Service Management Use Cases and Recommendations", October 2018.

[i.2] ETSI GR NFV-IFA 028 (V3.1.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Report on architecture options to support multiple administrative domains".

[i.3] ETSI GS NFV-IFA 032 (V3.2.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Interface and Information Model Specification for Multi-Site Connectivity Services".

[i.4] ETSI GS NFV-IFA 010 (V3.3.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Functional requirements specification".

[i.5] ETSI GS NFV-IFA 011 (V3.2.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; VNF Descriptor and Packaging Specification".

[i.6] ETSI GS NFV-IFA 014 (V3.3.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Network Service Templates Specification".

[i.7] ETSI GS NFV-IFA 031 (V3.3.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Requirements and interfaces specification for management of NFV-MANO".

[i.8] ETSI GS NFV-IFA 027 (V2.4.1): "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Performance Measurements Specification".

[i.9] ETSI GS NFV-TST 008 (V3.2.1): "Network Functions Virtualisation (NFV) Release 3; Testing; NFVI Compute and Network Metrics Specification".

[i.10] ETSI GR NFV 003 (V1.5.1): "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.11] ETSI TS 122 261 (V15.8.0): "5G; Service requirements for next generation new services and markets (3GPP TS 22.261 version 15.8.0 Release 15)".

[i.12] ETSI GS NFV-IFA 013 (V3.3.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Os-Ma-Nfvo reference point - Interface and Information Model Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GR NFV 003 [i.10] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.10] and the following apply:

AF	Application Function
MLPOC	Multiple Logical Points Of Contacts
NFVIaaS-C	NFVIaaS Consumer
NFVIaaS-P	NFVIaaS Provider
SLPOC	Single Logical Points Of Contacts

4 Use Cases

4.1 Introduction

In ETSI TS 122 261 [i.11] various services requiring low latency guarantees have been identified. These use cases include urgent healthcare and emergency services, which require latency guarantees from 1 ms to 10 ms. A second class of uses cases includes smart factories and tactile interaction applications, which require latency to stay between 0,5 ms and 1 ms. The requirements towards the network of these use cases are summarized in Table 4.1-1. Thus, it has to be emphasized that these latency requirements are strictly on an end-to-end service level. Consequently, any operations impacting the actual service deployment and run-time operation should guarantee that those upper bounds are not exceeded.

The present document investigates the gaps in NFV-MANO specifications to support low latency services that are provisioned over NFV Network Services (NS). Thus generic use cases are presented which are later analysed from the perspective of NFV-MANO system in supporting and managing such services within strict end-to-end delay bound. The NFV-MANO system will be analysed in order to highlight the various aspects that can potentially impact the latency bounds of an active service over the NFVI. With respect to the analysis, necessary recommendations will be provided.

Table 4.1-1: Performance requirements for low-latency and high reliability scenarios [i.11]

Scenario	Max. allowed end-to-end latency (note 2)	Survival time	Communication service availability (note 3)	Reliability (note 3)	User experienced data rate	Payload size (note 4)	Traffic density (note 5)	Connection density (note 6)	Service area dimension (note 7)
Discrete automation	10 ms	0 ms	99,99%	99,99%	10 Mbps	Small to big	1 Tbps/km^2	100 000/km^2	1000 x 1000 x 30 m
Process automation – remote control	60 ms	100 ms	99,9999%	99,999%	1 Mbps up to 100 Mbps	Small to big	100 Gbps/km^2	1 000/km^2	300 x 300 x 50 m
Process automation – monitoring	60 ms	100 ms	99,9%	99,9%	1 Mbps	Small	10 Gbps/km^2	10 000/km^2	300 x 300 x 50
Electricity distribution – medium voltage	40 ms	25 ms	99,9%	99,9%	10 Mbps	Small to big	10 Gbps/km^2	1 000/km^2	100 km along power line
Electricity distribution – high voltage (note 1)	5 ms	10 ms	99,9999%	99,999%	10 Mbps	Small	100 Gbps/km^2	1 000/km^2 (note 8)	200 km along power line
Intelligent transport systems – infrastructure backhaul	30 ms	100 ms	99,9999%	99,999%	10 Mbps	Small to big	10 Gbps/km^2	1 000/km^2	2 km along a road

NOTE 1: Currently realised via wired communication lines.
NOTE 2: This is the maximum end-to-end latency allowed for the 5G system to deliver the service in the case the end-to-end latency is completely allocated to the 5G system from the UE to the Interface to Data Network.
NOTE 3: Communication service availability relates to the service interfaces, and reliability relates to a given system entity. One or more retransmissions of network layer packets may take place in order to satisfy the reliability requirement.
NOTE 4: Small: payload typically ≤ 256 bytes
NOTE 5: Based on the assumption that all connected applications within the service volume require the user experienced data rate.
NOTE 6: Under the assumption of 100% 5G penetration.
NOTE 7: Estimates of maximum dimensions; the last figure is the vertical dimension.
NOTE 8: In dense urban areas.
NOTE 9: All the values in this table are example values and not strict requirements. Deployment configurations should be taken into account when considering service offerings that meet the targets.

4.2 Use Case 1: Re-routing a low latency network service

This use case considers the situation when a low-latency service may have to be re-routed e.g. due to a network element failing, the topology change inside the NFVI, congestion event.

The failing network elements can be located inside a NFVI-PoP or on elements that are used to ensure interconnectivity between different NFV-PoPs. Apart from network resources the use case also considers the failure of VNFs. This could potentially involve the relocation of a failed VNF, which then would imply changes to the underlying network infrastructure connecting the affected VNF to the other elements of the NS.

The investigation will take into account that a VNF itself could be managing a part of the low latency service itself, e.g. by monitoring redundant links with which it is connected to the other NS elements. The use case should investigate if and how these kinds of VNF could interact with the NFV-MANO system.

The use case does not assume any specific procedures for re-routing of NS, but the NS rerouting process should take into account the latency bounds for the low-latency service. If multiples routes are available; those fulfilling the latency bounds best should be preferred. This would potentially involve monitoring latency bounds for routes (e.g. application latency monitoring).

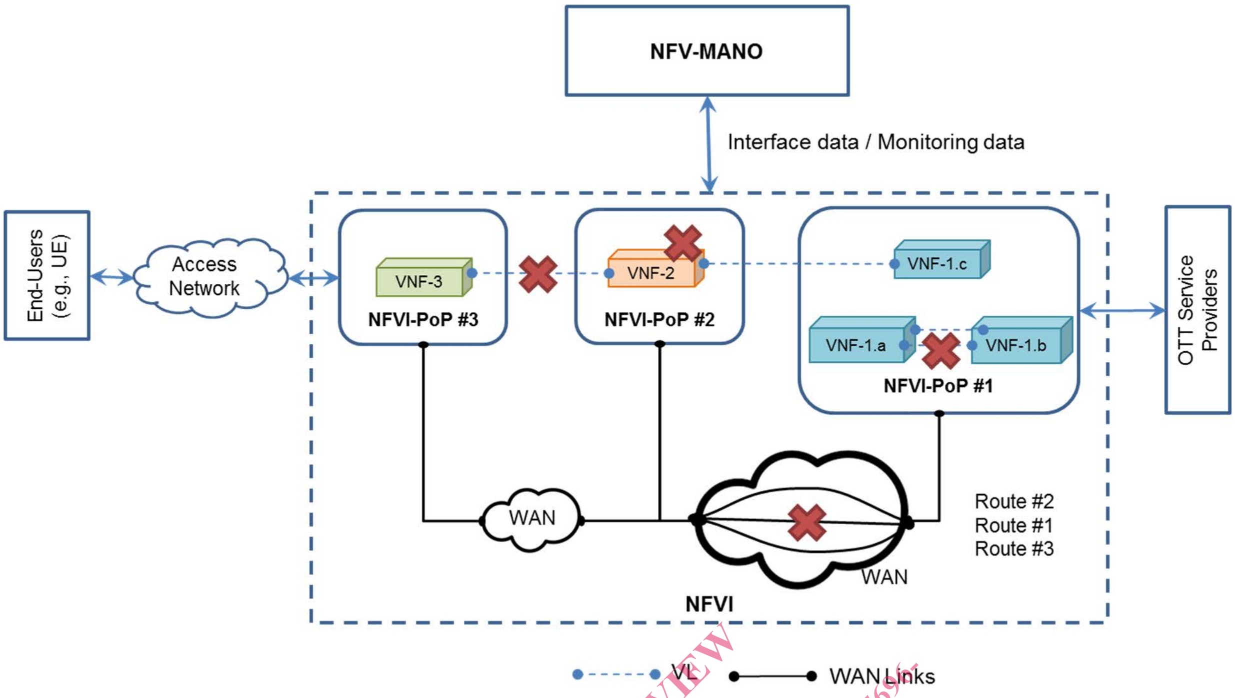

Figure 4.2-1: Overview of the use case 1 scenario

Figure 4.2-1 is presenting a network scenario consisting of 3 NFVI-PoPs interconnected over WAN links. There are two NS instances, a multisite NS and an intra-site NS instance. The multisite NS instance is composed of VNF instances, which are instantiated in different NFVI-PoPs, whereas the intra-site NS is composed of VNF instances that are instantiated within the same NFVI-PoP (i.e. VNF-1.a and VNF-1.b in NFVI-PoP #1 in Figure 4.2-1). A more detailed view on the WAN is showing different routes between NFVI-PoP #1 and NFVI-PoP #2. The following failure possibilities are assumed:

1) The current route #1 is failing and that there are 2 alternatives, one fulfilling the latency bounds of the low-latency service and one not fulfilling them.

2) Failure of a VL on a NS, within a single NFVI-PoP or across multiple NFVI-PoPs.

3) Failure of VNF itself that is part of a NS.

Each failure event will require the NFV-MANO system to trigger recovery actions to ensure time integrity of the affected NS.

4.3 Use Case 2: Mobility for a low latency network service

This use case considers the situation when a low-latency service is established and the client receiving the low-latency service is mobile. In such a situation, the client could change the access point it is connected to while receiving the service. The new access point could be connected to the same NFVI-PoP or even in a different NFVI-PoP. Usually the network connections are preconfigured and the NFV system does not even notice when clients move around. When dealing with low-latency services this stays basically the same but the network conditions might change when many clients receiving low-latency services move. When many clients move to the same new access point the network could get loaded in such a way that the low-latency conditions could no longer be guaranteed. In such a situation, the NFV-MANO system may have to detect and react to re-enforce the latency bounds given for the low-latency service.

In such a situation it is thus required that the NFV-MANO system is able to detect, or get notification of, degradation of low-latency services due to mobile users changing access points. When a service degradation is detected, the NFV-MANO system may have to derive and trigger suitable actions to restore the low-latency characteristics of the degraded service.

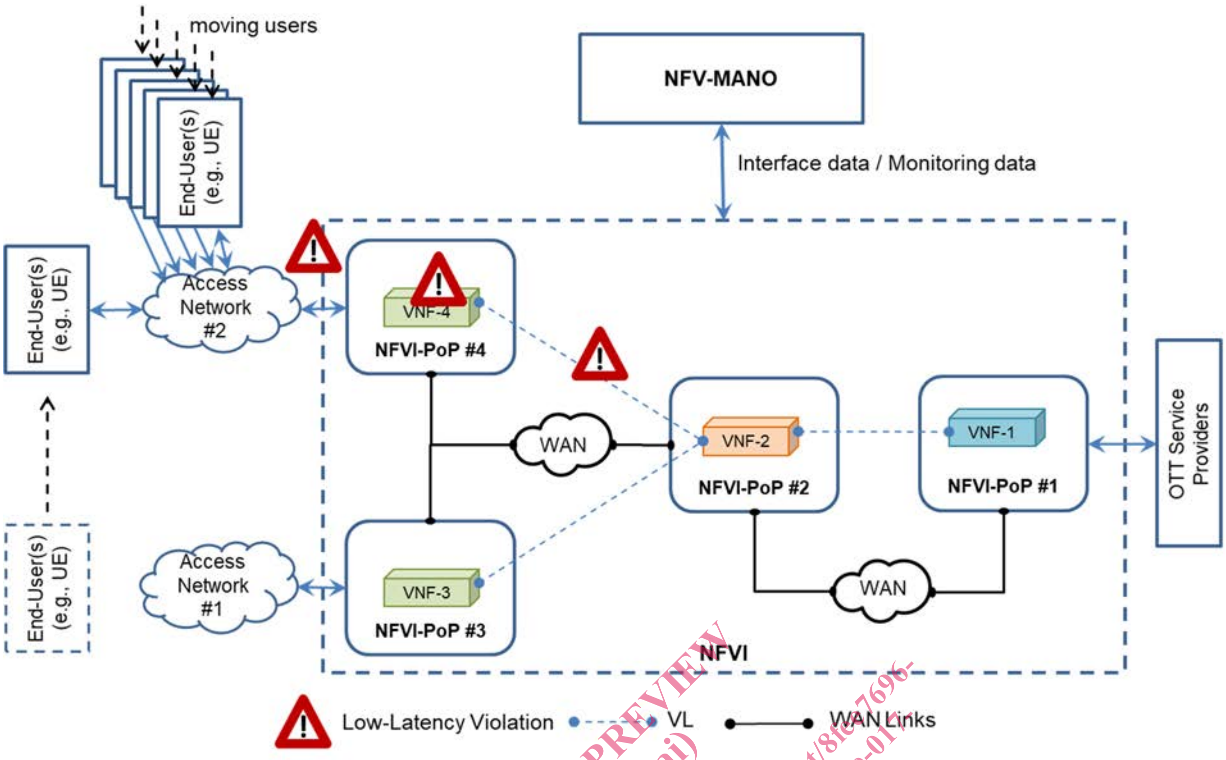

Figure 4.3-1: Overview of the use case 2 scenario

Figure 4.3-1 is presenting a network consisting of 4 NFVI-PoPs hosting different VNFs providing an NS and interconnecting WAN links. NFVI-PoP#3 and NFVI-PoP#4 are ingress for mobile end-users. Figure 4.3-1 also shows many end-users currently moving in to the access network connected to NFVI-PoP#4. Different locations are assumed where low-latency guarantees could be violated due to the mass of end-users moving in.

Each location that causes the violation of these guarantees will require the NFV-MANO system to trigger recovery actions to ensure low latency characteristics of the affected NS.

The investigation will analyse if the requirements for a low-latency NS will introduce additional requirements on NS monitoring to detect degradation of NS low-latency guarantees. In addition it will identify which management elements of the whole NFV-MANO system might be affected and may have to act to restore the low-latency characteristic of the degraded NS.

4.4 Use Case 3: Supporting Low latency Application Function Overlaying the Network Service

In ETSI GR NFV-IFA 012 [i.1] Application Functions (AFs) are introduced, where the AFs rely on the functional/operational characteristics of the NS or one or more of its constituent VNFs that are parts of NS(s) to deliver application services. On the other hand, the VNF(s) and/or the NS(s) may also utilize the functions provided by the AFs for their own operational/functional support, e.g. by analysing their KPIs to improve service delivery.

This use case considers NFV-MANO supporting AFs responsible for delivering low latency services, such as live streaming of multimedia content over NS. This is relevant because the AF instance could be the cause of delay and/or the underlying NS or one or more of its components can impact the latency bounds of the application service, and thus it is important for NFV-MANO to be aware of it. The application that is providing/serving the low-latency service could provide latency information about the end-to-end network path since it usually receives feedback from the clients and can retrieve traffic information from the underlying NS/VNF instance(s) as laid out in ETSI GR NFV-IFA 012 [i.1]. This latency information could then be provided to the management system of the AF.

ETSI GR NFV-IFA 012 [i.1] foresees relying on the interfaces on the Os-Ma-Nfvo reference point for an AF to interact with the NFV-MANO system. In this use case, the relevant notifications from the AF can be used by the OSS/BSS to trigger the NFV-MANO system about degraded conditions to help identify and improve the degraded latency conditions as far as the network path of an NS is concerned that the AF is using. The AF may have to provide information that enables the NFV-MANO system to map the application latency requirements to a NS being managed by NFV-MANO. To fulfil this task the AF might have to use other interfaces apart from the Os-Ma-Nfvo ones. The information provided by the AF can be manifold: it could be a simple Boolean value informing about bad conditions or might contain more fine grained information exchanged between the AF and the VNFs that couple it with the NS.

The use case will consider different causes for latency degradation such as load on the AF, load on the NS itself or users changing access points, etc. In such a situation it is beneficial that the NFV-MANO system gets help in detecting the degradation of low-latency services through notifications triggered by the AF. When a service degradation is detected and identified, the NFV-MANO system may have to derive and enforce suitable measures to resurrect the low-latency guarantees for the degraded service. These measures can be executed by different functional blocks of the NFV-MANO system depending on the cause of latency degradation.

The investigation of this use case will analyse how and to which functional blocks in NFV-MANO system AF specific performance and latency information may have to be provided.

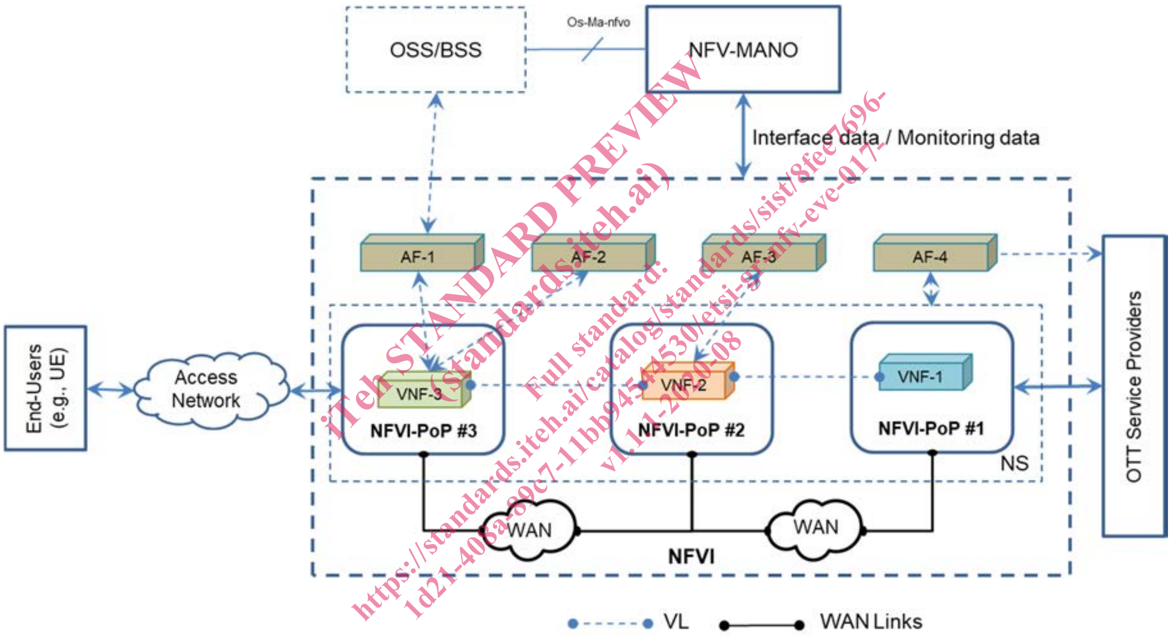

Figure 4.4-1: Overview of the use case 3 scenario

The use case scenario is illustrated in Figure 4.4-1 where AF instances are overlaid on a multi-site NS composed of 3 VNFs, namely VNF-1, VNF-2 and VNF-3 hosed in 3 NFVI-PoPs respectively. The 3 NFVI-PoPs are interconnected over WAN links. The AF instances 1 to 3 are coupled with a single VNF function whereas AF 4 is coupled with the whole NS. AF 4 could provide a low-latency service to an end-user over the NS while receiving application data from the NS or from an OTT service provider. The Figure shows the interaction of the AFs with the underlying NS and with the NFV-MANO system via the OSS/BSS over the Os-Ma-NFVO reference point, as specified in ETSI GR NFV-IFA 012 [i.1]. As an option, the AFs can interact with the NFV-MANO system over this reference point by providing application level latency information. This information could then trigger the NFV-MANO system via the OSS/BSS to take appropriate actions at the NS level to maintain the services' latency bounds.