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Zero-touch network and Service Management (ZSM); Cross-domain E2E service lifecycle management

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Zero-touch network and Service Management (ZSM).

Modal verbs terminology

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1 Scope

The present document investigates the management of End to End (E2E) services across Management Domains (MDs).

It defines the management processes during the lifecycle of E2E services (covering onboarding processes, fulfilment processes and assurance processes) and describes the interactions between E2E service management domain and management domains during these processes.

Furthermore, it maps the management services used in the management processes to the northbound interfaces of selected technology domains and references the underlying specifications of these interfaces. These mappings enable the automation of lifecycle management across domains.

2 References

2.1 Normative 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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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 necessary for the application of the present document.

[1] ETSI GS ZSM 002: "Zero-touch network and Service Management (ZSM); Reference Architecture".

[2] ETSI GS ZSM 007: "Zero-touch network and Service Management (ZSM); Terminology for concepts in ZSM".

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

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[7] ETSI TS 128 531: "5G; Management and orchestration; Provisioning (3GPP TS 28.531 Release 16)".

[8] ETSI TS 128 541: "5G; Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3 (3GPP TS 28.541 Release 17)".

[9] ETSI TS 128 632: "Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Inventory Management (IM) Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS) (3GPP TS 28.632 Release 16)".

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[19] BBF TR-411: "Definition of interfaces between CloudCO Functional Modules", Technical Report, Broadband Forum, April 2021.

[20] BBF TR-454: "YANG Modules for Network Map & Equipment Inventory", Technical Report, Broadband Forum, July 2021.

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[22] TMF633 (Version 4.0.0): "Service Catalog Management API REST Specification", TM Forum Specification.

[23] TMF638 (Version 4.0.1): "Service Inventory Management API User Guide", TM Forum Specification.

[24] TMF639 (Version 4.0.1): "Resource Inventory Management API User Guide", TM Forum Specification.

[25] TMF640 (Version 4.0.1): "Service Activation and Configuration API User Guide", TM Forum Specification.

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[39] IETF RFC 8299: "YANG Data Model for L3VPN Service Delivery".

[40] IETF RFC 8345: "A YANG Data Model for Network Topologies".

[41] IETF RFC 8346: "A YANG Data Model for Layer 3 Topologies".

[42] IETF RFC 8466: "A YANG Data Model for Layer 2 Virtual Private Network (L2VPN) Service Delivery".

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[44] IETF RFC 8641: "Subscription to YANG Notifications for Datastore Updates".

[45] IETF RFC 8650: "Dynamic Subscription to YANG Events and Datastores over RESTCONF".

[46] IETF RFC 8795: "YANG Data Model for Traffic Engineering (TE) Topologies".

[47] IETF RFC 8944: "A YANG Data Model for Layer 2 Network Topologies".

[48] IETF RFC 9094: "A YANG Data Model for Wavelength Switched Optical Networks (WSONs)".

[49] IETF RFC 9182: "A YANG Network Data Model for Layer 3 VPNs".

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 GS ZSM 009-1: "Zero-touch network and Service Management (ZSM); Closed-loop automation; Part 1: Enablers".

[i.2] ETSI TS 123 288: "5G; Architecture enhancements for 5G System (5GS) to support network data analytics services (3GPP TS 23.288 Release 16)".

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[i.16] draft-ietf-opsawg-sap: "A Network YANG Model for Service Attachment Points (SAPs)", Internet draft, Version 04, work in progress.

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[i.17] draft-ietf-opsawg-yang-vpn-service-pm: "A YANG Model for Network and VPN Service Performance Monitoring", Internet draft, Version 07, work in progress.

NOTE: Available at https://datatracker.ietf.org/doc/draft-ietf-opsawg-yang-vpn-service-pm/.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GS ZSM 007 [2] and the following apply:

domain service: service that is managed by a management domain

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS ZSM 007 [2] and the following apply:

5G	5th Generation
API	Application Programming Interface
BBF	Broadband Forum
CCAMP	Common Control and Measurement Plane
CCO	Cloud Central Office
CCO DO	Cloud Central Office Domain Orchestrator
CloudCO	Cloud Central Office
CRUD	Create, Read, Update, Delete
CRUD-N	CRUD plus Notify
E2E	End-to-End
E-UTRAN	Evolved Universal Mobile Telecommunications System Terrestrial Radio Access Network
EPC	Evolved Packet Core
ETSI	European Telecommunications Standards Institute
FM	Fault Management
gNMI	gRPC Network Management Interface
gRPC	Google Remote Procedure Call
IETF	Internet Engineering Task Force
IFA	InterFaces and Architecture
IOC	Information Object Class
KPI	Key Performance Indicator
L2	Layer 2
L2NM	Layer 2 Network Model
L2SM	Layer 2 Service Model
L2VPN	Layer 2 VPN
L3	Layer 3
L3NM	Layer 3 Network Model
L3SM	Layer 3 Service Model
L3VPN	Layer 3 VPN
LCM	LifeCycle Management
LTE	Long-Term Evolution
MD	Management Domain
MDA	Management Data Analytics
MDAS	Management Data Analytics Service
MnF	Management Function
MnS	Management Service
MOI	Managed Object Instance

n/a	not applicable
NBI	NorthBound Interface
NFV	Network Functions Virtualisation
NFVO	NFV Orchestrator
NRM	Network Resource Model
NSC	Network Slice Controller
NWDAF	Network Data Analytics Function
ONF	Open Networking Foundation
OTN	Optical Transport Network
PM	Performance Management
SDK	Software Development Kit
SOL	SOLutions
TAPI	Transport Application Programming Interfaces
TEAS	Traffic Engineering Architecture and Signaling
TMF	TM Forum
TR	Technical Report
UC	Use Case
VNF	Virtualised Network Function
VPN	Virtual Private Network
WG	Working group
XML	eXtensible Markup Language
YANG	Yet Another Next Generation

4 Overview of cross-domain E2E service lifecycle management

The E2E service lifecycle is managed using different processes.

Roughly, the processes can be divided into:

- *onboarding processes* that ingest a service model that was created during an out-of-scope service design phase into the ZSM framework;
- *fulfilment processes* that bring up a service instance based on an onboarded service model, configure the service instance, activate it for use and finally terminate it;
- *assurance processes* that ensure a service is free of faults (service problem management) and meets its SLSs (service quality management).

Onboarding and fulfilment processes are typically finite and are executed per request. Assurance processes typically execute continuously once set up, ideally in closed loops. ETSI GS ZSM 009-1 [i.1] defines enablers for closed loops.

The present document focuses on the cross-domain aspects of these management processes and what management services can be used to implement those processes.

Figure 4-1 illustrates the management processes during the E2E service lifecycle. Furthermore, the figure indicates as example the groups of management services introduced in ETSI GS ZSM 002 [1] that can be used to implement the processes. Apart from the processes that start the lifecycle of a service instance (service instantiation and assurance set-up) and end it (service decommissioning and assurance tear-down), the figure depicts sets of processes with no particular order. The processes are further detailed in clause 5.

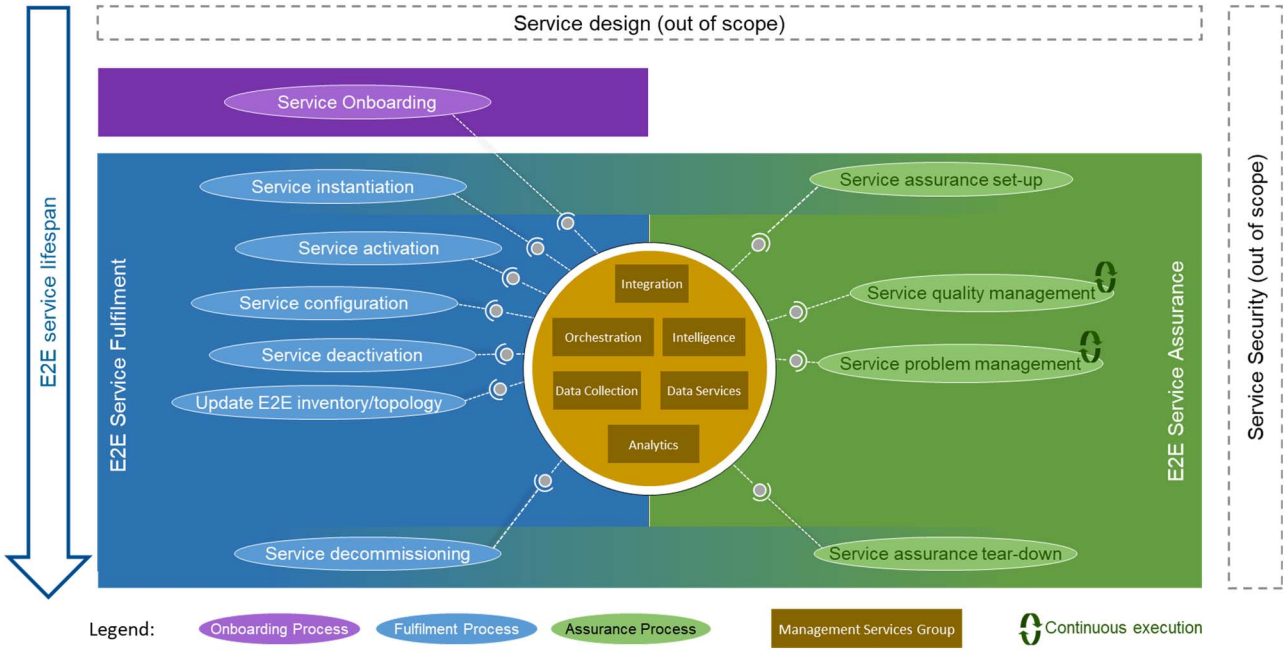


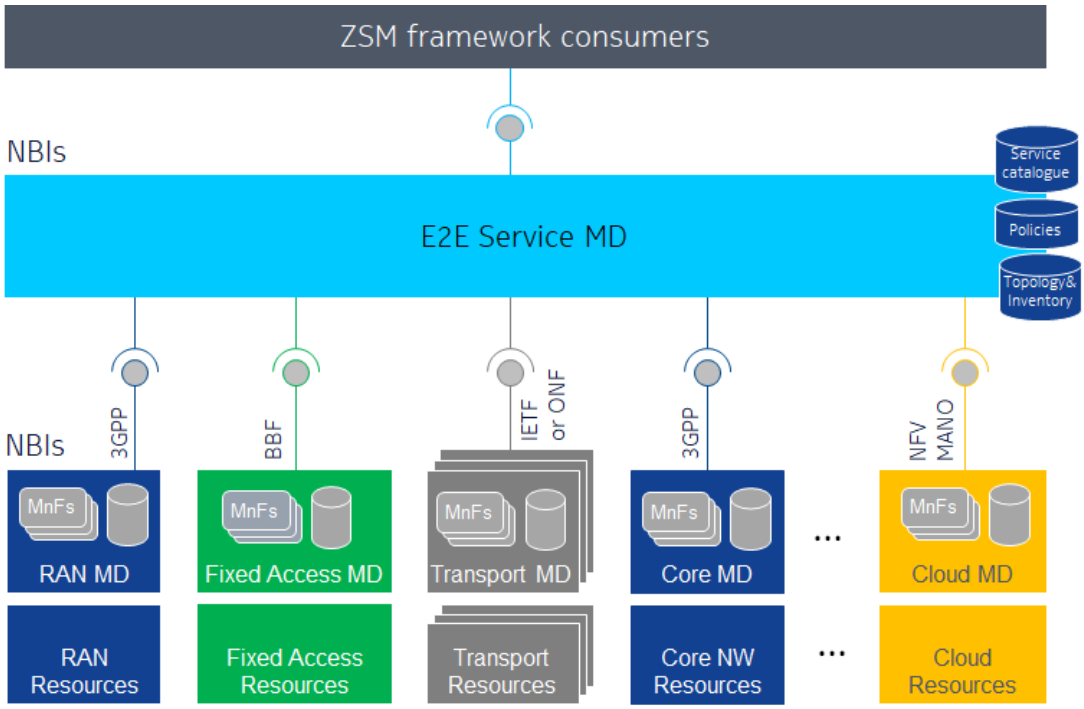
Figure 4-1: Management processes during the lifecycle of E2E services

Each management process during the E2E service lifecycle requires that the E2E service management domain consumes management services from the management domains. For example, a fulfilment process might use Orchestration services for service configuration, and Data Collection services to validate if the service quality requirements are met initially. As another example, an assurance process might be realized as a closed loop using Data Collection services, Data Analytics Services, Intelligence services together with Orchestration services to improve the configuration in order to maintain the desired service quality.

A large set of these management services depends on the technology used in the underlying management domain. The E2E service management domain needs to be able to consume the various management services from the management domains via the endpoints that make up the northbound interface of the domain.

Figure 4-2 illustrates the set of technology domains considered in the present document. In deployments, there may be additional technology domains. Clause 6 documents the northbound interfaces of management domains based on different technologies.

In the present document, the NBIs of the E2E service management domain are defined in terms of ZSM management services (see ETSI GS ZSM 002 [1] with extensions defined in Annex A of the present document). The technology mapping of these NBIs is out of scope of the present document.



NOTE 1: NBIs depicted in figure 4-2 are neither mandatory nor exhaustive ones, but examples to be utilized.
NOTE 2: The cross-domain integration fabric is not depicted in figure 4-2 for simplicity.

Figure 4-2: Domain NBIs consumed during the management of the lifecycle of E2E services

Clause 7 documents gaps and commonalities between the different technology domains with respect to their northbound interfaces.

5 Cross-domain E2E service lifecycle management processes

5.1 Overview

Clause 5 introduces typical lifecycle management processes that the E2E service management domain performs to manage E2E services throughout their lifespan and during which it interacts with the underlying management domains that manage resources and domain services which are needed for the E2E service.

In deployments, processes may be combined or split.

For each process, a description, a process flow and a list of related management services are provided. The description explains the overall purpose and task of the process. The procedure flow provides a graphical and a textual representation of the individual steps of the process. For simplicity's sake, only requests are shown in the flows and responses and acknowledgements are omitted. Furthermore, for the unsuccessful execution of the procedures, only error conditions are defined, but no detailed error flows are specified. The list of related management services includes management services that are produced or consumed by the E2E service management domain and therefore represent a cross-domain integration point. Management services that are invoked internally by the management domain or E2E service management domain (i.e. where producer and consumer are in the same domain) are not listed as these do not require cross-domain integration or coordination.

In the following, the term "domain service" is used as shorthand for "a service that is managed by a management domain".

The processes are split into three categories: Service onboarding, Service fulfilment and Service assurance, as depicted in figure 4-1.

5.2 Service onboarding

5.2.1 Overview

The following sub-clauses introduce typical onboarding processes, i.e. processes that the E2E service management domain performs to obtain E2E service models from service design (which is out of scope of the present document) and that prepare the E2E service management domain and the management domains for the instantiation of such services.

5.2.2 Process: Service onboarding

5.2.2.1 Description

The "Service onboarding" process imports a new service model into the service catalogue of the E2E service management domain, following the service design phase that is outside the scope of the present document. The E2E service model is introduced in clause 6.6.5.2.3 of ETSI GS ZSM 002 [1].

Onboarding may optionally include the importing of a service template that allows to parameterize the service model when a subsequent service instance creation is requested. A service template contains a customer-facing part and a resource-facing part. The customer facing part, called the service offer descriptor, defines a set of parameters with their allowed values or value ranges which can be used by the ZSM framework consumers to configure the characteristics of the service they request to instantiate. The resource-facing part defines how to map the parameters in the service offer descriptor to the realization of the service.

5.2.2.2 Procedure flow

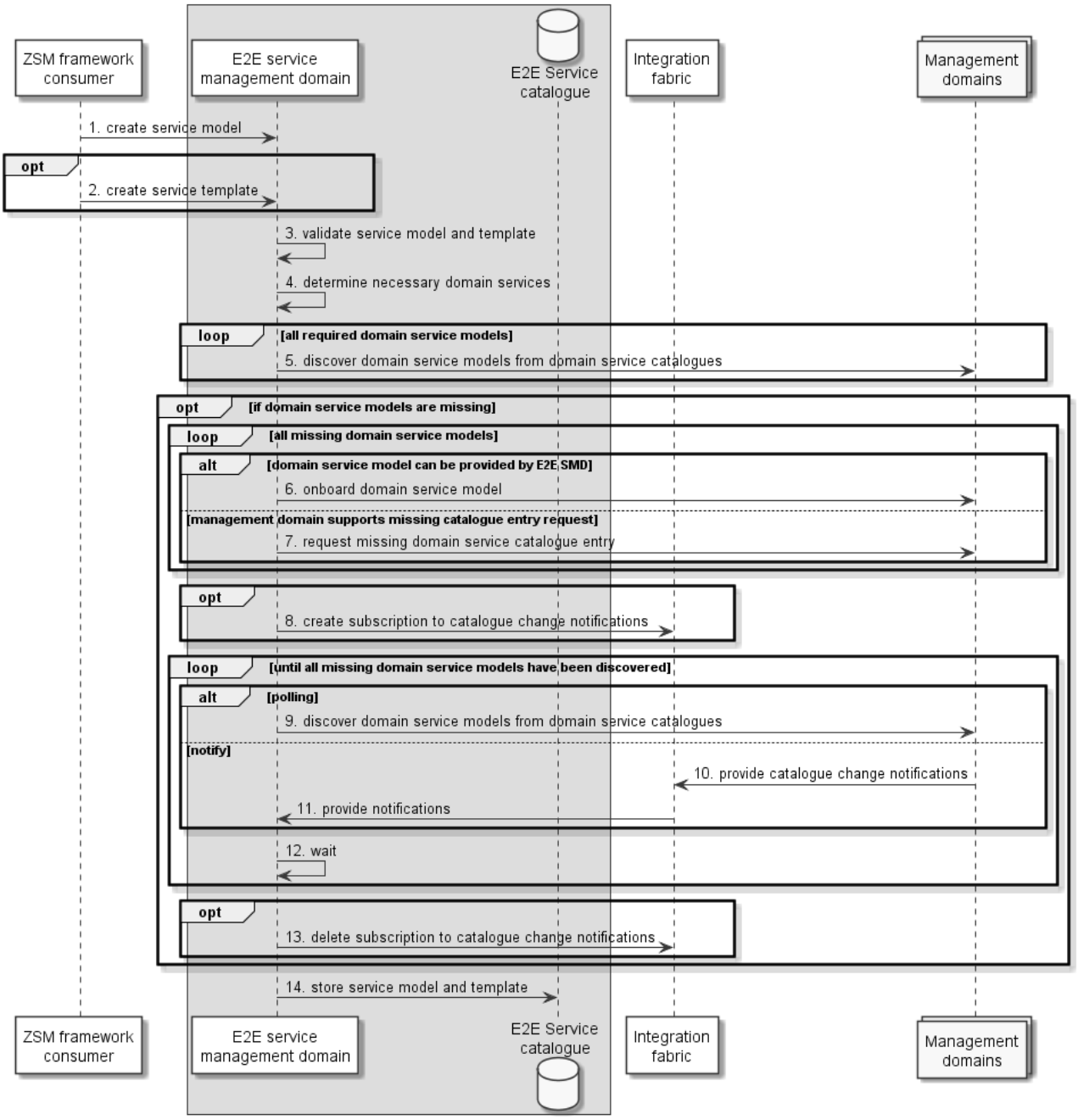


Figure 5.2.2.2-1: Service onboarding

PRECONDITIONS:

- None.

The procedure, as illustrated in figure 5.2.2.2-1, consists of the following steps:

1. The ZSM framework consumer requests the creation of a service model and its import into the service catalogue managed by the E2E service management domain by consuming the "Manage service models" capability of the "Managed services catalogue management service".

2. Optionally, the ZSM framework consumer also requests the creation of a related service template and its import into the service catalogue, consuming the same service.

3. The E2E service management domain validates the service model and, if it has been provided, the service template.

4. The E2E service management domain determines the domain services that are necessary to provide the E2E service.

5. To determine the missing domain service models (if any), the E2E service management domain queries from the involved management domains the service catalogue entries of those domain service models that are needed as components of the E2E service, using the "Manage service models" capability of the "Managed services catalogue management service".

If domain service models are missing that are needed by the E2E service, steps 6 to 8 are performed:

6. Optionally, in special cases if the E2E service management domain is able to provide certain domain service models to the management domains, it onboards them into the relevant management domains, using the "Manage service models" capability of the "Managed services catalogue management service".

7. Optionally, if management domains support being informed about the need to provide certain domain services that are currently missing, the E2E service management domain informs them using the "Request missing service catalogue entry" capability of the "Managed services catalogue management service".

NOTE: This allows the E2E service management domain to express towards a management domain the need for adding a particular domain service model to the domain's service catalogue and preparing the management domain for instantiating the service.

8. If the E2E service management domain intends to receive notifications about catalogue changes, it subscribes to these notifications towards the integration fabric, using the "Manage subscriptions" capability of the "Management communication service".

In a loop over steps 9 to 12, the E2E service management domain waits until all needed domain service models are available:

9. As first alternative, the E2E service management domain queries from the involved management domains the service catalogue entries of those domain service models that were missing, to check whether they have become available, using the "Manage service models" capability of the "Managed services catalogue management service".

10. As second alternative, the management domains send notifications towards the integration fabric to inform subscribers about changes in the service catalogue, using the "Provide notifications" capability of the "Managed services catalogue management service".

11. Further as part of the second alternative, the integration fabric receives these notifications and forwards them to the subscribers, including the E2E service management domain, using the using the "Receive data" and "Provide data" capabilities of the "Managed services catalogue management service".

12. If some needed domain service models are still unavailable, the loop waits until one or more further changes in the availability of service models occur. In order to continue the process, information that a particular domain service is now available may either be polled or may be provided using the "Provide catalogue change notifications" capability of the "Managed services catalogue management service". Alternatively, the loop may fail at the first error or after a time-out. See "ERROR CONDITIONS" for more information.

13. If the E2E service management domain has created a subscription to catalogue change notifications in step 8, it terminates that subscription, using the "Manage subscriptions" capability of the "Management communication service".

14. The E2E service management domain stores the related data in the service catalogue in the Domain Data Services or Cross-domain Data Services using the "Store data" capability of the "Data persistence service".

POSTCONDITIONS:

- The E2E service model has been onboarded.

- The individual management domains have available in their catalogues the service models of the component services from which the E2E service is composed.

ERROR CONDITIONS:

- In case the validation of the service model / service template fails in step 3, the procedure terminates with an error.
- In case not all needed domain service models are available and the loop cannot wait in step 11 for these becoming available or the waiting has timed out, the procedure terminates with an error.

5.2.2.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service orchestration: "Manage service models" capability of the "Managed services catalogue management service".

The following management services produced by the management domains are used in this procedure:

- Domain orchestration: "Manage service models", "Provide catalogue change notifications" and "Request missing service catalogue entry" capabilities of the "Managed services catalogue management service".

The following additional management services are used in this procedure:

- ZSM Integration Fabric: "Manage subscriptions", "Provide data" and "Receive data" capabilities of the "Management communication service".

NOTE 1: It is up to each deployment to decide whether to use the cross-domain integration fabric or the domain integration fabric or a combination of both.

- ZSM Data Services: "Store data" capability of the "Data persistence service".

NOTE 2: It is up to each deployment to decide whether to use the cross-domain data services or the domain data services to store the information. Therefore, the use of the "Data persistence service" cross-domain is optional.

5.3 Service fulfilment

5.3.1 Overview

The following clauses introduce typical fulfilment processes, i.e. processes that the E2E service management domain performs to manage E2E service instances from their creation (also known as instantiation) until their termination (aka decommissioning).

5.3.2 Process: Service instantiation

5.3.2.1 Description

This process creates an E2E service instance by requesting the orchestration of the domain service instances that make up the E2E service from one or more management domains. This means that all the necessary service instances in the management domains exist, and the necessary resources have been allocated by the management domains. It also performs service feasibility check, service configuration and testing. If a service template was onboarded with the service model (see clause 5.2.2), the service instantiation request from the ZSM framework consumer contains values to assign to the parameters defined in the service template.

5.3.2.2 Procedure flow

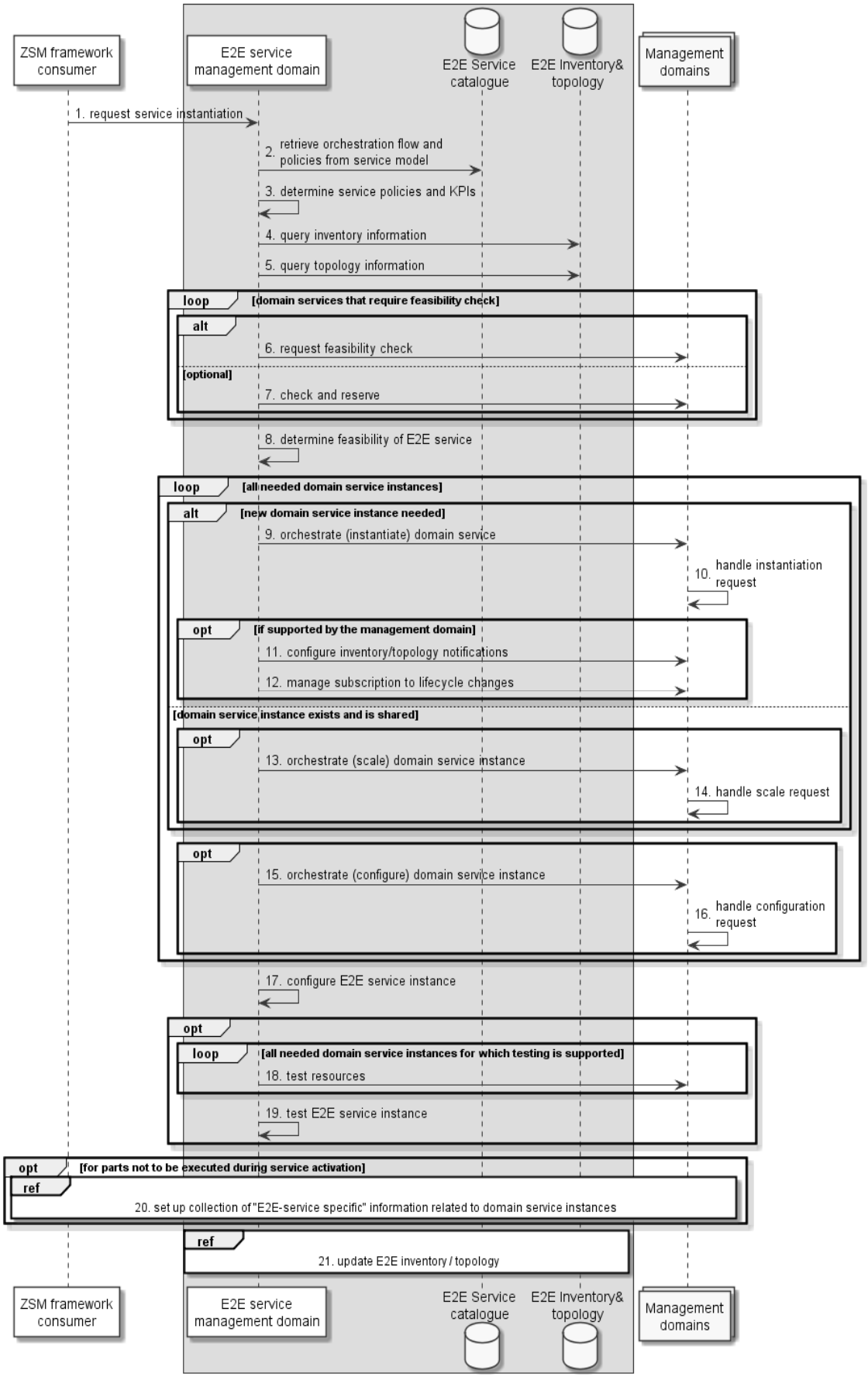


Figure 5.3.2.2-1: Service instantiation

PRECONDITIONS:

- The E2E service model has been onboarded.
- The individual management domains need to have available in their catalogues the service models of the component services from which the E2E service is composed.

The procedure, as illustrated in figure 5.3.2.2-1, consists of the following steps:

1. The ZSM framework consumer requests the instantiation of an E2E service, using the "Manage service lifecycle" capability of the "E2E service orchestration service".
2. The E2E service management domain retrieves the orchestration flow and service policies from the service model stored in the service catalogue in the Domain Data Services or Cross-domain Data Services using the "Query data" capability of the "Data persistence service".
3. Based on this information, the E2E service management domain determines the applicable policies and KPIs.
4. The E2E service management domain queries information from its inventory database locally, using the "Query inventory information" capability of the "E2E services inventory information service" or the "Query data" capability of the "Data persistence service".
5. The E2E service management domain queries information from its topology database locally, using the "Query topology information" capability of the "E2E services topology information service" or the "Query data" capability of the "Data persistence service".
6. The E2E service management domain requests an E2E service feasibility check by requesting the management domains to perform feasibility checks of those of the individual domain services that require such a check and that are components of the E2E service, using the "Check deployment feasibility" capability of the "Feasibility Check Service" of the involved management domains.
7. As an alternative, it may use the optional "Check and reserve" capability of the "Feasibility Check Service" to request a check with the reservation of the needed resources.
8. The E2E service management domain determines the feasibility of the requested E2E service based on the information obtained in steps 3 to 7.

The following steps 9 to 16 are executed for all individual domain service instances from which the E2E service instance is composed.

NOTE 1: It is up to the E2E service management domain to decide whether a domain service instance "owned" by it is shared by more than one E2E service instance.

If the E2E service management domain decides that a new domain service instance needs to be created to support the newly-created E2E service instance, steps 9 to 12 are performed.

9. The E2E service management domain requests the instantiation of a new domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domains.
10. The management domain handles the request and instantiates a new domain service instance. It allocates the necessary resources (possibly taking previous reservations into account) and initially configures them ("Day 0 configuration").
11. If supported by the management domain, the E2E service management domain configures notifications about inventory / topology changes related to the new domain service instance, using the "Configure notifications" capability of the "Domain inventory information service" and "Domain topology information service".
12. If supported by the management domain, the E2E service management domain subscribes to notifications about lifecycle changes related to the new domain service instance, using the "Manage subscription to lifecycle changes" capability of the "Domain orchestration service".

If the E2E service management domain decides to share a pre-existing domain service instance between the newly-created E2E service instance and another pre-existing E2E service instance, steps 13 and 14 are performed.

13. If there is the need to increase the capacity, the E2E service management domain requests the scaling of the shared domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

14. The management domain handles the request and scales the domain service instance. If necessary, the management domain allocates resources (possibly taking previous reservations into account) or scales them, and initially configures them ("Day 0 configuration").

If the E2E service management domain decides to (re)configure the domain service instance, steps 15and 16 are performed.

15. If necessary, the E2E service management domain requests the (re)configuration of the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

16. The management domain configures the domain service instance and related resources.

17. The E2E service management domain initially configures the E2E service instance ("Day 0 configuration").

The following two steps are typically executed to ensure the new service instance is functioning, but the ZSM framework consumer can indicate in the instantiation request to omit the test, for example if speed of instantiation is prioritized over reliability.

18. The E2E service management domain requests testing the resources of the domain service instances that are involved in the E2E service instance by consuming the "Testing service" from those of the involved management domains that expose this service. This includes managing the test models, initiating the tests and obtaining the test results using the "Manage test specifications", "Test resources" and "Query tests" service capabilities.

NOTE 2: It is optional for the management domains to expose the testing service.

19. The E2E service management domain tests the E2E service instance.

20. Subsequently, the E2E service management domain executes the procedure to set up the collection of information specific to the newly created E2E service instance, as defined in clause 5.4.2.2.2, for parts of this procedure that will not be executed as part of the service activation process (see clause 5.3.3).

21. At the end of the flow, the E2E service management domain triggers an internal event to update the E2E service inventory / topology, as defined in clause 5.3.7.

POSTCONDITIONS:

- The E2E service has been instantiated.

ERROR CONDITIONS:

- Failing individual steps of this procedure will terminate the procedure with an error, except for the testing steps.

- If a testing step fails, it is up to operator policy whether a test failure can be ignored and the procedure can still finish successfully. In such a case, it might be up to a subsequent assurance procedure to repair or optimize the E2E service instance.

5.3.2.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service orchestration: "Manage service lifecycle" capability of the "E2E service orchestration service".

The following management services produced by the management domains are used in this procedure:

- Domain orchestration: "Check deployment feasibility" and "Check and reserve" (if supported) capabilities of the "Feasibility check service".

- Domain orchestration: "Manage service lifecycle" capability of the "Domain orchestration service", including functionality to instantiate, scale and configure the domain service.
- Domain orchestration: "Manage subscription to lifecycle changes" capability of the "Domain orchestration service" (if exposed).
- Domain orchestration: "Configure notifications" capability of the "Domain inventory information service", if supported.
- Domain orchestration: "Configure notifications" capability of the "Domain topology information service", if supported.
- Domain orchestration: "Manage test specifications", "Test resources" and "Query tests" capabilities of the "Testing service".

The following additional management services are used in this procedure:

- ZSM Data Services: "Query data" capability of the "Data persistence service".

NOTE: It is up to each deployment to decide whether to use the cross-domain data services or the domain data services to store the information. Therefore, the use of the "Data persistence service" cross-domain is optional.

5.3.3 Process: Service activation

5.3.3.1 Description

This process activates an E2E service instance. After activation, the service instance is able to provide its services.

5.3.3.2 Procedure flow

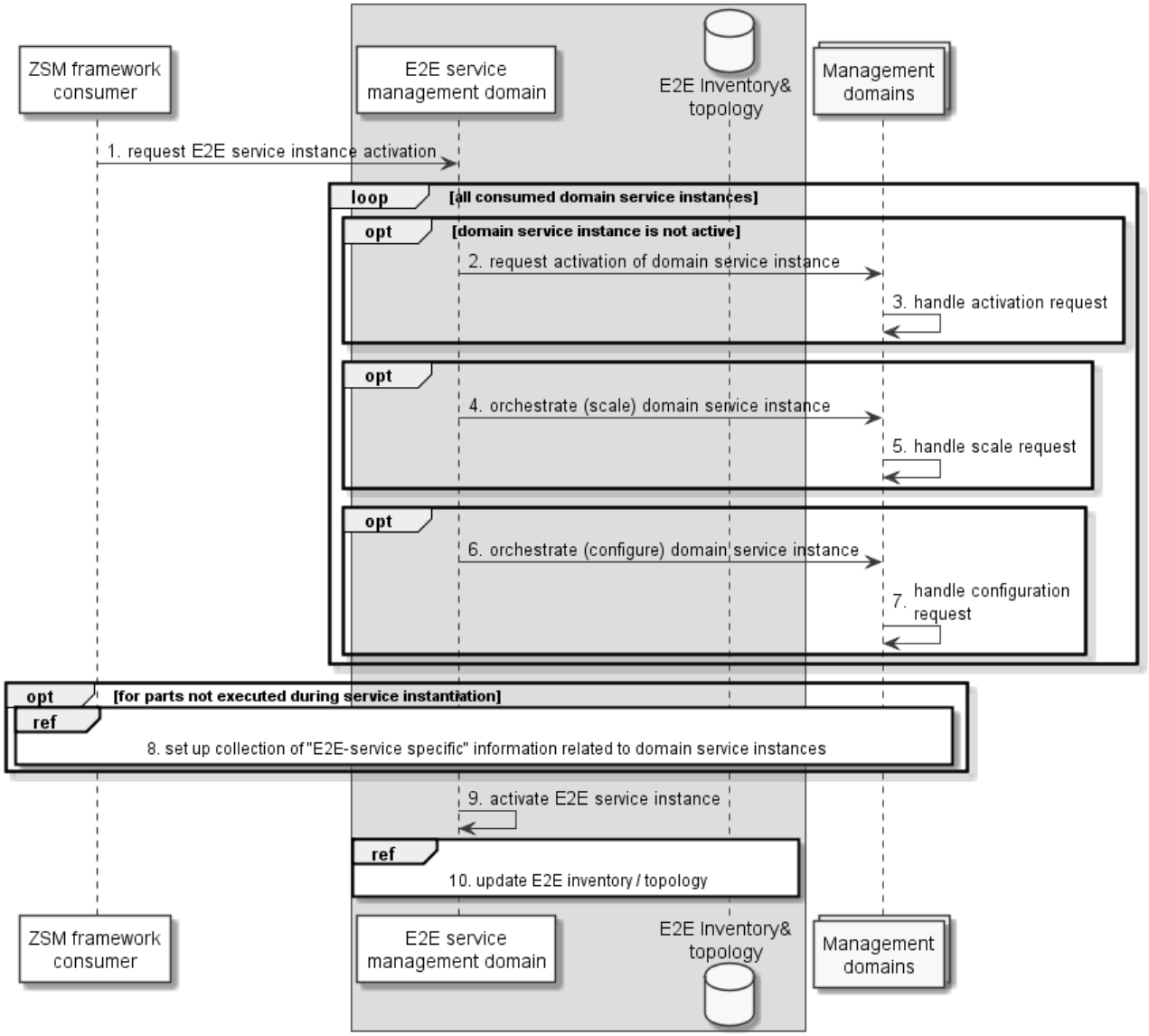


Figure 5.3.3.2-1: Service activation

PRECONDITIONS:

- The E2E service instance has been instantiated and configured.

The procedure, as illustrated in figure 5.3.3.2-1, consists of the following steps:

1. The ZSM framework consumer requests the activation of an E2E service instance, using the "Manage service lifecycle" capability of the "E2E service orchestration service".

The following steps 2 to 7 are executed for all domain service instances that are consumed by the E2E service instance being activated.

If the domain service instance is not yet activated, steps 2 and 3 are executed:

2. The E2E service management domain requests the orchestration (activation) of the individual domain service instance consumed by the E2E service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

3. The management domain handles the activation request. First, the management domain activates the domain service instance. Further, the management domain might apply changes such as scaling or reconfiguring of resources to reflect that they are now consumed by the activated service instance.

If necessary, typically because the domain service instance is shared and adding another E2E service instance needs more capacity of that domain service instance, steps 4 and 5 are executed:

4. The E2E service management domain requests to scale out / up the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

5. The management domain handles the scaling request. First, the management domain scales the domain service instance. Further, depending on the type of resource, the resources used by the domain service instance are scaled or reconfigured to increase their capacity.

If necessary, steps 6 and 7 are executed:

6. The E2E service management domain requests the (re)configuration of the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

7. Further in that case, the management domain (re)configures the domain service instance and the related resources.

Further, the following steps are executed:

8. Subsequently, the E2E service management domain executes the procedure to set up the collection of information specific to the E2E service instance to be activated, as defined in clause 5.4.2.2.2, for parts of this procedure that were not executed as part of the service instantiation process (see clause 5.3.2).

9. The E2E service management domain activates the E2E service instance by updating its state to reflect that the managed service instance is now active, i.e. available for consumption.

10. At the end of the flow, the E2E service management domain triggers an internal event to update the E2E service inventory / topology, as defined in clause 5.3.7.

POSTCONDITIONS:

- The E2E service instance has been activated.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.3.3.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service orchestration: "Manage service lifecycle" capability of the "E2E service orchestration service".

The following management services produced by the management domains are used in this procedure:

- Domain orchestration: "Manage service lifecycle" capability of the "Domain orchestration service", including functionality to activate and configure the managed service.

5.3.4 Process: Service configuration

5.3.4.1 Description

This process modifies the configuration of an E2E service instance.

5.3.4.2 Procedure flow

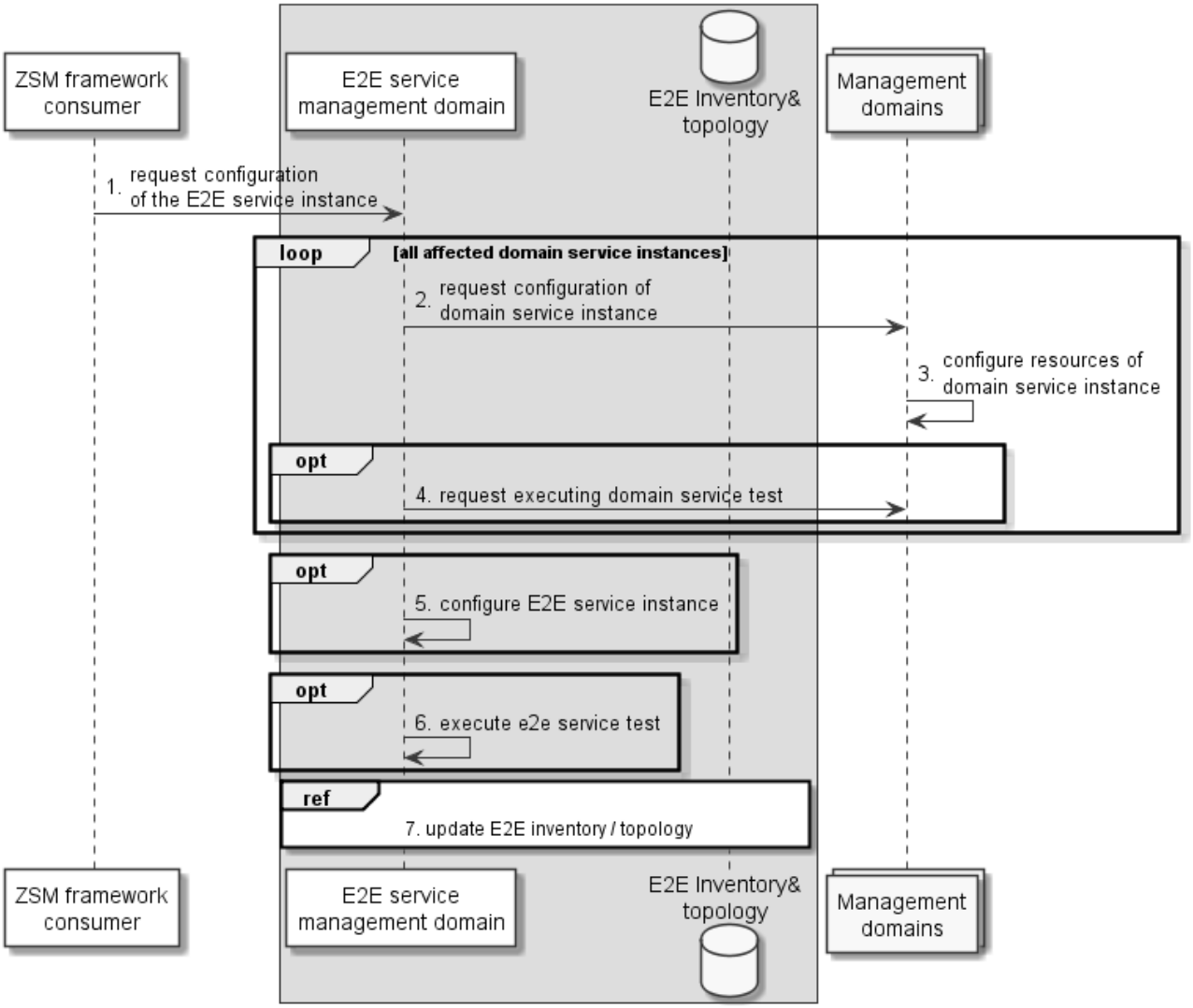


Figure 5.3.4.2-1: Service configuration

PRECONDITIONS:

- The E2E service has been instantiated.

NOTE: Service configuration can be invoked for an activated as well as for a non-activated E2E service instance.

The procedure, as illustrated in figure 5.3.4.2-1, consists of the following steps:

1. The ZSM framework consumer requests to modify the configuration of an E2E service instance, using the "Manage service lifecycle" capability of the "E2E service orchestration service".

In a loop, steps 2 to 4 are executed the individual domain service instances from which the E2E service is composed that are affected by the configuration change:

2. The E2E service management domain requests the domain orchestration service to change the configuration of the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service".

3. The management domain configures the necessary resources and / or domain service instances.

4. Optional: The E2E service management domain requests executing a test to validate the configuration and the related domain service instance from the domain perspective, using the "Manage test specifications", "Test resources" and "Query tests" capabilities of the "Testing service" in the management domain.

5. The E2E service management domain changes configuration parameters that are associated with the E2E service instance.

6. Optional: The E2E service management domain executes a test to validate the configuration and related E2E service from the E2E perspective.

7. At the end of the flow, the E2E service management domain triggers an internal event to update the E2E service inventory / topology, as defined in clause 5.3.7.

POSTCONDITIONS:

- The configuration of the E2E service instance has been modified.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.3.4.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service orchestration: "Manage service lifecycle" capability of the "E2E service orchestration service".

The following management services produced by the management domains are used in this procedure:

- Domain orchestration: "Manage service lifecycle" capability of the "Domain orchestration service", including functionality to configure the domain service.

- Domain orchestration: "Manage test specifications", "Test resources" and "Query tests" capabilities of the "Testing service".

5.3.5 Process: Service deactivation

5.3.5.1 Description

This process deactivates an E2E service instance. After deactivation, the E2E service instance is no longer able to provide its services.

5.3.5.2 Procedure flow

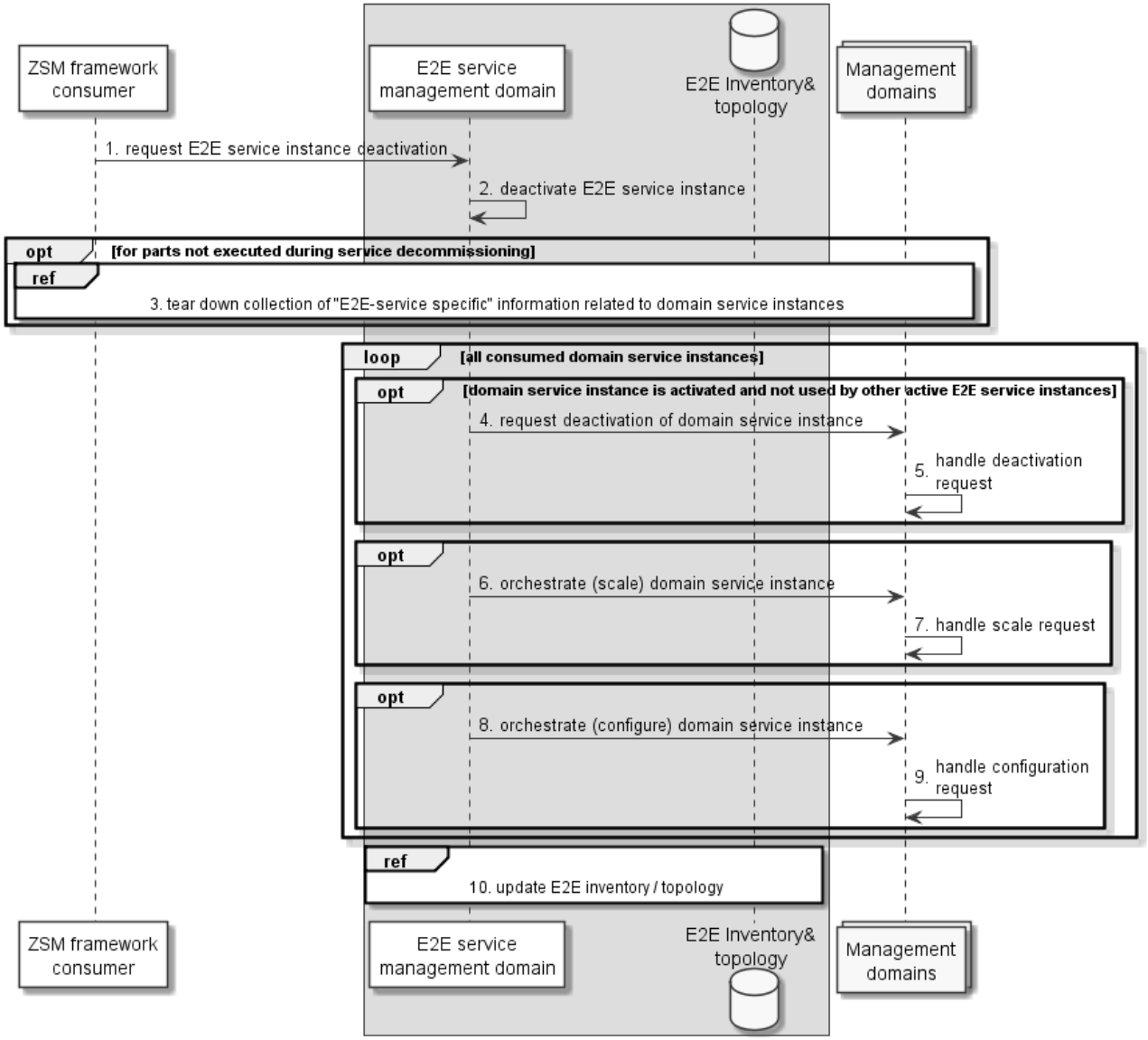


Figure 5.3.5.2-1: Service deactivation

PRECONDITIONS:

- The E2E service instance has been activated.

The procedure, as illustrated in figure 5.3.5.2-1, consists of the following steps:

1. The ZSM framework consumer requests the deactivation of an E2E service instance, using the "Manage service lifecycle" capability of the "E2E service orchestration service".

2. The E2E service management domain deactivates the E2E service instance by updating its state to reflect that the managed service instance is now inactive, i.e. not available for consumption.

3. Subsequently, the E2E service management domain executes the procedure to tear down the collection of information specific to the deactivated E2E service instance, as defined in clause 5.4.5.2.2, for parts of this procedure that will not be executed as part of the service decommissioning process (see clause 5.3.6).

The following steps 4 to 9 are executed for all domain service instances that are consumed by the E2E service instance being deactivated.

If the domain service instance is active and not used by other active E2E service instances, steps 4 and 5 are executed:

4. The E2E service management domain requests the orchestration (deactivation) of the individual domain service instance consumed by the E2E service instance being deactivated, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domains.

5. The management domain handles the deactivation request. First, the management domain deactivates the domain service instance. Further, the management domain might apply changes, such as scaling or reconfiguring of resources to reflect that they are no longer consumed by the deactivated service instance.

6. If necessary, typically because the domain service instance is shared and deactivating an E2E service instance needs less capacity of that domain service instance, the E2E service management domain requests to scale in / down the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

7. Further in that case, the management domain handles the scaling request. First, the management domain scales the domain service instance. Further, depending on the type of resource, the resources used by the domain service instance are scaled or reconfigured to decrease their capacity.

8. If necessary, the E2E service management domain requests the (re)configuration of the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

9. Further in that case, the management domain (re)configures the domain service instance and the related resources.

10. At the end of the flow, the E2E service management domain triggers an internal event to update the E2E service inventory / topology, as defined in clause 5.3.7.

POSTCONDITIONS:

- The E2E service instance has been deactivated.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.3.5.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service orchestration: "Manage service lifecycle" capability of the "E2E service orchestration service".

The following management services produced by the management domains are used in this procedure:

- Domain orchestration: "Manage service lifecycle" capability of the "Domain orchestration service", including functionality to deactivate, scale and configure the managed service.

5.3.6 Process: Service decommissioning

5.3.6.1 Description

This process decommissions an E2E service instance, i.e. it removes it and frees the resources and domain service instances that were used by this E2E service instance.

5.3.6.2 Procedure flow

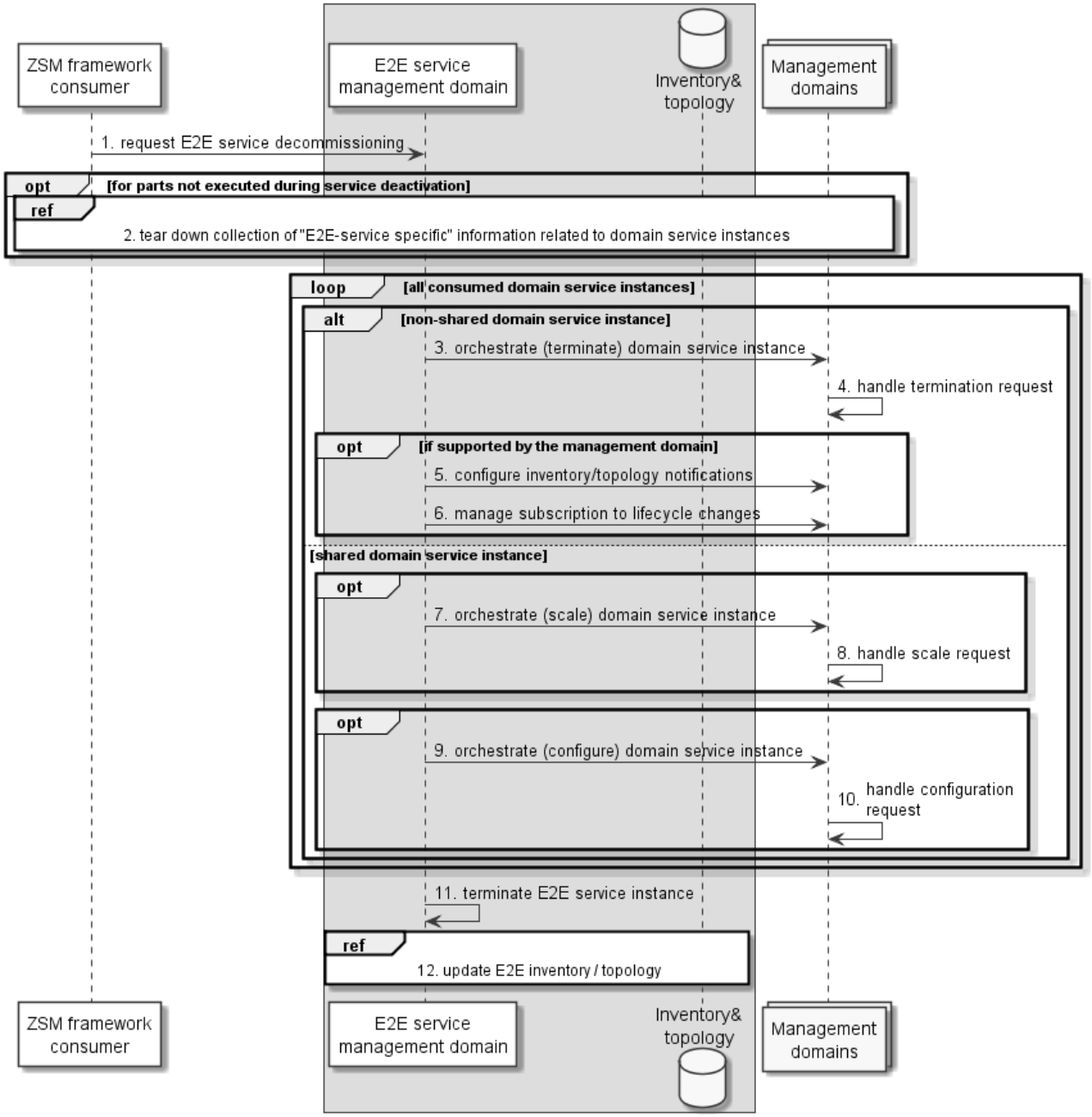


Figure 5.3.6.2-1: Service decommissioning

PRECONDITIONS:

- The E2E service instance has been instantiated and is not activated.

The procedure, as illustrated in figure 5.3.6.2-1, consists of the following steps:

1. The ZSM framework consumer requests the decommissioning of an E2E service instance, using the "Manage service lifecycle" capability of the "E2E service orchestration service".

2. Subsequently, the E2E service management domain executes the procedure to tear down the collection of information specific to the E2E service instance being decommissioned, as defined in clause 5.4.5.2.2, for parts of this procedure that were not executed as part of the service deactivation process (see clause 5.3.5).

The following steps 3 to 10 are executed for all domain service instances that are consumed by the E2E service instance being decommissioned.

If the domain service instance is no longer needed (i.e. it is only used by the decommissioned E2E service instance), steps 3 to 6 are executed:

3. The E2E service management domain requests the orchestration (termination) of the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

4. The management domain handles the termination request. First, the management domain terminates the domain service instance. Further, the management domain might apply changes such as scaling or reconfiguring of resources to reflect that they are no longer consumed by the terminated domain service instance.

5. If supported by the management domain, the E2E service management domain undoes the configuration of notifications about inventory / topology changes related to the terminated domain service instance, using the "Configure notifications" capability of the "Domain inventory information service" and "Domain topology information service".

6. If supported by the management domain, the E2E service management domain terminates subscriptions to notifications about lifecycle changes related to the terminated domain service instance, using the "Manage subscriptions to lifecycle changes" capability of the "Domain orchestration service".

If the E2E service instance to be decommissioned shares the domain service instance with other E2E service instances, steps 7 to 10 are executed:

7. If there is the need to decrease the capacity, the E2E service management domain requests the scaling of the shared domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

8. Further in that case, the management domain handles the scaling request. First, the management domain scales the domain service instance. Further, the management domain might apply changes such as scaling or reconfiguring of resources to reflect the changes in capacity.

9. If necessary, the E2E service management domain requests the (re)configuration of the domain service instance, using the "Manage service lifecycle" capability of the "Domain Orchestration Service" of the involved management domain.

10. Further in that case, the management domain configures the domain service instance and the related resources.

11. The E2E service management domain terminates the E2E service instance.

12. At the end of the flow, the E2E service management domain triggers an internal event to update the E2E service inventory / topology, as defined in clause 5.3.7.

POSTCONDITIONS:

- The E2E service instance has ceased to exist.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.3.6.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service orchestration: "Manage service lifecycle" capability of the "E2E service orchestration service".

The following management services produced by the management domains are used in this procedure:

- Domain orchestration: "Manage service lifecycle" capability of the "Domain orchestration service", including functionality to terminate, scale and configure a domain service.

- Domain orchestration: "Manage subscription to lifecycle changes" capability of the "Domain orchestration service" (if exposed).
- Domain orchestration: "Configure notifications" capability of the "Domain inventory information service", if supported.
- Domain orchestration: "Configure notifications" capability of the "Domain topology information service", if supported.

5.3.7 Process: Update E2E inventory / topology

5.3.7.1 Description

This auxiliary process keeps up to date the information held by the E2E service management domain regarding the inventories of domain service instances and resources (if exposed), as well as the related topologies in the management domains.

Update E2E inventory / topology is an asynchronous process triggered by *internal* or *external events* which indicate potential modifications to the inventory and / or topology information held by the E2E service management domain. While the E2E service management domain is aware of internal events, it needs to receive notification messages from the management domains to be informed about external events.

When an event occurs, the E2E service management domain discovers the related changes and reconciles these in its inventory. This way, the consolidated inventory of the E2E service management domain provides it with a view of the underlying management domains, and its own service instances, which it can for example use in closed loops or as part of feasibility checks.

Internal events that can be assumed to indicate an inventory or topology change include but are not limited to:

- The E2E service management domain has requested orchestration actions from a management domain which have likely affected topology and / or inventory.
- The E2E service management domain intends to instantiate a service and therefore needs to check whether the needed component service instances are available in the underlying management domains.
- A timer for a time-based regular update check has expired.

External events include changes of the inventory or topology of a management domain, as well as events related to the lifecycle management of domain service instances or externally visible resources of the domain. Notification messages related to such external events are supported by certain management domains.

NOTE: Notifications regarding inventory / topology changes are supported by some types of management domains (such as 3GPP- NFV- or IETF-based management domains). As these capabilities are not modelled in ETSI GS ZSM 002 [1], Annex B provides the definitions of these capabilities as an update of the related management services defined in [1].

5.3.7.2 Procedure flow

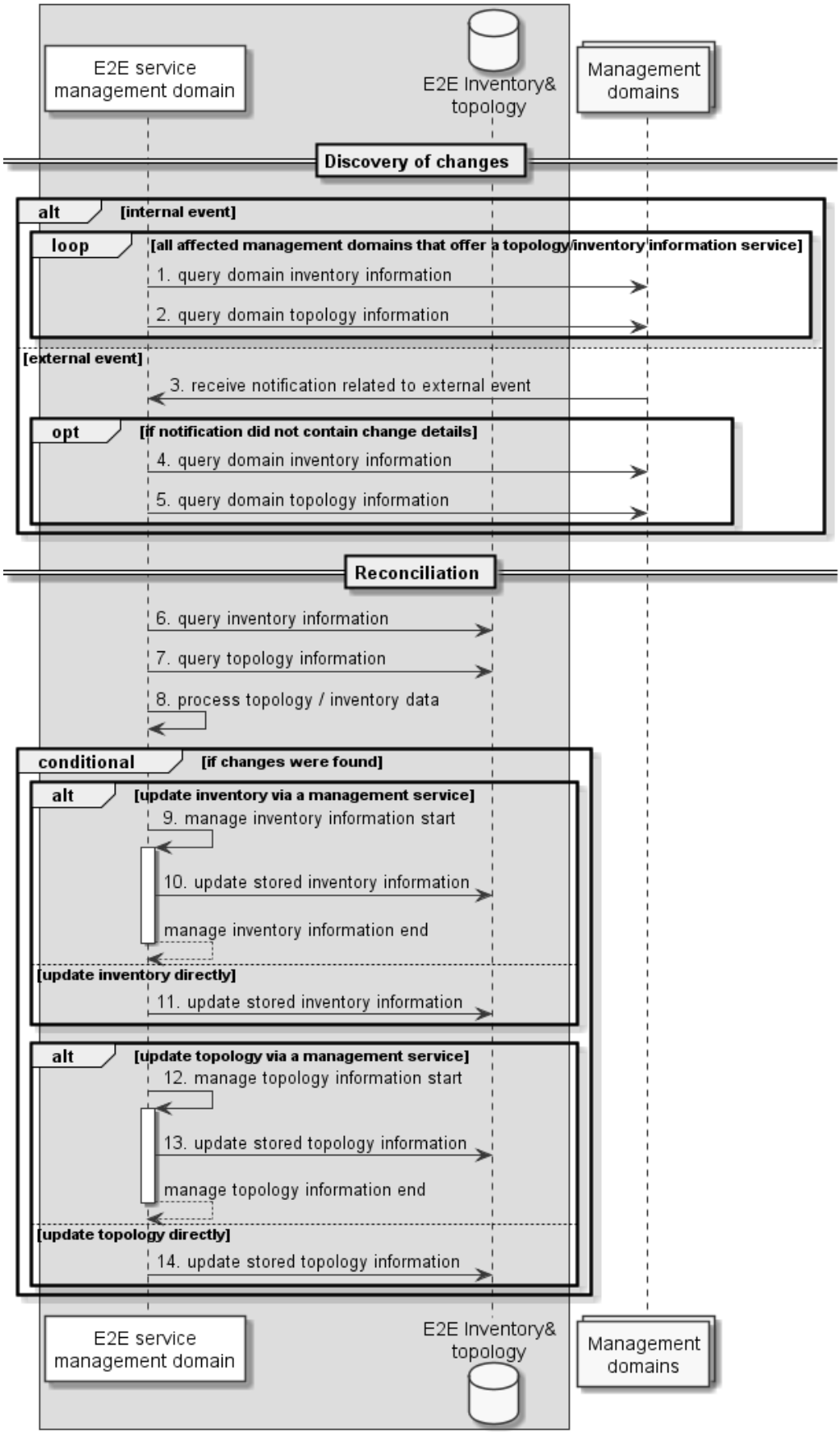


Figure 5.3.7.2-1: Inventory / topology update

PRECONDITIONS:

- An internal or external event has occurred that indicates a possible change to the inventory or topology.

The procedure, as illustrated in figure 5.3.7.2-1, consists of the following steps:

An internal event triggers the following discovery steps:

1. The E2E service management domain queries inventory information from management domains that may be affected by the change indicated by the internal event, using the "Query inventory of available resources" capability of the "Domain inventory information service". Such query can be selective based on information about the event, if applicable.

2. The E2E service management domain queries topology information from management domains that may be affected by the change indicated by the internal event, using the "Query topology information" capability of the "Domain topology information service". Such query can be selective based on information about the event, if applicable.

An external event triggers the execution of the following discovery steps:

3. The E2E service management domain receives notifications related to changes of inventory / topology from the affected management domains directly, using the "Provide notifications about lifecycle changes" capability of the "Domain orchestration service" or the "Provide notifications about lifecycle changes" capability of services derived from the "Generic resource lifecycle management service", such as the "Virtualised resource lifecycle management service" (if exposed). Alternatively (not depicted), the E2E service management domain receives these notifications indirectly via the integration fabric. Such notifications may merely inform that a change has occurred or may include detailed information about the modified entities.

4. If the notification has merely informed that an inventory change has occurred, the E2E service management domain obtains the changed inventory information from the management domain that has originated the notification, using the "Query inventory of available resources" capability of the "Domain inventory information service".

5. Further, if the notification has merely informed that a topology change has occurred, the E2E service management domain obtains the changed topology information from the management domain that has originated the notification, using the "Query topology information" capability of the "Domain topology information service".

Subsequently, the following steps are executed for both internal and external events:

6. The E2E service management domain queries information from its inventory database using the "Query inventory of available services" capability of the "E2E services inventory information service" or the "Query data" capability of the "Data persistence service".

7. The E2E service management domain queries information from its topology database using the "Query topology information" capability of the "E2E services topology information service" or the "Query data" capability of the "Data persistence service".

8. The E2E service management domain processes the inventory / topology data it has received from the management domains in the previous steps and reconciles its own inventory / topology data with that received data.

If the reconciliation process has detected changes to the inventory / topology data managed by the E2E service management domain, the following steps 9 to 14 are executed:

If the E2E service management domain updates its inventory database using a management service, the following steps are executed:

9. The E2E service management domain invokes its management service for managing inventory information.

10. That service performs the update to the information stored in the inventory database managed by the E2E service management domain, using the "Store data" capability of the "Data persistence service".

Alternatively, if the E2E service management domain updates its inventory database directly, the following step is executed:

11. The E2E service management domain directly updates the information stored in the inventory database managed by the E2E service management domain, using the "Store data" capability of the "Data persistence service".

If the E2E service management domain updates its topology database using a management service, the following steps are executed:

12. The E2E service management domain invokes its management service for managing topology information.

13. That service performs the update to the information stored in the topology database managed by the E2E service management domain, using the "Store data" capability of the "Data persistence service".

Alternatively, if the E2E service management domain updates its topology database directly, the following step is executed:

14. The E2E service management domain directly updates the information stored in the topology database managed by the E2E service management domain, using the "Store data" capability of the "Data persistence service".

POSTCONDITIONS:

- The inventory and topology information held by the E2E service management domain is in sync with the information available in the underlying management domains.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.3.7.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- None.

The following management services produced by the management domains are used in this procedure:

- Domain orchestration: "Query inventory of available resources" capability of "Domain inventory information service" (if exposed).

- Domain orchestration: "Query topology information" capability of "Domain topology information service" (if exposed).

- Domain orchestration: "Provide notifications about lifecycle changes" capability of the "Domain orchestration service".

- Domain control: "Provide notifications about lifecycle changes" capability of services derived from the "Generic resource lifecycle management service", such as the "Virtualised resource lifecycle management service" (if exposed).

The following additional management services are used in this procedure:

- ZSM Data Services: "Store data" and "Query data" capability of the "Data persistence service"

NOTE: It is up to each deployment to decide whether to use the cross-domain data services or the domain data services to store the information. Therefore, the use of the "Data persistence service" cross-domain is optional.

5.4 Service assurance

5.4.1 Overview

The following clauses introduce typical assurance processes, including those that the E2E service management domain performs to manage service quality and mitigate service problems of E2E service instances during their lifespan.

Service assurance processes make heavy use of notifications for which the ZSM framework reference architecture (ETSI GS ZSM 002 [1]) foresees two ways of delivery:

1) direct delivery from service producer to service consumer; and

2) delivery via the management communication service in the integration fabric.

Some service producers allow service consumers to subscribe to notifications and receive the subscribed notifications directly from them, whereas other service producers only support pushing notifications into a channel on the integration fabric to which the service consumer needs to subscribe in order to obtain the notifications. When setting up the collection of information (see clauses 5.4.2.2.1, 5.4.2.2.2 and 5.4.3.2.2) and during notification delivery itself, deployments need to consider these different choices accordingly, depending on the subscription and notification delivery mechanisms supported by the service producers. Delivery via the integration fabric is the recommended variant, and the only possible variant in case of producer-initiated set-up of information collection (see clause 5.4.2.2.1).

5.4.2 Process: Service assurance set-up

5.4.2.1 Description

The processes defined in this clause fulfil preconditions to assure an E2E service. The preparation consists of two separate auxiliary processes:

1) Producer-initiated: Based on management domain policy, this auxiliary process prepares to collect and provide information related to domain service instances, initiated by the producing management domains. The production of such information is based entirely on the fact that a service instance is provided by a management domain, independent from whether or not this service instance is consumed by any E2E service instance.

2) Consumer-initiated: Based on knowledge about the E2E service as available in the E2E service model, this auxiliary process prepares to collect and provide "E2E-service specific" information related to domain service instances provided by the management domains. Such "E2E service specific" information is necessary to assure a particular E2E service instance.

5.4.2.2 Procedure flows

5.4.2.2.1 Producer-initiated set-up of information collection related to domain service instance

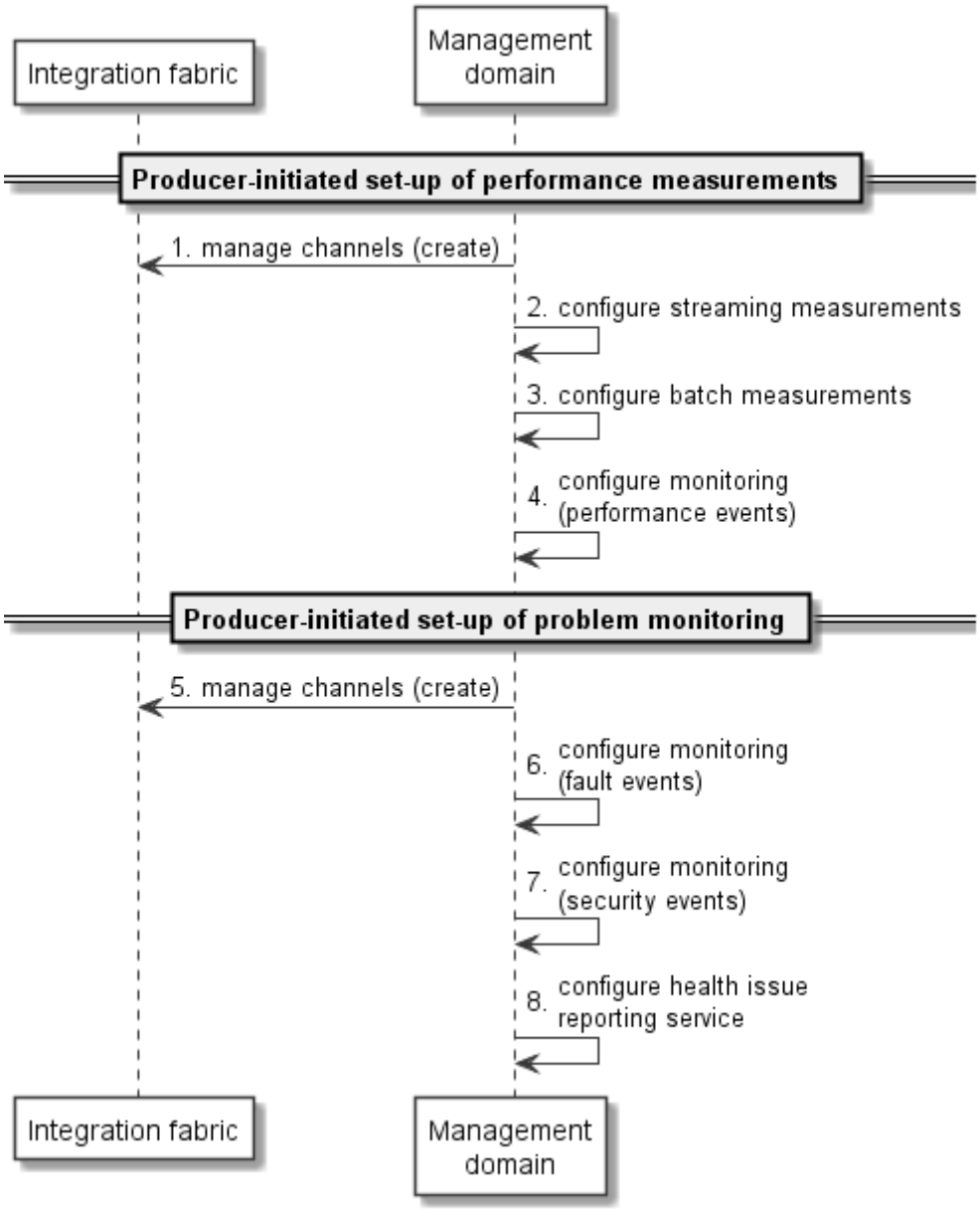


Figure 5.4.2.2.1-1: Producer-initiated set-up of information collection related to domain service instance

Using the procedure illustrated in figure 5.4.2.2.1-1, the producer management domain sets up measurements for a newly instantiated or activated produced domain service instance and (optionally) the externally visible resources associated with this instance managed by the management domain. In the steps below, the shorthand "produced service instance / associated resources" is used for these. Decision about the information collected can be made inside the management domain and is typically controlled by policy. This procedure is triggered either during service instantiation or service activation, or during both of these processes if it is intended to split the procedure into two parts that complement each other.

PRECONDITIONS:

- New domain service is instantiated or domain service instance is activated.

The procedure, as illustrated in figure 5.4.2.2.1-1, consists of the following steps:

1. The management domain creates channels in the integration fabric through which the performance-related information can later be provided, using the "Manage channels" capability of the "Management communication service".

2. The management domain configures the collection of streaming measurements related to the produced service instance / associated resources, using the "Configure measurements" capability of the "Performance measurements streaming service".

3. The management domain configures the collection of batch measurements related to the produced service instance / associated resources, using the "Configure batch measurements" capability of the "Performance measurements collection service".

4. The management domain configures the monitoring of the performance and creation of performance events (threshold crossings) related to the produced service instance / associated resources, using the "Configure monitoring" capability of the "Performance events service".

5. The management domain creates channels in the integration fabric through which the problem-related information can later be provided, using the "Manage channels" capability of the "Management communication service".

6. The management domain configures the monitoring of faults related to the produced service instance / associated resources, using the "Configure monitoring" capability of the "Fault events service".

7. The management domain configures the monitoring of security events related to the produced service instance / associated resources, using the "Configure monitoring" capability of the "Security events service".

8. The management domain configures the health issue reporting service related to the produced service instance, using the "Configure service" capability of the "Health issue reporting service".

NOTE: Any combination of steps 2, 3, 4 and 6, 7, 8 may be executed in any order.

POSTCONDITIONS:

- Notifications related to issues and performance, as well as streaming and batch measurements that the producing management domain intends to expose for the domain service instance, are produced.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the management domain is able to recover from the process step failure / failures.

5.4.2.2.2 Consumer-initiated set-up of collecting "E2E-service specific" information related to domain service instances

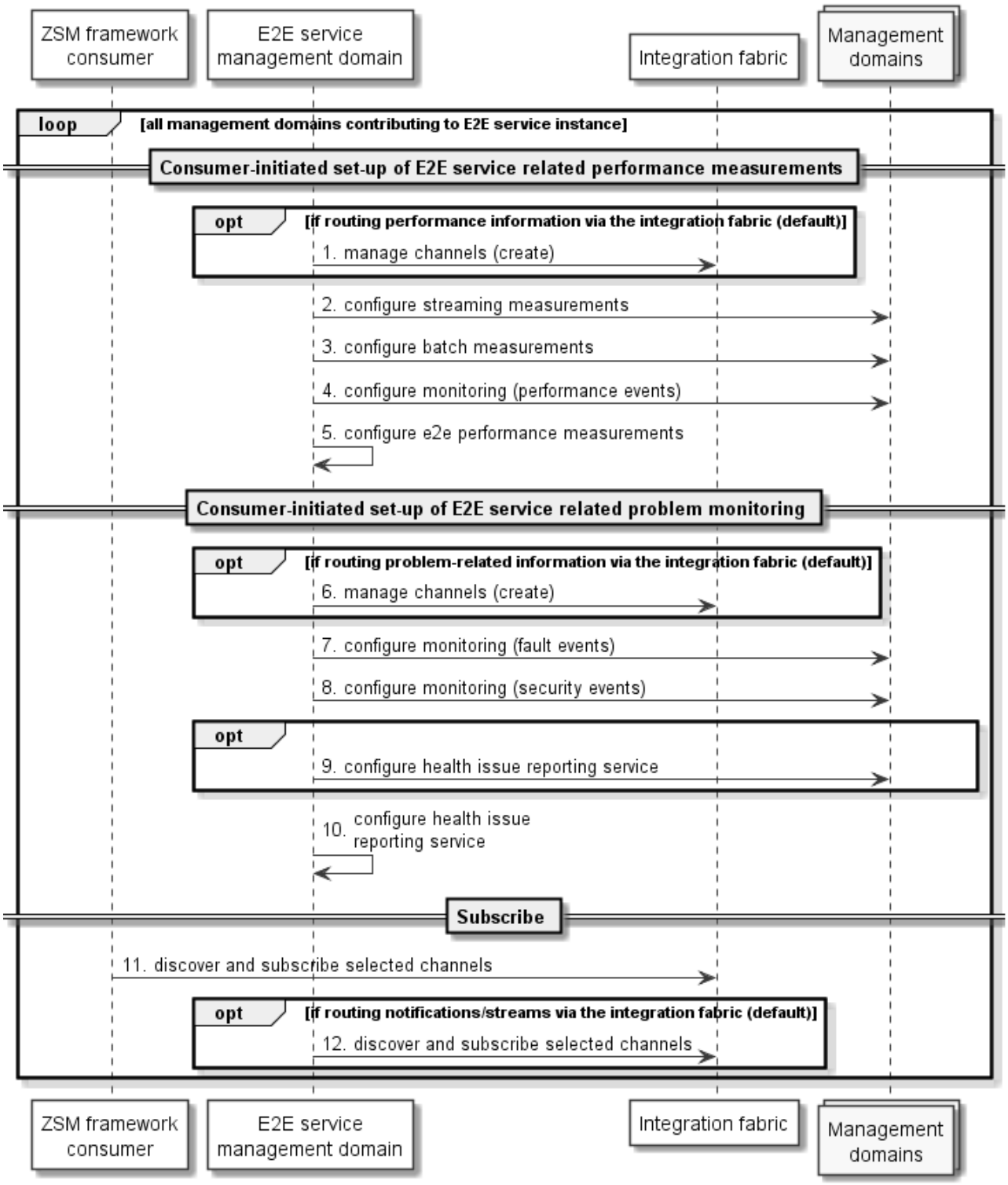


Figure 5.4.2.2.2-1: Consumer-initiated set-up of information collection related to domain service instances

Using the procedure as illustrated in figure 5.4.2.2.2-1, based on knowledge of the composition of the E2E service, the E2E service management domain as consumer sets up the collection of information from the MDs related to domain service instances consumed by the particular E2E service instance and (optionally) externally visible resources associated with these domain service instances. In the steps below, the shorthand "consumed domain service instances / associated resources" is used for these. As this requires cross-domain knowledge, the decision is made by the E2E service management domain, typically controlled by policy, e.g. defined in the E2E service model. This procedure is triggered either during E2E service instantiation or E2E service activation, or during both of these processes if it is intended to split the procedure into two parts that complement each other.

PRECONDITIONS:

- New E2E service is instantiated or E2E service instance is activated.

The procedure, as illustrated in figure 5.4.2.2.2-1, consists of the following steps:

1. If the E2E service management domain intends to obtain performance-related information via the integration fabric (default assumption), it creates channels in the integration fabric through which the information can later be provided, using the "Manage channels" capability of the "Management communication service".

NOTE 1: Alternatively, this step can be omitted which means that in the subsequent steps 2 to 4, the management domains need to be configured to provide the notifications directly to the E2E service management domain, bypassing the integration fabric.

2. The E2E service management domain configures in the management domains the collection of streaming measurements related consumed domain service instances / associated resources, using the "Configure measurements" capability of the "Performance measurements streaming service".

3. The E2E service management domain configures the collection of batch measurements related to consumed domain service instances / associated resources, using the "Configure batch measurements" capability of the "Performance measurements collection service".

4. The E2E service management domain configures the monitoring of the performance and creation of performance events (threshold crossings) related to consumed domain service instances / associated resources, using the "Configure monitoring" capability of the "Performance events service".

5. The E2E service management domain configures the collection of performance measurements related to the E2E service instance.

6. If the E2E service management domain intends to obtain problem-related information via the integration fabric (default assumption), it creates channels in the integration fabric through which the information can later be provided, using the "Manage channels" capability of the "Management communication service".

NOTE 2: Alternatively, this step can be omitted which means that in the subsequent steps 7 to 9, the management domains need to be configured to provide the information directly to the E2E service management domain, bypassing the integration fabric.

7. The E2E service management domain configures in the management domains the monitoring of faults related to the consumed domain service instances / associated resources, using the "Configure monitoring" capability of the "Fault events service".

8. The E2E service management domain configures the monitoring of security events related to the consumed domain service instances / associated resources, using the "Configure monitoring" capability of the "Security events service".

9. If the health issue reporting service is exposed by the management domain, the E2E service management domain configures this service related to the consumed domain service instances, using the "Configure service" capability of the "Health issue reporting service".

10. The E2E service management domain configures its own health issue reporting service related to the E2E service instance, using the "Configure service" capability of the "Health issue reporting service".

NOTE 3: Any combination of steps 2, 3, 4 and 7, 8, 9 may be executed in any order.

11. The ZSM framework consumer discovers the available channels and subscribes to selected channels which carry service quality violation notifications and health issue notifications using the "Manage channels" and "Manage subscriptions" capabilities of the "Management communication service" in the integration fabric.

12. If the E2E service management domain intends to obtain performance-related or problem-related information via the integration fabric (default assumption), it discovers the available channels and subscribes to selected channels which carry performance event notifications, streaming performance measurements, notifications related to the availability of batches of performance measurements or notifications related to fault and security events, using the "Manage channels" and "Manage subscriptions" capabilities of the "Management communication service" in the integration fabric.

NOTE 4: Steps 11 and 12 may be executed in any order.

POSTCONDITIONS:

- Notifications related to issues and performance, as well as streaming and batch measurements that the E2E service management has requested from the management domains to assure an E2E service instance, are produced by the management domains.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.4.2.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- None.

The following management services produced by the management domains are used in this procedure:

- Domain data collection: "Configure monitoring" capability of the "Performance events service".
- Domain data collection: "Configure measurements" capability of the "Performance measurements streaming service".
- Domain data collection: "Configure batch measurements" capability of the "Performance measurements collection service".
- Domain data collection: "Configure monitoring" capability of the "Fault events service".
- Domain data collection: "Configure monitoring" capability of the "Security events service".
- Domain intelligence: "Configure service" capability of the "Health issue reporting service" (if exposed).

The following additional management services are used in this procedure:

- ZSM integration fabric: "Manage channels" and "Manage subscriptions" capabilities of the "Management communication service".

NOTE: It is up to each deployment to decide whether to use the cross-domain integration fabric or the domain integration fabric or a combination of both.

5.4.3 Process: Service quality management

5.4.3.1 Description

Typically, this process runs in a loop and assures that the E2E service instance meets its service level specification. If the E2E service management domain cannot fix a detected service quality issue or if intervention is needed, it escalates the problem by reporting a service quality violation to the ZSM framework consumer.

This process is also able to perform cross-domain investigation of quality issues. As part of the procedure, the necessary analytics methods to be performed by the domains, or additional performance information to be collected by the domains, are determined and discovered by the E2E service management domain. This process allows to perform E2E service analytics based on analytics results generated by domain analytics services in multiple domains or based on additional performance information collected by multiple domains, as triggered by the E2E service management domain

5.4.3.2 Procedure flows

5.4.3.2.1 Main service quality management flow

This procedure represents the main E2E service quality management process.

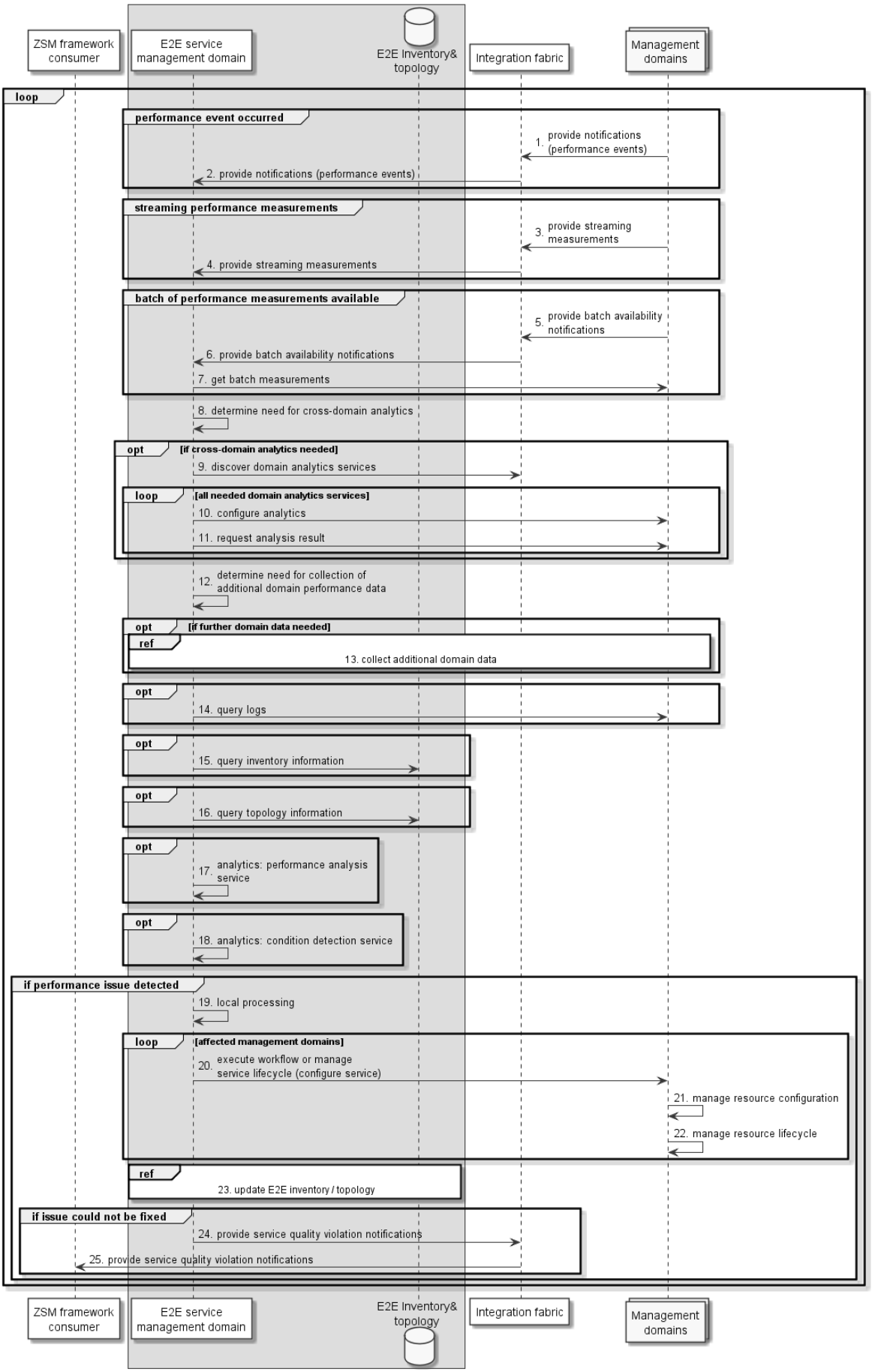


Figure 5.4.3.2.1-1: Managing service quality

PRECONDITIONS:

- The "Service assurance set-up" procedures defined in clause 5.4.2.2 have been executed.

The procedure, as illustrated in figure 5.4.3.2.1-1, consists of the following steps.

The following groups of steps 1 and 2; steps 3 and 4; and steps 5 to 7 are executed in any order, using the "Management communication service" in the integration fabric unless otherwise specified:

1. Via the "Provide notifications" capability of the "Performance events service", the management domains provide notifications on performance events (such as threshold crossings) to the integration fabric, using the "Receive data" capability of the "Management communication service".

2. The integration fabric forwards the notifications on performance events to the management functions in the E2E service management domain that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

3. Via the "Provide streaming measurements" capability of the "Performance measurements streaming service", the management domains provide streaming measurements to the integration fabric, using the "Receive data" capability of the "Management communication service".

4. The integration fabric forwards the streaming measurements to the management functions in the E2E service management domain that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

5. Via the "Provide batch availability notifications" capability of the "Performance measurements collection service", the management domains provide notifications related to the availability of batches of performance measurements to the integration fabric, using the "Receive data" capability of the "Management communication service".

6. The integration fabric forwards the notifications related to the availability of batches of performance measurements to the management functions in the E2E service management domain that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

7. The E2E service management domain obtains the collected batches of measurements from the management domain using the "Get batch measurements" capability of the "Performance measurements collection service".

8. Based on the performance information received, the E2E service management domain determines whether there is the need for additional analytics to be performed by the MDs.

If additional analytics is needed, the following steps are performed:

9. The E2E service management domain discovers the analytics services that are exposed by the management domains, using the "Query service list" and "Get service info" capabilities of the "Management services discovery service" in the cross-domain integration fabric.

In a loop over all needed analytics services, the following steps are performed:

10. The E2E service management domain configures the management domains to perform such analytics, using the "Configure analytics" capability of the needed analytics services.

11. Further in this case, the E2E service management domain requests the analytics results from the management domains, using the "Request analysis result" capability of the needed analytics services.

The following further steps are performed:

12. The E2E service management domain determines the need for additional performance data to be collected from the MDs.

13. If additional performance data are needed, the E2E service management domain performs the "Collect additional domain performance data" auxiliary process as defined in clause 5.4.3.2.

14. Optionally and if exposed by the management domains, the E2E service management domain queries the logs of the management domain, using the "Query logs" capability of the "Log collection service" in the management domains.

15. Optionally, if E2E inventory information is needed by the following analytics steps, the E2E service management domain queries the E2E inventory, using the "Query inventory of available services" capability of the "E2E services inventory information service" or the "Query data" capability of the "Data persistence service".

16. Optionally, if E2E topology information is needed by the following analytics steps, the E2E service management domain queries the E2E topology database, using the "Query topology information" capability of the "E2E services topology information service" or the "Query data" capability of the "Data persistence service".

The received performance information is analysed in the following steps by a set of one or more performance analysis services that depend on the E2E service management domain, such as the following:

17. The performance information is analysed using the "Performance analysis service".

18. The performance information is analysed by the "Condition detection service".

If a performance issue is detected, the following steps are executed:

19. Local processing in the E2E service management domain makes decisions regarding how the performance issue can be mitigated.

20. For the affected management domains, the execution of orchestration workflows or the modification of the configuration of domain service instances is triggered using the "Execute workflow" or "Manage service lifecycle" capabilities of the "Domain orchestration service" to attempt resolving the performance issue.

21. If necessary, the affected management domains modify the configuration of resources, using the "Manage resource configuration" capability of the "Resource configuration management service" locally.

22. If necessary, the affected management domains manage the resource lifecycle (such as scaling, instantiating or terminating resources) using the "Manage resource lifecycle" capability of services derived from the "Generic Resource lifecycle management service" locally.

23. The E2E service management domain triggers an internal event to update the E2E service inventory / topology, as defined in clause 5.3.7.

If the performance issue cannot be fixed, the problem is escalated to the ZSM framework consumers by the following steps:

24. Via the "Provide violation notifications" capability of the "E2E service quality management service", the E2E service management domain provides a service quality violation notification to the integration fabric, using the "Receive data" capability of the "Management communication service".

25. The integration fabric forwards the notification to the ZSM framework consumers that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

POSTCONDITIONS:

- The performance issue was fixed or escalated.

ERROR CONDITIONS:

- The procedure fails and the issue is escalated to the ZSM framework consumers if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.4.3.2.2 Auxiliary process to collect additional domain performance data

This auxiliary process allows the E2E service management domain to collect on demand additional performance data from the management domains to allow E2E service analytics processes to further analyse a service quality issue. It is triggered as part of the main service quality management flow (see clause 5.4.3.2.1) and has been separated from that flow for the purpose of modularization.

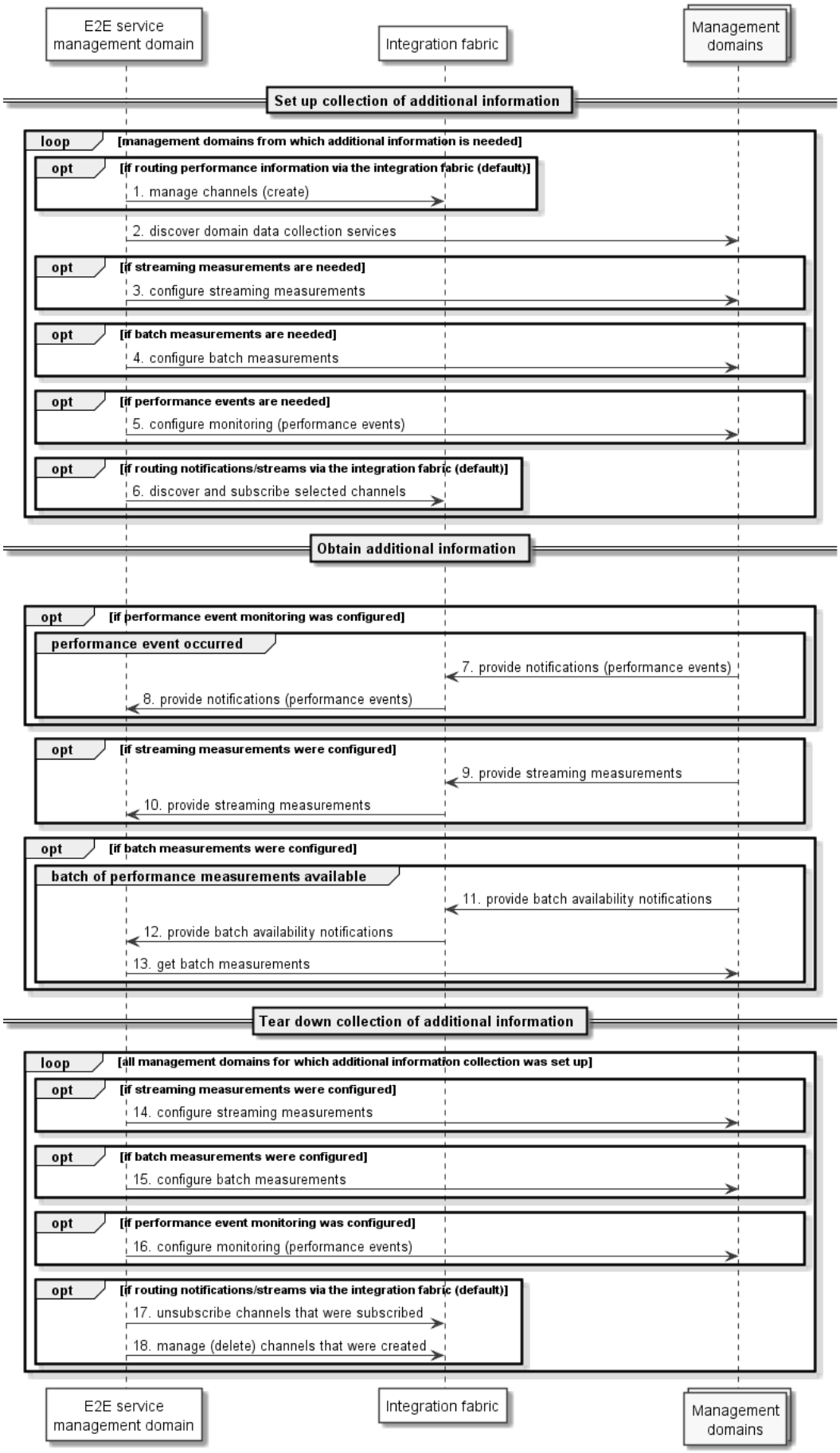


Figure 5.4.3.2.2-1: Collecting additional domain performance data

PRECONDITIONS:

- None.

The procedure, as illustrated in figure 5.4.3.2.2-1, consists of the following steps.

1. If the E2E service management domain intends to obtain performance-related information via the integration fabric (default assumption), it creates channels in the integration fabric through which the information can later be provided, using the "Manage channels" capability of the "Management communication service".

NOTE 1: Alternatively, this step can be omitted which means that in the subsequent steps 3 to 5, the management domains need to be configured to provide the notifications directly to the E2E service management domain, bypassing the integration fabric.

2. The E2E service management domain discovers from the integration fabric the data collection services that are exposed by the management domains, using the "Query service list" and "Get service info" capabilities of the "Management services discovery service" in the integration fabric.

3. If streaming measurements are needed, the E2E service management domain configures in the management domains the collection of streaming measurements related to the consumed domain service instances / associated resources, using the "Configure measurements" capability of the "Performance measurements streaming service".

4. If batch measurements are needed, the E2E service management domain configures the collection of batch measurements related to the consumed domain service instances / associated resources, using the "Configure batch measurements" capability of the "Performance measurements collection service".

5. If performance events are needed, the E2E service management domain configures the monitoring of the performance and creation of performance events (threshold crossings) related to the consumed domain service instances / associated resources, using the "Configure monitoring" capability of the "Performance events service".

NOTE 2: Any combination of steps 3, 4 and 5 may be executed in any order.

6. If the E2E service management domain intends to obtain performance-related information via the integration fabric (default assumption), it discovers the available channels and subscribes to selected channels which carry performance event notifications, streaming performance measurements, notifications related to the availability of batches of performance measurements or notifications related to fault and security events, using the "Manage channels" and "Manage subscriptions" capabilities of the "Management communication service" in the integration fabric.

Any combination of the following groups of steps 7 and 8; steps 9 and 10; and steps 11 to 13 is executed in any order, using the "Management communication service" in the integration fabric unless otherwise specified:

7. Via the "Provide notifications" capability of the "Performance events service", the management domains provide notifications on performance events (such as threshold crossings) to the integration fabric, using the "Receive data" capability of the "Management communication service".

8. The integration fabric forwards the notifications on performance events to the management functions in the E2E service management domain that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

9. Via the "Provide streaming measurements" capability of the "Performance measurements streaming service", the management domains provide streaming measurements to the integration fabric, using the "Receive data" capability of the "Management communication service".

10. The integration fabric forwards the streaming measurements to the management functions in the E2E service management domain that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

11. Via the "Provide batch availability notifications" capability of the "Performance measurements collection service", the management domains provide notifications related to the availability of batches of performance measurements to the integration fabric, using the "Receive data" capability of the "Management communication service".

12. The integration fabric forwards the notifications related to the availability of batches of performance measurements to the management functions in the E2E service management domain that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

13. The E2E service management domain obtains the collected batches of measurements from the management domain using the "Get batch measurements" capability of the "Performance measurements collection service".

The following steps are executed to stop the collection of performance-related information:

14. If the E2E service management domain has executed step 3 to configure in the MDs the collection of streaming measurements related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure measurements" capability of the "Performance measurements streaming service".

15. If the E2E service management domain has executed step 4 to configure in the MDs the collection of batch measurements related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure batch measurements" capability of the "Performance measurements collection service".

16. If the E2E service management domain has executed step 5 to configure in the MDs the monitoring of performance events (threshold crossings) related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure monitoring" capability of the "Performance events service".

17. If the E2E service management domain has executed step 6 to subscribe to channels related to the collection of information about consumed domain service instances / associated resources, it unsubscribes with the integration fabric from those channels using the "Manage subscriptions" capability of the "Management communication service".

18. If the E2E service management domain has executed step 1 to create channels in the integration fabric related to the assurance of the E2E service instance, it deletes these channels using the "Manage channels" capability of the "Management communication service".

POSTCONDITIONS:

- Additional performance-related information is available to the E2E service management domain.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.4.3.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service analytics: "Provide violation notifications" capability of the "E2E service quality management service".

The following management services produced by the management domains are used in this procedure:

- Domain data collection: "Configure monitoring" and "Provide notifications" capabilities of the "Performance events service".

- Domain data collection: "Configure measurements" and "Provide streaming measurements" capabilities of the "Performance measurements streaming service".

- Domain data collection: "Configure batch measurements", "Provide batch availability notifications" and "Get batch measurements" capabilities of the "Performance measurements collection service".
- Domain data collection: "Query logs" capability of the "Log collection service" (if exposed).
- Domain analytics: "Configure analytics" and "Request analysis result" capabilities of specific domain analytics services derived from the "Generic analytics service".
- Domain orchestration: "Execute workflow" and "Manage service lifecycle (configure)" capabilities of the "Domain orchestration service".

The following additional management services are used in this procedure:

- ZSM integration fabric: "Manage channels", "Manage subscriptions", "Receive Data" and "Provide data" capabilities of the "Management communication service".
- ZSM integration fabric: "Query service list" and "Get service info" capabilities of the "Management services discovery service".

NOTE 1: It is up to each deployment to decide whether to use the cross-domain integration fabric or the domain integration fabric or a combination of both.

- ZSM Data Services: "Query data" capability of the "Data persistence service".

NOTE 2: It is up to each deployment to decide whether to use the cross-domain data services or the domain data services to store the information. Therefore, the use of the "Data persistence service" cross-domain is optional.

5.4.4 Process: Service problem management

5.4.4.1 Description

Typically, this process runs in a loop and assures that the E2E service instance is free of faults and issues. Sometimes, the fixing of detected issues is also termed "service healing". If the E2E service management domain cannot fix a detected issue or if intervention is needed, it escalates the problem by reporting an E2E service health issue.

This process is also able to perform cross-domain investigation of problems. As part of the procedure, the necessary analytics methods to be performed by the domains are determined and discovered by the E2E service management domain. This process allows performing E2E service analytics based on analytics results generated by domain analytics services in multiple domains as triggered by the E2E service management domain.

5.4.4.2 Procedure flow

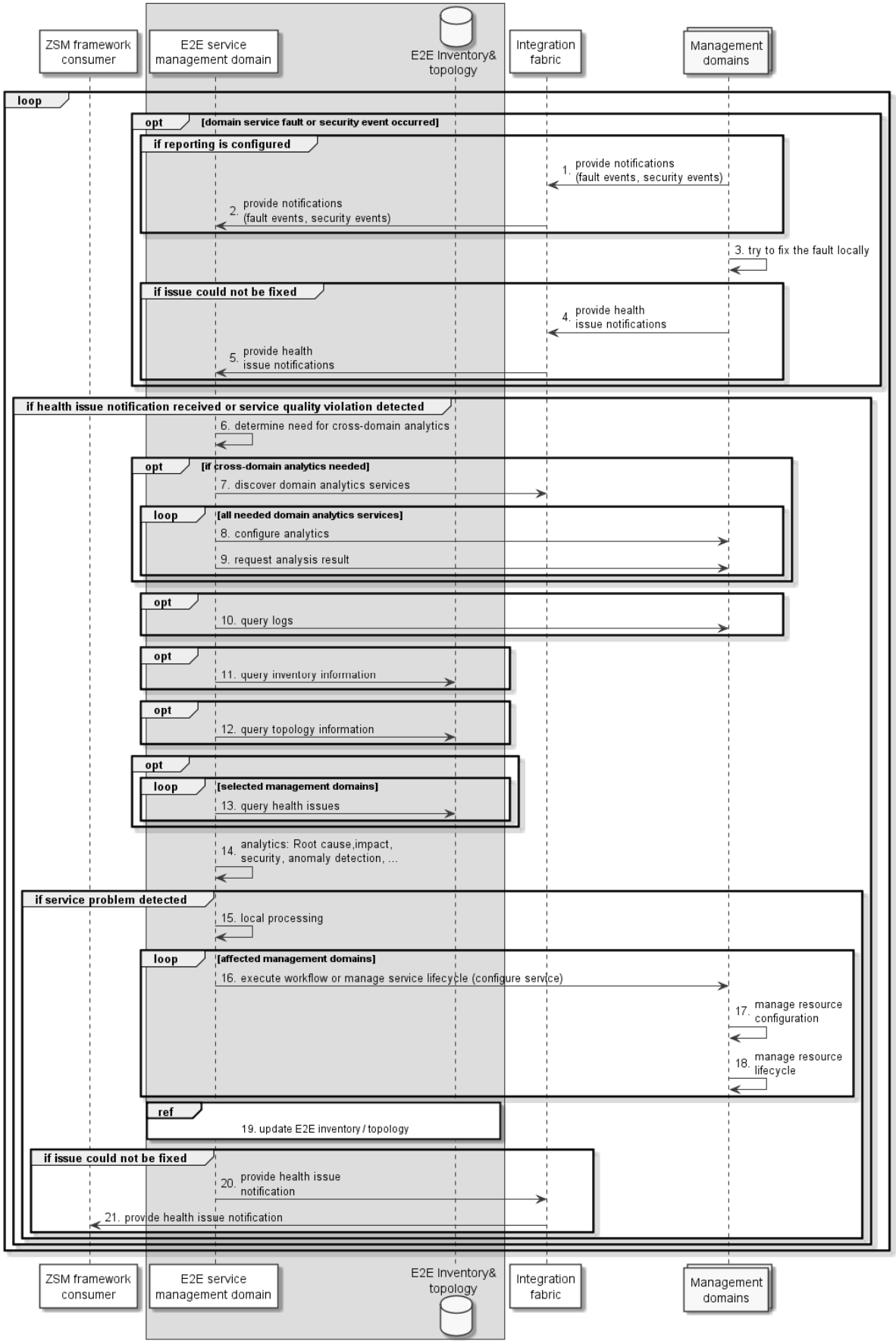


Figure 5.4.4.2-1: Managing service problems

PRECONDITIONS:

- The "Service assurance set-up " auxiliary processes as defined in clause 5.4.2.2 have been executed.

The procedure, as illustrated in figure 5.4.4.2-1, consists of the following steps:

If a fault or security problem occurs in a management domain related to a domain service instance, the following steps are executed:

1. In case reporting the event outside the management domain is configured, an event notification is provided by the management domain via the "Provide notification" capability of the "Fault events service" or "Security events service" to the integration fabric, using the "Receive data" capability of the "Management communication service".

2. Further in this case, the integration fabric forwards the notification in a channel to the E2E service management domain using the "Provide data" capability of the "Management communication service", assuming the E2E service management domain has a subscription for that channel.

3. The management domain tries to fix the fault locally, e.g. using a closed loop (see ETSI GS ZSM 009-1 [i.1]).

4. If the issue cannot be fixed, the management domain tracks the problem as a health issue. If the "Health issue reporting service" is exposed, the management domain provides, via the "Provide health issue notification" capability of the "Health issue reporting service", a health issue notification to the integration fabric, using the "Receive data" capability of the "Management communication service".

5. Further in this case, the integration fabric forwards the notification in a channel to the E2E service management domain, using the "Provide data" capability of the "Management communication service", assuming the E2E service management domain has subscribed for that channel.

If a service quality violation in the E2E service management domain has been detected (see clause 5.4.3) or a health issue has been notified related to a domain service instance that is used by the E2E service, the following steps are executed:

6. Based on the information received from the management domains, the E2E service management domain determines whether there is the need for additional analytics to be performed by the MDs.

If additional analytics is needed, the following steps are performed:

7. The E2E service management domain discovers the analytics services that are exposed by the management domains, using the "Query service list" and "Get service info" capabilities of the "Management services discovery service" in the cross-domain integration fabric. Services used can include the "Reactive incident analysis service" if exposed.

In a loop over all needed analytics services, the following is performed:

8. The E2E service management domain configures the management domains to perform such analytics, using the "Configure analytics" capability of the needed analytics services.

9. Further in this case, the E2E service management domain requests the analytics results from the management domains, using the "Request analysis result" capability of the needed analytics services.

The following further steps are performed:

10. Optionally and if exposed by the management domains, the E2E service management domain queries the logs of the management domain, using the "Query logs" capability of the "Log collection service" in the management domains.

11. Optionally, if E2E inventory information is needed by the following analytics steps, the E2E service management domain queries the E2E inventory, using the "Query inventory of available services" capability of the "E2E services inventory information service" or the "Query data" capability of the "Data persistence service".

12. Optionally, if E2E topology information is needed by the following analytics steps, the E2E service management domain queries the E2E topology database, using the "Query topology information" capability of the "E2E services topology information service" or the "Query data" capability of the "Data persistence service".

13. Optionally, for selected management domains involved in providing the E2E service, the E2E management domain queries detailed information regarding health issues, using the "Query health issues" capability of the "Health issue reporting service".

14. The E2E service management domain performs analytics locally, using services that have been derived from the "Generic analytics service", optionally including the "Root cause analysis service" and "Security analytics service".

If the analytics result indicates that there is a service problem to be fixed, the following steps are executed:

15. Local processing in the E2E service management domain makes decisions regarding how the issue can be mitigated.

16. For the affected management domains, the execution of orchestration workflows or the modification of the configuration of domain service instances is triggered using the "Execute workflow" or "Manage service lifecycle" capabilities of the "Domain orchestration service" to attempt resolving the issue.

17. If necessary, the affected management domains modify the configuration of resources using the "Manage resource configuration" capability of the "Resource configuration management service" locally.

18. If necessary, the affected management domains manage the resource lifecycle (such as scaling, instantiating or terminating resources) using the "Manage resource lifecycle" capability of services derived from the "Generic Resource lifecycle management service" locally.

19. After performing changes, the E2E service management domain triggers an internal event to update the E2E service inventory, as defined in clause 5.3.7.

If the service problem cannot be fixed, it is tracked as a health issue and escalated to the ZSM framework consumers by the following steps:

20. Via the "Provide violation notifications" capability of the "E2E Health issue reporting service", the E2E service management provides a health issue notification to the integration fabric, using the "Receive data" capability of the "Management communication service".

21. The integration fabric forwards the notification to the ZSM framework consumers that have subscribed to the related channels, using the "Provide data" capability of the "Management communication service".

POSTCONDITIONS:

- The service issue was fixed or escalated.

ERROR CONDITIONS:

- The procedure fails and the issue is escalated to the ZSM framework consumers if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.4.4.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- E2E service intelligence: "Provide health issue notifications capability of the "E2E service health issue reporting service".

The following management services produced by the management domains are used in this procedure:

- Domain data collection: "Provide notifications" capability of "Fault events service" and "Security events service".

- Domain data collection: "Query logs" capability of the "Log collection service" (if exposed).

- Domain analytics: "Configure analytics" and "Request analysis result" capabilities of specific domain analytics services derived from the "Generic analytics service", optionally including the Reactive incident analysis service (if exposed).
- Domain intelligence: "Provide health issue notifications" of the "Health issue reporting service" (if exposed).
- Domain orchestration: "Execute workflow" and "Manage service lifecycle (configure)" capabilities of the "Domain orchestration service".

The following additional management services are used in this procedure:

- ZSM integration fabric: "Provide data" capability of the "Management communication service".
- ZSM integration fabric: "Query service list" and "Get service info" capabilities of the "Management services discovery service".

NOTE: It is up to each deployment to decide whether to use the cross-domain integration fabric or the domain integration fabric or a mix of both.

5.4.5 Process: Service assurance tear-down

5.4.5.1 Description

In analogy to the two different assurance set-up auxiliary processes defined clause 5.4.2, this clause defines auxiliary processes to tear down the collection of information set up by those processes. The tear-down consists of two separate processes:

1) Producer-initiated: This auxiliary process tears down the collection and provisioning of information related to domain service instances that cease to exist or are deactivated, initiated by the management domains that are producing these services. The tear-down is based entirely on the fact that a service instance ceases to be provided by a management domain due to it being decommissioned or deactivated. The procedure undoes the steps that were executed during "producer-initiated set- up of information collection related to domain service instances" (see clause 5.4.2.2.1).

2) Consumer-initiated: This auxiliary process is executed by the E2E service management domain when an E2E service instance is decommissioned or deactivated. It undoes the steps that were executed for this service instance during "consumer-initiated set-up of collecting 'E2E-service specific' information related to domain service instances" (see clause 5.4.2.2.2).

5.4.5.2 Procedure flows

5.4.5.2.1 Producer-initiated tear-down of information collection related to domain service instances

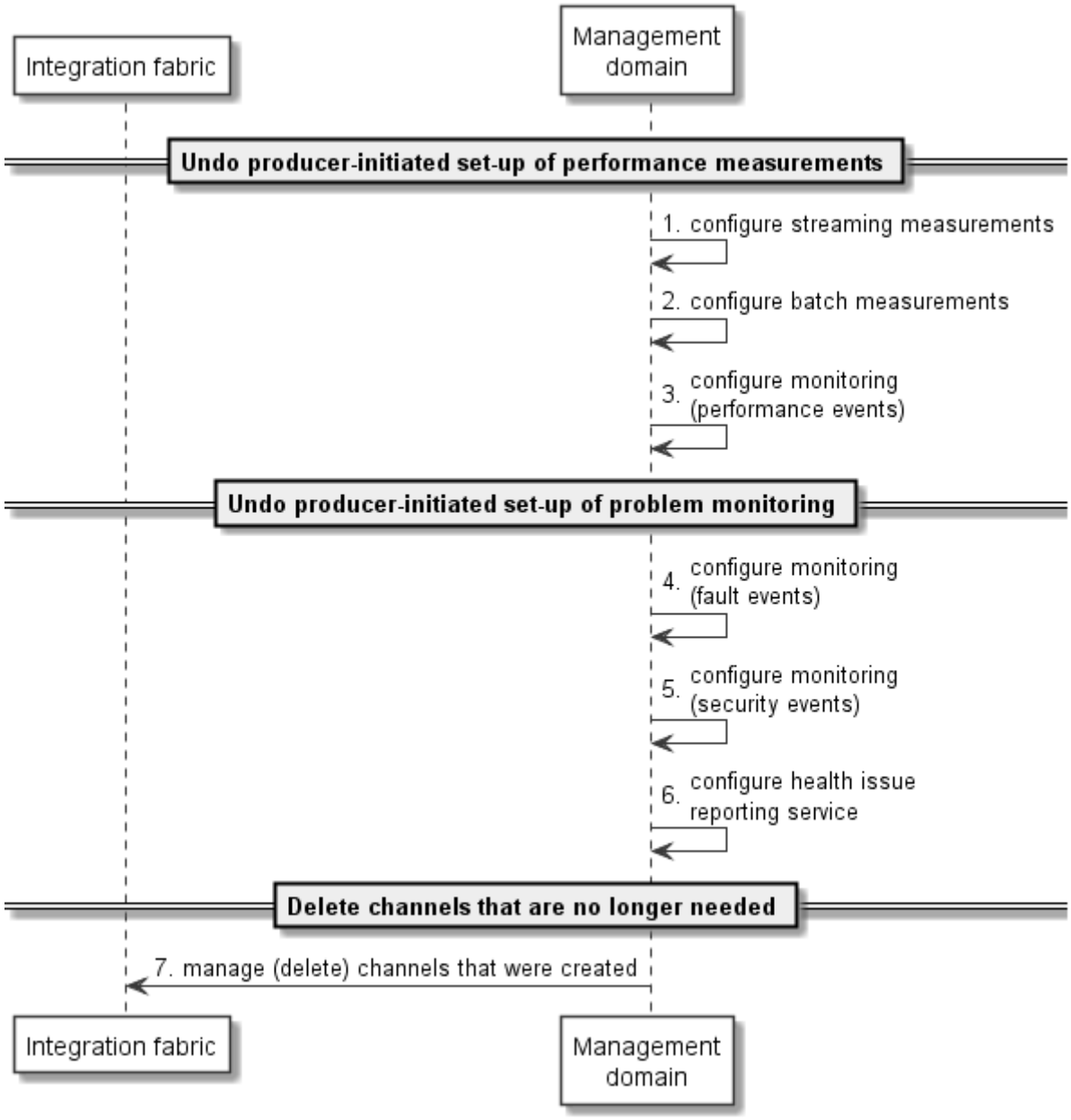


Figure 5.4.5.2.1-1: Producer-initiated tear-down of information collection related to domain service instances

When a domain service instance ceases to exist or is deactivated, the producing management domain tears down the collection of information that it has previously set up related to that produced domain service instance and (optionally) the externally visible resources associated with this instance. In the steps below, the shorthand "produced service instance / associated resources" is used for these. This procedure, which is illustrated in figure 5.4.5.2.1-1, is triggered either during service decommissioning or service deactivation, or during both of these processes if it is intended to split the procedure into two parts that complement each other.

PRECONDITIONS:

- A domain service instance ceases to exist or is deactivated.

The procedure, as illustrated in figure 5.4.5.2.1-1, consists of the following steps:

1. If the management domain has configured the collection of streaming measurements related to the produced service instance / associated resources, it reverts this configuration using the "Configure measurements" capability of the "Performance measurements streaming service".

2. If the management domain has configured the collection of batch measurements related to the produced service instance / associated resources, it reverts this configuration using the "Configure batch measurements" capability of the "Performance measurements collection service".

3. If the management domain has configured the monitoring of performance events (threshold crossings) related to the produced service instance / associated resources, it reverts this configuration using the "Configure monitoring" capability of the "Performance events service".

4. If the management domain has configured the monitoring of faults related to the produced service instance / associated resources, it reverts this configuration using the using the "Configure monitoring" capability of the "Fault events service".

5. If the management domain has configured the monitoring of security events related to the produced service instance / associated resources, it reverts this configuration using the "Configure monitoring" capability of the "Security events service".

6. If the management domain has configured the reporting of health issues related to the produced service instance, it reverts this configuration using the "Configure service" capability of the "Health issue reporting service".

NOTE: Any combination of steps 1, 2, 3, 4, 5 and 6 may be executed in any order.

7. If the management domain has created channels in the integration fabric through which the collected information has been provided, it deletes these channels using the "Manage channels" capability of the "Management communication service".

POSTCONDITIONS:

- Notifications related to issues and performance, as well as streaming and batch measurements that the producing management domain has exposed for a domain service instance, are no longer produced.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the management domain is able to recover from the process step failure / failures.

5.4.5.2.2 Consumer-initiated tear-down of collecting "E2E-service specific" information related to domain service instances

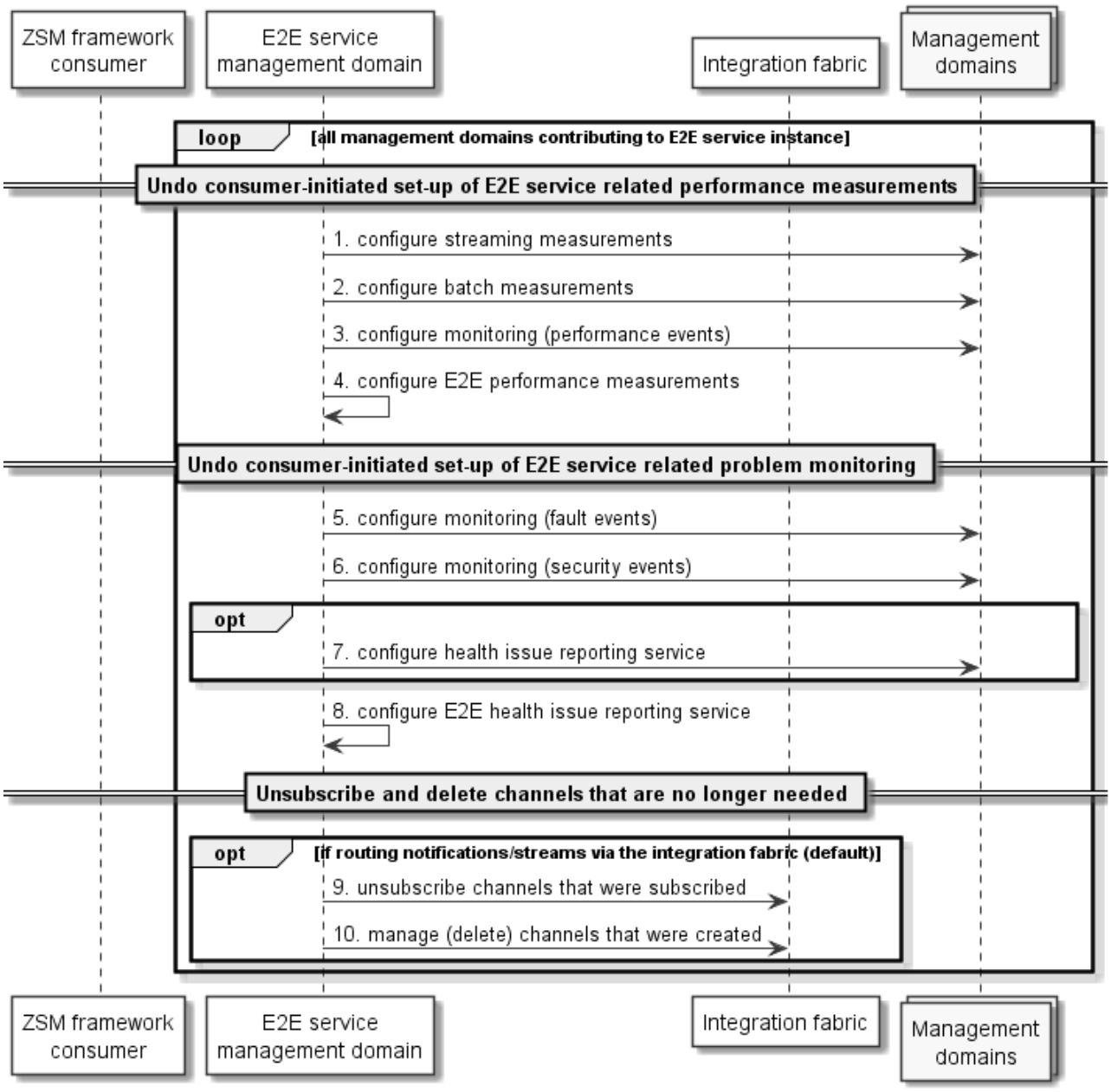


Figure 5.4.5.2.2-1: Consumer-initiated tear-down of collecting "E2E-service specific" information related to domain service instances

When an E2E service instance ceases to exist or is deactivated, the E2E service management domain tears down the collection of information from the MDs related to domain service instances consumed by that particular E2E service instance and (optionally) externally visible resources associated with these domain service instances. In the steps below, the shorthand "consumed domain service instances / associated resources" is used for these. Such information collection for a particular E2E service instance has previously been set up when the E2E service was instantiated or activated. This procedure, which is illustrated in figure 5.4.5.2.2-1, is triggered either during E2E service decommissioning or E2E service deactivation, or during both of these processes if it is intended to split the procedure into two parts that complement each other.

PRECONDITIONS:

- An E2E service instance is being decommissioned or deactivated.

The procedure, as illustrated in figure 5.4.5.2.2-1, consists of the following steps:

1. If the E2E service management domain has configured in the MDs the collection of streaming measurements related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure measurements" capability of the "Performance measurements streaming service".

2. If the E2E service management domain has configured in the MDs the collection of batch measurements related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure batch measurements" capability of the "Performance measurements collection service".

3. If the E2E service management domain has configured in the MDs the monitoring of performance events (threshold crossings) related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure monitoring" capability of the "Performance events service".

4. The E2E service management domain reverts its own configuration of collecting performance measurements related to the E2E service instance.

5. If the E2E service management domain has configured in the MDs the monitoring of faults related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure monitoring" capability of the "Fault events service".

6. If the E2E service management domain has configured in the MDs the monitoring of security events related to consumed domain service instances / associated resources, it reverts this configuration using the "Configure monitoring" capability of the "Security events service".

7. If the E2E service management domain has configured in the MDs the reporting of health issues related to consumed domain service instances, it reverts this configuration using the "Configure service" capability of the "Health issue reporting service" (if exposed).

8. The E2E service management domain removes its own configuration of the health issue reporting service related to the E2E service instance, using the "Health issue reporting service".

NOTE: Any combination of steps 1, 2, 3 and steps 5, 6, 7 may be executed in any order.

9. If the E2E service management domain has subscribed previously to channels related to the collection of information about consumed domain service instances / associated resources, it unsubscribes with the integration fabric from those channels using the "Manage subscriptions" capability of the "Management communication service".

10. If the E2E service management domain has created channels in the integration fabric related to the assurance of the E2E service instance, it deletes these channels using the "Manage channels" capability of the "Management communication service".

POSTCONDITIONS:

- Notifications related to issues and performance, as well as streaming and batch measurements that the E2E service management has requested from the management domains to assure an E2E service instance, are no longer produced by the management domains.

ERROR CONDITIONS:

- The procedure fails if any of the individual steps fails, unless the E2E service management domain is able to recover from the process step failure / failures.

5.4.5.3 Related management services

The management services groups and the actual management services (see ETSI GS ZSM 002 [1] and Annex A of the present document) involved in the procedure are summarized below.

The following management services are produced by the E2E service management domain in this procedure:

- None.

The following management services produced by the management domains are used in this procedure:

- Domain data collection: "Configure monitoring" capability of the "Performance events service".
- Domain data collection: "Configure measurements" capability of the "Performance measurements streaming service".
- Domain data collection: "Configure batch measurements" capability of the "Performance measurements collection service".
- Domain data collection: "Configure monitoring" capability of the "Fault events service".
- Domain data collection: "Configure monitoring" capability of the "Security events service".
- Domain intelligence: "Configure service" capability of the "Health issue reporting service" (if exposed).

The following additional management services are used in this procedure:

- ZSM integration fabric: "Manage channels" and "Manage subscriptions" capabilities of the "Management communication service".

NOTE: It is up to each deployment to decide whether to use the cross-domain integration fabric or the domain integration fabric or a combination of both.

6 Management domain support for cross-domain E2E service lifecycle management

6.1 Overview

The following clauses define mappings of the management services referenced in the management processes in clause 5 to the NorthBound Interfaces (NBIs) of different technology domains. A detailed definition of the referenced management services is provided in ETSI GS ZSM 002 [1]. Additions to these service definitions are defined in Annex A of the present document.

6.2 3GPP Core domain and 3GPP RAN domain

This clause defines the mapping of the ZSM management services to their 3GPP-defined Core and RAN counterparts. As 3GPP has unified management procedures, both types of domains are documented in the same clause. The only difference are the data models used and these differences are called out in table 6.2-1 where applicable.

Table 6.2-1: Mapping of ZSM MnSs and 3GPP management services in 3GPP Core and 3GPP RAN domains

Referenced ZSM MnS + capability	Specification reference	External organizations' APIs / operations	Description / Comment
Domain orchestration: Managed services catalogue management service			
Manage service models	n/a		
Provide catalogue change notifications	n/a		
Request missing service catalogue entry	n/a		

Domain orchestration: Feasibility check service			
Check deployment feasibility	ETSI TS 128 531 [7] ETSI TS 128 541 [8]	Use case and procedure of network slice subnet feasibility check [7] FeasibilityCheckAnd-ReservationJob IOC [8]	Clauses 5.1.21 and 7.14 of ETSI TS 128 531 [7] define a use case and a flow for a feasibility check with reservation that is geared towards network slice subnets. Additionally, ETSI TS 128 541 [8] defines a "FeasibilityCheckAnd-ReservationJob" IOC. This IOC allows the creation of feasibility check jobs with and without resource reservation.
Check and reserve (if supported)	ETSI TS 128 531 [7] ETSI TS 128 541 [8]	Use case and procedure of network slice subnet feasibility check [7] FeasibilityCheckAnd-ReservationJob IOC [8]	
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	ETSI TS 128 532 [6]	createMOI	
Manage service lifecycle (scale service)	ETSI TS 128 532 [6]	modifyMOIAttributes	
Manage service lifecycle (configure service)	ETSI TS 128 532 [6]	modifyMOIAttributes	
Manage service lifecycle (activate service)	ETSI TS 128 532 [6]	modifyMOIAttributes	
Manage service lifecycle (deactivate service)	ETSI TS 128 532 [6]	modifyMOIAttributes	
Manage service lifecycle (terminate service)	ETSI TS 128 532 [6]	deleteMOI	
Execute workflow	n/a		
Manage subscriptions to lifecycle changes (if exposed)	ETSI TS 128 532 [6]	createMOI modifyMOIAttributes deleteMOI	The subscription NRM control fragment is defined in ETSI TS 128 622 [12] as "NtfSubscriptionControl" information element.
Provide notifications about lifecycle changes	ETSI TS 128 532 [6]	notifyMOICreation notifyMOIDeletion notifyMOIAttributeValueChanges notifyEvent notifyMOIChanges	Subscriptions are needed to receive notifications. "notifyMOICreation" notifies about the creation of a new MOI instance. "notifyMOIDeletion" notifies about the deletion of an MOI instance. "notifyMOIAttributeValueChanges" notifies about the modification of attribute values in an MOI instance. "notifyEvent" notifies about certain network events with potential service impact, e.g. system restart. "notifyMOIChanges" is a composite notification that notifies about multiple updates of MOIs (creation, deletion, attribute value change). The management service producer decides whether to send separate "notifyMOICreation", "notifyMOIDeletion" and "notifyMOIAttributeValueChanges" notifications, or an aggregate "notifyMOIChanges" notification.
Domain orchestration: Testing service			
Manage test specifications	n/a		
Test resources	n/a		
Query tests	n/a		

Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	ETSI TS 128 532 [6] ETSI TS 128 622 [12] ETSI TS 128 541 [8] ETSI TS 128 632 [9] ETSI TS 128 658 [13] ETSI TS 128 708 [14]	getMOIAttributes	ETSI TS 128 532 [6] defines the provisioning service to access the NRM (network resource model) which is a federated model spanning multiple specifications that includes a large set of information, including inventory information. The model consists of parts defined in the following specifications: ETSI TS 128 622 [12] defines the 3GPP root model. ETSI TS 128 541 [8] defines the 5G-specific model for RAN and Core. ETSI TS 128 632 [9] defines the pre-5G legacy inventory model for hardware. ETSI TS 128 658 [13] defines the LTE radio (E-UTRAN) model and ETSI TS ETSI TS 128 708 [14] specifies the LTE core (EPC) model.
Configure notifications (if supported)	ETSI TS 128 532 [6] ETSI TS 128 622 [12]	createMOI modifyMOIAttributes deleteMOI	The subscription NRM control fragment is defined in ETSI TS 128 622 [12] as "NtfSubscriptionControl" IOC.
Provide notifications about inventory changes (if supported)	ETSI TS 128 532 [6]	notifyMOIAttributeValueChanges notifyMOIChanges notifyMOIDeletion	Subscriptions are needed to receive notifications. "notifyMOIAttributeValueChanges" contains a list of changed attributes with the changes performed for a single MOI. "notifyMOIChanges" notifies about changes performed on multiple MOIs. "notifyMOIDeletion" notifies about the deletion of an MOI.
Domain orchestration: Domain topology information service			
Query topology information (if exposed)	ETSI TS 128 532 [6] ETSI TS 128 622 [12] ETSI TS 128 541 [8] ETSI TS 128 632 [9] ETSI TS 128 658 [13] ETSI TS 128 708 [14]	getMOIAttributes	ETSI TS 128 532 [6] defines the provisioning service to access the NRM (Network Resource Model) which is a federated model spanning multiple specifications that includes a large set of information, including topology information. Two aspects of topology are defined in the NRM. "Logical topology" is modelled by the so-called name-containment, defining a hierarchy of managed objects, and used as a central concept all over the NRM). "Network topology" is modelled as End-Points (EPs) each of which can reference another EP, defining which network node communicates with which other network node using which interfaces. Interfaces are modelled as endpoints which are name-contained within the managed functions.

			For instance, in ETSI TS 128 541 [8], the "EP_x" IOCs represent the different endpoint types. Examples for logical topology can be found in figure 4.2.1.1-1 of ETSI TS 128 541 [8] and for network topology in figure 4.2.1.1-2 of ETSI TS 128 541 [8]. The relevant model parts are the same as the ones defined for "Query inventory of available resources".
Configure notifications (if supported)	ETSI TS 128 532 [6]	createMOI modifyMOIAttributes deleteMOI	The subscription NRM control fragment is defined in ETSI TS 128 622 [12] as "NtfSubscriptionControl" information element.
Provide notifications about topology changes (if supported)	ETSI TS 128 532 [6]	notifyMOIAttributeValueChanges notifyMOIChanges notifyMOIDeletion	Subscriptions are needed to receive notifications. "notifyMOIAttributeValueChanges" contains a list of changed attributes with the changes performed for a single MOI. "notifyMOIChanges" notifies about changes performed on multiple MOIs. "notifyMOIDeletion" notifies about the deletion of an MOI.
Domain control: Virtualised resource lifecycle management service			
Manage subscription to lifecycle changes (if exposed)	ETSI TS 128 527 [17]	See clause 6.5	3GPP is re-using the specifications of ETSI NFV for the management of NFV network services and VNFs. ETSI TS 128 527 [17] provides references to these specifications. The relevant functionality is therefore the same as those defined for "Configure notifications" of this service in clause 6.5.
Provide notifications about lifecycle changes (if exposed)	ETSI TS 128 527 [17]	See clause 6.5	3GPP is re-using the specifications of ETSI NFV for the management of NFV network services and VNFs. ETSI TS 128 527 [17] provides references to these specifications. The relevant notifications are therefore the same as those defined for "Provide notifications about lifecycle changes" in clause 6.5.
Domain data collection: Performance events service			
Configure monitoring	ETSI TS 128 532 [6] ETSI TS 128 622 [12] ETSI TS 128 552 [10] ETSI TS 132 425 [15] ETSI TS 132 426 [16]	createMOI modifyMOIAttributes deleteMOI	Three types of control fragments are provisioned as MOIs, using operations defined in ETSI TS 128 532 [6], to configure the monitoring.

			Performance metrics jobs are based on the "PerfMetricJob" NRM control fragment defined in ETSI TS 128 622 [12]. They produce measurements for which the following definitions apply: For 5G, RAN and Core measurements are defined in ETSI TS 128 552 [10]. For LTE, E-UTRAN measurements are defined in ETSI TS 132 425 [15] and EPC measurements are defined in ETSI TS 132 426 [16]. Threshold monitors are based on the "ThresholdMonitor" NRM control fragment defined in ETSI TS 128 622 [12]. They generate notifications if a metric that is produced by a performance metric job crosses a threshold. Subscriptions are based on the "NtfSubscriptionControl" NRM control fragment defined in ETSI TS 128 622 [12]. They route the generated notifications to the subscribers. A management domain may pre-create a default set of performance metrics job, threshold monitor and subscription control fragments.
Provide notifications	ETSI TS 128 532 [6]	notifyThresholdCrossing	Subscriptions are needed to receive notifications. "notifyThresholdCrossing" informs a subscriber that a threshold monitor has detected a threshold crossing.
Domain data collection: Performance measurements streaming service			
Configure measurements	ETSI TS 128 532 [6] ETSI TS 128 622 [12] ETSI TS 128 552 [10] ETSI TS 128 554 [11] ETSI TS 132 425 [15] ETSI TS 132 426 [16]	createMOI modifyMOIAttributes deleteMOI	Performance metrics jobs are provisioned as MOIs, using operations defined in ETSI TS 128 532 [6], based on the "PerfMetricJob" NRM control fragment defined in ETSI TS 128 622 [12]. They produce measurements and KPIs for which the following definitions apply: For 5G, RAN and Core measurements are defined in ETSI TS 128 552 [10] and related KPIs are specified in ETSI TS 128 554 [11]. For LTE, E-UTRAN measurements are defined in ETSI TS 132 425 [15] and EPC measurements are defined in ETSI TS 132 426 [16]. No KPIs have been standardized for LTE. The reporting control properties ("ReportingCtrl") of the PerfMetricsJob control fragments are set to choose streaming delivery of the metrics.

			A management domain may pre-create a default set of performance metrics job control fragments.
Provide streaming measurements	ETSI TS 128 532 [6]	establishStreamingConnection reportStreamData addStream deleteStream terminateStreamingConnection	
Domain data collection: Performance measurements collection service			
Configure batch measurements	ETSI TS 128 532 [6] ETSI TS 128 622 [12]. ETSI TS 128 552 [10] ETSI TS 128 554 [11] ETSI TS 132 425 [15] ETSI TS 132 426 [16]	createMOI modifyMOIAttributes deleteMOI	Two types of control fragments are provisioned as MOIs, using operations defined in ETSI TS 128 532 [6], to configure the collection of metrics and KPIs. Performance metrics jobs are based on the "PerfMetricJob" NRM control fragment defined in ETSI TS 128 622 [12]. They produce measurements and KPIs for which the following definitions apply: For 5G, RAN and Core measurements are defined in ETSI TS 128 552 [10] and related KPIs are specified in ETSI TS 128 554 [11]. For LTE, E-UTRAN measurements are defined in ETSI TS 132 425 [15] and EPC measurements are defined in ETSI TS 132 426 [16]. No KPIs have been standardized for LTE. The reporting control properties ("ReportingCtrl") of the PerfMetricsJob control fragments are set to choose file delivery of the metrics. Subscriptions are based on the "NtfSubscriptionControl" NRM control fragment defined in ETSI TS 128 622 [12]. They route the generated notifications about the availability of batches of collected measurements to the subscribers. A management domain may pre-create a default set of performance metrics job and subscription control fragments.

Provide batch availability notifications	ETSI TS 128 532 [6]	notifyFileReady notifyFilePreparationError	Subscriptions are needed to receive notifications. "notifyFileReady" informs that a file with collected performance information is available for retrieval. "notifyFilePreparationError" informs that the preparation of a file with collected performance information has failed.
Get batch measurements	ETSI TS 128 532 [6]	listAvailableFiles	"listAvailableFiles" allows to list information about the available files as an alternative to parsing the notifications. The file is obtained from the location (path, URI) signaled in "notifyFileReady" or "listAvailableFiles". The actual means to retrieve the files is not specified by 3GPP.
Domain data collection: Fault events service			
Configure monitoring	ETSI TS 128 532 [6]	createMOI modifyMOIAttributes deleteMOI	Subscriptions to alarm notifications are provisioned as MOIs, using operations defined in ETSI TS 128 532 [6], based on the "NtfSubscriptionControl" NRM control fragment defined in ETSI TS 128 622 [12]. They route the generated alarm notifications to the subscribers. A management domain may choose to pre-create default subscription control fragments.
Provide notifications	ETSI TS 128 532 [6]	notifyNewAlarm notifyChangedAlarmGeneral notifyChangedAlarm	Subscriptions are needed to receive notifications. "notifyNewAlarm" informs about a new alarm. "notifyChangedAlarmGeneral" informs about changes in the perceived severity of an alarm. "notifyChangedAlarm" specifically informs about changes in the perceived severity of an alarm, other than clearing the alarm. The set of applicable alarm attributes is defined in clause 12.2.1.2.2 of [6].
Domain data collection: Security events service			
Configure monitoring	ETSI TS 128 532 [6]	createMOI modifyMOIAttributes deleteMOI	The security events service uses the same mechanism as the fault events service above. Subscriptions to alarm notifications are provisioned as MOIs, using operations defined in ETSI TS 128 532 [6], based on the "NtfSubscriptionControl" NRM control fragment defined in ETSI TS 128 622 [12]. They route the generated alarm notifications to the subscribers. A management domain may choose to pre-create default subscription control fragments.

Provide notifications	ETSI TS 128 532 [6]	notifyNewAlarm notifyChangedAlarmGeneral notifyChangedAlarm	Subscriptions are needed to receive notifications. "notifyNewAlarm" informs about a new alarm. "notifyChangedAlarmGeneral" informs about changes in the perceived severity of an alarm. "notifyChangedAlarm" specifically informs about changes in the perceived severity of an alarm, other than clearing the alarm. The set of applicable alarm attributes for security-related alarms is defined in clause 12.2.1.2.3 of [6].
Domain data collection: Log collection service (if exposed)			
Query logs	n/a		
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	3GPP TS 28.104 [i.3]	(work in progress)	3GPP Rel.17 includes the definition of the Management Data Analytics Service (MDAS). 3GPP TS 28.104 [i.3] defines requirements and the data consumed for performing a set of standardized analytics use cases in the 3GPP management plane. It can import data from the Network Data Analytics Function (NWDAF) (see ETSI TS 123 288 [i.2]) which allows requesting a set of pre-defined analytics for the control plane of the 3GPP Core domain.
Request analysis result	3GPP TS 28.104 [i.3]	(work in progress)	
Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service (optional)			
Query data	n/a		
Store data	n/a		

6.3 Fixed access domain

Broadband Forum (BBF) has defined an architecture framework called "Cloud Central Office (CloudCO)" (see BBF TR-384 [18]) that supports the zero-touch automation of SDN functionality, the re-use of existing BBF-defined resources and their migration to the cloud. The CCO DO (Cloud CO Domain Orchestrator) within that architectural framework produces management services towards consumers, including OSS / BSS, other management domains and the E2E service management domain, that allows the management and orchestration of the network services provided by the fixed access domain.

BBF TR-411 [19] provides a general definition of the interfaces between the CloudCO elements and defines the protocols and data models to be used on these interfaces by referencing related TM Forum specifications. Therefore, compared to other domain mappings in the present document that are strictly stage-2, the BBF mapping is closer to the stage-3.

The "Os-Ma-ccodo" reference point in the CloudCO architecture is the main integration point between the CloudCO-based fixed access domain and the E2E service management domain.

Table 6.3-1: Mapping of ZSM MnSs and BBF management interfaces in Fixed access domain

Referenced ZSM MnS + capability	Spec ref	External organizations' APIs / operations	Description / comment
Domain orchestration: Managed services catalogue management service			
Manage service models	BBF TR-411 [19]	Service Catalog Management API (TMF633 [22])	TMF633 [22] offers the E2E service management domain means of querying the CCO DO run-time Service Catalogue to determine the service types available within the CCO domain. In addition, TM633 [22] offers a complete set of CRUD-N capabilities to lifecycle manage the content of the CCO DO run-time Service Catalogue.
Provide catalogue change notifications	BBF TR-411 [19]	Service Catalog Management API (TMF633 [22])	
Request missing service catalogue entry	n/a		
Domain orchestration: Feasibility check service			
Check deployment feasibility	BBF TR-411 [19]	Service Qualification Management API (TMF645 [28])	TMF645 [28] offers the E2E service management domain a standard means of validating whether specific service characteristics can be offered at a geographic location.
Check and reserve (if supported)	n/a		
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	BBF TR-411 [19]	Service Ordering Management API (TMF641 [26]) Resource Inventory Management API (TMF639 [24])	TMF641 [26] offers the E2E service management domain a standard means of ordering services from the CCO DO, enabling the Network-as-a-Service/Subscriber-as-a-Service paradigms. Notifications of changes to the order item(s) state and service instance are also offered. Error handling notifications are exposed northbound to the E2E service management domain. A service order for resource facing services can optionally reference resources that are represented in the resource inventory (TMF639 [24]).
Manage service lifecycle (scale service)	n/a		
Manage service lifecycle (configure service)	BBF TR-411 [19]	Service Ordering Management API (TMF641 [26]) Resource Inventory Management API (TMF639 [24])	
Manage service lifecycle (activate service)	BBF TR-411 [19]	Service Ordering Management API (TMF641 [26]) Resource Inventory Management API (TMF639 [24])	
Manage service lifecycle (deactivate service)	BBF TR-411 [19]	Service Ordering Management API (TMF641 [26]) Resource Inventory Management API (TMF639 [24])	
Manage service lifecycle (terminate service)	BBF TR-411 [19]	Service Ordering Management API (TMF641 [26]) Resource Inventory Management API (TMF639 [24])	
Execute workflow	n/a		

Manage subscriptions to lifecycle changes (if exposed)	BBF TR-411 [19]	Service Ordering Management API (TMF641 [26]) Resource Inventory Management API (TMF639 [24]) Service Inventory Management API (TMF638 [23])	
Provide notifications about lifecycle changes	BBF TR-411 [19]	Service Ordering Management API (TMF641 [26]) Resource Inventory Management API (TMF639 [24]) Service Inventory Management API (TMF638 [23])	
Domain orchestration: Testing service			
Manage test specifications	BBF TR-411 [19]	Service Test Management API (TMF653 [29])	TMF653 [29] offers the E2E service management domain standard means of requesting and managing service tests for services orchestrated by the CCO DO.
Test resources	BBF TR-411 [19]	Service Test Management API (TMF653 [29])	
Query tests	BBF TR-411 [19]	Service Test Management API (TMF653 [29])	
Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	BBF TR-411 [19]	Service Inventory Management API (TMF638 [23]) Resource Inventory Management API (TMF639 [24]) YANG based equipment inventory / network map (BBF TR-454 [20])	TMF638 [23] offers the E2E service management domain a standard means of query, updating and receiving notifications from the CCO DO's Service Inventory including to service state recorded in the catalogue. TMF639 [24] offers the E2E service management domain a standard means of querying, updating and receiving notifications from the CCO DO's Resource Inventory. BBF TR-454 [20] provides a YANG based equipment inventory and associated infrastructure network map.
Configure notifications (if supported)	BBF TR-411 [19]	Service Inventory Management API (TMF638 [23]) Resource Inventory Management API (TMF639 [24]) YANG based equipment inventory / network map (BBF TR-454 [20])	
Provide notifications about inventory changes (if supported)	BBF TR-411 [19]	Service Inventory Management API (TMF638 [23]) Resource Inventory Management API (TMF639 [24]) YANG based equipment inventory / network map (BBF TR-454 [20])	
Domain orchestration: Domain topology information service			
Query topology information (if exposed)	BBF TR-411 [19]	Resource Inventory Management API (TMF639 [24]) YANG based equipment inventory / network map (BBF TR-454 [20])	TMF639 [24] offers the E2E service management domain a standard means of querying, updating and receiving notifications from the CCO DO's Resource Inventory. BBF TR-454 [20] provides a YANG based equipment inventory and associated infrastructure network map.
Configure notifications (if supported)	BBF TR-411 [19]	Resource Inventory Management API (TMF639 [24]) YANG based equipment inventory / network map (BBF TR-454 [20])	

Provide notifications about topology changes (if supported)	BBF TR-411 [19]	Resource Inventory Management API (TMF639 [24]) YANG based equipment inventory / network map (BBF TR-454 [20])	
Domain control: Virtualised resource lifecycle management service			
Manage subscription to lifecycle changes (if exposed)	BBF TR-411 [19]	Subscribe Terminate subscription (See clause 6.4.16 of ETSI GS NFV-SOL 005 [5])	BBF is re-using the specifications of ETSI NFV for the management of NFV network services and VNFs. The relevant notifications are therefore the same as those defined for "Provide notifications about lifecycle changes" in clause 6.5. The CloudCO Domain Orchestration Function provides the capability of directly exposing the CloudCO Domain Orchestration NFVO capabilities defined by the Os-Ma-nfvo reference point across the Os-Ma-ccodo reference point as specified in ETSI GS NFV-SOL 005 [5].
Provide notifications about lifecycle changes (if exposed)	BBF TR-411 [19]	Provide notifications about lifecycle changes (clause 6.6 of ETSI GS NFV-SOL 005 [5])	BBF is re-using the specifications of ETSI NFV for the management of NFV network services and VNFs. The relevant notifications are therefore the same as those defined for "Provide notifications about lifecycle changes" in clause 6.5. The CloudCO Domain Orchestration Function provides the capability of directly exposing the CloudCO Domain Orchestration NFVO capabilities defined by the Os-Ma-nfvo reference point across the Os-Ma-ccodo reference point as specified in ETSI GS NFV-SOL 005 [5] including fault and performance management.
Domain data collection: Performance events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Performance measurements streaming service			
Configure measurements	n/a		
Provide streaming measurements	n/a		
Domain data collection: Performance measurements collection service			
Configure batch measurements	n/a		
Provide batch availability notifications	n/a		
Get batch measurements	n/a		
Domain data collection: Fault events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Security events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Log collection service (if exposed)			
Query logs (if exposed)	n/a		
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	n/a		
Request analysis result	n/a		

Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service (optional)			
Query data	n/a		
Store data	n/a		

6.4 Transport domain

6.4.1 Overview

Within the transport domain, different technologies at different layers are used that need to be managed. Transport aspects include optical transport, layer 2 and layer 3 VPNs allowing point-to-point and point-to-multipoint connections, and transport slices.

The subscribe-notify mechanism used in transport domains with IETF-based NBI is based on a combination of two RFCs: IETF RFC 8639 [43] defines a YANG model and mechanisms that allows subscribing to a publisher's event streams and accessing these streams in a transport protocol agnostic way. IETF RFC 8641 [44] known as "YANG Push" extends the subscription model defined in IETF RFC 8639 [43] with capabilities that allow subscribers to define the triggers to retrieve updates on datastores and control these triggers by filters. Two notification mechanisms are defined that provide the values of selected sets of nodes in the model tree:

1) periodic notifications which repeatedly send the current values of the subscribed nodes after each period of configurable length;

2) change notifications which send the current values of those subscribed nodes that have changed. To prevent notification storms, a dampening period can be configured that restricts the rate of generating notifications.

For subscription, the YANG models that represent the resources and services in the datastore to which the subscription applies, as well as the data models defined for the subscription to event streams (ietf-subscribed-notifications) and their augmentation for YANG Push (ietf-yang-push) are relevant. The subscription mechanism defined by IETF RFC 8639 [43] and IETF RFC 8641 [44] allows to create, modify and delete subscriptions to notifications on a per-client basis. When subscribing, "stream filters" can be specified with subtree filters or XML Path Language (XPath) filters related to the resources and services data models, so that only contents of interest will be sent.

The notifications are accessed via a stream resource using the protocol defined in IETF RFC 8650 [45]. The address of the stream resource is returned upon subscription. The content of the notifications represents a part of the model tree that has been selected during subscription. Even though IETF RFC 8639 [43] and IETF RFC 8641 [44] are transport-agnostic, the mappings defined in tables 6.4.2-1 and 6.4.4-1 assume RESTCONF protocol bindings of the dynamic subscription capability to both publisher's event streams and YANG-Push.

Different management interfaces have been developed to manage these different aspects of transport networks. In the following clauses, these different transport management interfaces are mapped to the ZSM management services.

6.4.2 Optical transport domain with IETF-based NBI

Optical transport networks provide services of different level, including the client layer, the OTN layer, the wavelength layer, etc. the information / data model has been aligned with IETF, there are multiple WGs covering the optical transport network service models which include but not limited to TEAS and CCAMP WG. The models are all described in the YANG [35] modeling language and support operations via multiple protocols e.g. NETCONF [36] or RESTCONF [38].

Table 6.4.2-1: Mapping of ZSM MnSs and IETF management interfaces in Optical transport domain

Referenced ZSM MnS + capability	Spec ref	External organizations' APIs / operations	Description / comment
Domain orchestration: Managed services catalogue management service			
Manage service models	n/a		
Provide catalogue change notifications	n/a		
Request missing service catalogue entry	n/a		
Domain orchestration: Feasibility check service			
Check deployment feasibility	draft-ietf-teas-yang-te [i.8] draft-ietf-teas-yang-path-computation [i.9]	Operation: POST Data model: ietf-te-path-computation [i.9]	This API can be used for path computation and check the feasibility before service deployment.
Check and reserve (if supported)	n/a		
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-otn-tunnel-model [i.10] draft-ietf-ccamp-wson-tunnel-model [i.11] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: POST Data models: ietf-te [i.8] ietf-otn-tunnel [i.10] ietf-wson-tunnel [i.11] ietf-trans-client-service [i.12]	In IETF, a TE tunnel or client service can be instantiated by creating a tunnel or client service instance.
Manage service lifecycle (scale service)	draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-otn-tunnel-model [i.10]	Operation: PATCH Data models: ietf-te [i.8] ietf-otn-tunnel [i.10]	In IETF, the reserved TE tunnel resources can be modified using the patch method.
Manage service lifecycle (configure service)	draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-otn-tunnel-model [i.10] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: PATCH Data models: ietf-te [i.8] ietf-otn-tunnel [i.10] ietf-trans-client-service [i.12]	Optical transport MD can support TE tunnel and client service modification by their PATCH method.
Manage service lifecycle (activate service)	draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: PATCH Data models: ietf-te [i.8] ietf-trans-client-service [i.12]	By setting TE tunnel's or client service's administrative state to up, the TE tunnel or client service would be activated.
Manage service lifecycle (deactivate service)	draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: PATCH Data models: ietf-te [i.8] ietf-trans-client-service [i.12]	By setting TE tunnel's or client service's administrative state to down, the TE tunnel or client service would be deactivated.
Manage service lifecycle (terminate service)	draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: DELETE Data models: ietf-te [i.8] ietf-trans-client-service [i.12]	TE tunnel and client service instance can be removed by its DELETE API.
Execute workflow	n/a		

Manage subscriptions to lifecycle changes (if exposed)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45] draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44] Data models for subscribed content: ietf-trans-client-service [i.12] ietf-te [i.8]	The details of subscribe / notify are described in clause 6.4.1. Subscription to change notifications related to TE tunnels and client services will allow to receive notifications about new / modified / removed TE tunnels and client service instances.
Provide notifications about lifecycle changes	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription.
Domain orchestration: Testing service			
Manage test specifications	n/a		
Test resources	n/a		
Query tests	n/a		
Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-otn-tunnel-model [i.10] draft-ietf-ccamp-wson-tunnel-model [i.11] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: GET Data models: ietf-te [i.8] ietf-otn-tunnel [i.10] ietf-wson-tunnel [i.11] ietf-trans-client-service [i.12]	Information about TE tunnel and client service instances can be obtained using the GET method.
Configure notifications (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8795 [46] draft-ietf-teas-yang-te [i.8] draft-ietf-ccamp-otn-tunnel-model [i.10] draft-ietf-ccamp-wson-tunnel-model [i.11] draft-ietf-ccamp-client-signal-yang [i.12]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44]] Data models for subscribed content: ietf-te [i.8] ietf-otn-tunnel [i.10] ietf-wson-tunnel [i.11] ietf-trans-client-service [i.12]	The details of subscribe / notify are described in clause 6.4.1. Subscription to change notifications related to TE tunnels and client services will allow to receive notifications about new / modified / removed TE tunnels and client service instances.
Provide notifications about inventory changes (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription.

Domain orchestration: Domain topology information service			
Query topology information (if exposed)	IETF RFC 8345 [40] IETF RFC 8795 [46] draft-ietf-ccamp-otn-topo-yang [i.13] IETF RFC 9094 [48] draft-ietf-ccamp-eth-client-te-topo-yang [i.14]	Operation: GET Data models: ietf-network [40] ietf-network-topology [40] ietf-te-topology [46] ietf-otn-topology [i.13] ietf-wson-topology [48] ietf-eth-te-topology [i.14]	IETF RFC 8795 [46] defines the optical transport TE topology model which represents topology information.
Configure notifications (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45] IETF RFC 8345 [40] IETF RFC 8795 [46] draft-ietf-ccamp-otn-topo-yang [i.13] IETF RFC 9094 [48] draft-ietf-ccamp-eth-client-te-topo-yang [i.14]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44] Data models for subscribed content: ietf-network [40] ietf-network-topology [40] ietf-te-topology [46] ietf-otn-topology [i.13] ietf-wson-topology [48] ietf-eth-te-topology [i.14]	The details of subscribe / notify are described in clause 6.4.1. Subscriptions to change notifications related to topology data stores will allow to receive notifications about topology changes. A service consumer may enable "topology data changes" subscription by setting the "stream-filter" (described by "sub-tree" or "xPath" which contains the concerned topology models) in the subscription request input.
Provide notifications about topology changes (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription.
Domain control: Virtualised resource lifecycle management service			
Manage subscription to lifecycle changes (if exposed)	n/a		
Provide notifications about lifecycle changes (if exposed)	n/a		
Domain data collection: Performance events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Performance measurements streaming service			
Configure measurements	n/a		
Provide streaming measurements	n/a		
Domain data collection: Performance measurements collection service			
Configure batch measurements	n/a		
Provide batch availability notifications	n/a		
Get batch measurements	n/a		
Domain data collection: Fault events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Security events service			
Configure monitoring	n/a		
Provide notifications	n/a		

Domain data collection: Log collection service (if exposed)			
Query logs	n/a		
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	n/a		
Request analysis result	n/a		
Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service(optional)			
Query data	n/a		
Store data	n/a		

6.4.3 Optical transport domain with TAPI as NBI

The present clause describes the ONF approach of integrating the management of an optical transport domain with E2E-level management entities. The ONF has defined the Transport Application Programming Interface which allows an E2E management entity to manage the services of an optical transport domain based on YANG models. These YANG models have been derived from UML models, both of which are defined in the "ONF Transport API SDK" specification [34]. The "TAPI Reference Implementation Agreement" specifications ONF TR-547 [32] and ONF TR-548 [33] define a number of typical Use Cases (UCs). Each Use Case (UC) defines or references a procedure and includes information which attributes of the YANG data models in [34] are relevant for that use case at the northbound interface of the optical transport domain. In table 6.4.3-1 the applicable use cases are referenced per each MnS capability to define the mapping. ONF TR-547 [32] focuses on connectivity management use cases. ONF TR-548 [33] defines streaming support. In the present version, the main uses of streaming are:

1) keeping the client's view consistent with updates to the state of the network; and

2) streaming of alarm notifications.

The support of streaming per ONF TR-548 [33] as an alternative way to deliver notifications is optional in TAPI.

Table 6.4.3-1: Mapping of ZSM MnSs and the ONF Transport API in Optical transport domain

Referenced ZSM MnS + capability	Spec ref	External organizations' APIs / operations	Description / comment
Domain orchestration: Managed services catalogue management service			
Manage service models	n/a		TAPI does not support a service catalogue service. However, the different provisioning use cases defined in sections 6.2 and 6.3 of ONF TR-547 [32] and referenced in the row "Domain orchestration service - Manage service lifecycle" below reflect the set of types of managed services that can be instantiated.
Provide catalogue change notifications	n/a		
Request missing service catalogue entry	n/a		

Domain orchestration: Feasibility check service			
Check deployment feasibility	n/a		
Check and reserve (if supported)	n/a		
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	ONF TR-547 [32]	UC 1.0 UCs 1a..1h UCs 2a..2c UCs 3a..3f	TAPI distinguishes between unconstrained and constrained service provisioning. UC 1.0 defines the main procedure and the set of parameters that is shared among all provisioning use cases. In unconstrained provisioning, the service request does not include any routing constraint, therefore the service producer uses its routing capabilities to select the network resources for the service instance. The use cases 1a to 1h and 2a to 2c define additional specific parameters on top of the general use case 1.0 for services with different characteristics. In constrained provisioning, routing constrains (e.g. constraints with respect to specific nodes, links, routes) or policies are included in the service request. The use cases 3a to 3f define additional specific parameters on top of the general use case 1.0 services with different characteristics. TAPI defines use cases 5b, 5c, 6a, 6b, 7a, 7b, 8 and 9 related to resiliency aspects of the services. Service resilience properties have to be chosen at service instantiation time.
Manage service lifecycle (scale service)	n/a		
Manage service lifecycle (configure service)	n/a		The present version of TAPI does not define use cases for the modification of service instances.
Manage service lifecycle (activate service)	TAPI SDK [34]		Administrative state is represented in the TAPI YANG models. However, administrative state provisioning is not covered by a use case in the present version of TAPI.
Manage service lifecycle (deactivate service)	TAPI SDK [34]		Administrative state is represented in the TAPI YANG models. However, administrative state provisioning is not covered by a use case in the present version of TAPI.
Manage service lifecycle (terminate service)	ONF TR-547 [32]	UC 10	UC 10 defines the procedure for service deletion.
Execute workflow	n/a		
Manage subscriptions to lifecycle changes (if exposed)	ONF TR-547 [32]	UC 13a UCs 14b, 15b, 15c	UC 13a defines the general procedure for subscription to notifications. The remaining use cases define parameters for the specific subscriptions.

Provide notifications about lifecycle changes	ONF TR-547 [32]	UC 13a UCs 14b, 15b, 15c	To receive notifications, a prior subscription based on UC 13a is required. UC 13a also defines the procedure for notifications delivery. The notifications relate to insertion / removal of connectivity objects aka services (UC 14b), status changes of these (15 b) or switching condition of these (15c).
Domain orchestration: Testing service			
Manage test specifications	n/a		
Test resources	n/a		
Query tests	n/a		
Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	ONF TR-547 [32]	UCs 4a, 4b UC 5a UC 0c	UC 4a allows to access external inventory that is not defined as part of TAPI. UC 4b allows access to the complete inventory for the NBI, including all devices and physical equipment. UC 5a allows to discover the resiliency scheme embedded in the network. 1) Physical inventory: In TAPI, inventory use cases 4a, 4b and 5a reflect the inventory of physical resources. 2) Logical inventory: Use case 0c allows to discover connectivity services and their supporting connections in the network.
Configure notifications (if supported)	ONF TR-547 [32] ONF TR-548 [33]	TR-547: UC 13a UCs 14b, 15b, 15c TR-548: UCs ST-0.2, ST-5.1	ONF TR-547 [32]: 1) Physical inventory: The present version of ONF TR-547 [32] does not define use cases for subscriptions related to the physical inventory. 2) Logical inventory: Subscription to notifications related to changes to the service instances (see also domain orchestration service) can be performed based on the use cases 13a (generic subscription) and 14b, 15b, 15c (parameters for the specific subscriptions). ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. The definitions in the informative UC ST-5.1 also apply for changes to the logical inventory. Streams can be discovered and selected by the service consumer as per UC ST-0.2.

Provide notifications about inventory changes (if supported)	ONF TR-547 [32] ONF TR-548 [33]	TR-547: UC 13a UCs 14b, 15b, 15c TR-548: UCs ST-1.1, ST-1.2 UCs ST-3.1, ST-2.1 UC ST-5.1 UCs ST-5.2, ST-5.3	ONF TR-547 [32]: 1) Physical inventory: The present version of ONF TR-547 [32] does not define use cases for subscriptions related to the physical inventory. 2) Logical inventory: Notifications related to changes to the service instances (see also domain orchestration service) can be delivered using the generic notification mechanism defined in UC 13a. The notifications relate to insertion / removal of connectivity objects aka services (UC 14b), status changes of these (15 b) or switching condition of these (15c). To receive notifications, a prior subscription based on UC 13a is required. ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. For some cases, ONF TR-548 [33] defines concrete informative use cases how to provide streams of such changes: UC ST-5.2 relates to changes triggered by the execution of provisioning use cases (UCs 1x, 2x, 3x) and UC ST-5.3 relates to changes triggered by the deletion Use Case (UC 10). This assumes the prior set-up of the streams by the producer as per UC ST-5.1, the consumer executing UC ST-3.1 to set up / manage the reception of the streams and UC ST-2.1 to align with the streams, and the producer executing UCs ST-1.1 and ST-1.2 to manage the production of the streams.

Domain orchestration: Domain topology information service			
Query topology information (if exposed)	ONF TR-547 [32]	UCs 0a, 0b, 0d	The TAPI topology describes nodes and links. The nodes are logical entities providing switching capabilities and typically cover multiple layer-networks. The links describe how nodes are connected at a given layer network. A link in a layer network is supported by a connection in the next lower layer network. Provisioning a connectivity service leads to the creation of a connection. The following use cases allow together the discovery of topology: UC 0a (Context & Service Interface Points discovery), UC 0b (Topology discovery) and UC 0d (Multi-domain OTN interdomain links discovery). The discovered topology can be mapped to the logical inventory discovered in UC 0c.
Configure notifications (if supported)	ONF TR-547 [32] ONF TR-548 [33]	TR-547: UC 13a UCs 14a, 15a TR-548: UCs ST-0.2, ST-5.1	ONF TR-547 [32]: UC 13a defines the general procedure for subscription to notifications. The use cases 14a and 15a define parameters for the specific subscriptions. ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. The definitions in the informative UC ST-5.1 also apply for changes to the topology. Streams can be discovered and selected by the service consumer as per UC ST-0.2.

Provide notifications about topology changes (if supported)	ONF TR-547 [32] ONF TR-548 [33]	TR-547: UC 13a UCs 14a, 15a TR-548: UCs ST-1.1, ST-1.2 UCs ST-3.1, ST-2.1 UC ST-5.1 UCs ST-5.2, ST-5.3	ONF TR-547 [32]: To receive notifications, a prior subscription based on UC 13a is required. UC 13a also defines the procedure for notifications delivery. The notifications relate to insertion / removal of topology objects (UC 14a) or status changes of these (15a). ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. For some cases, ONF TR-548 [33] defines concrete informative use cases how to provide streams of such changes: UC ST-5.2 relates to changes triggered by the execution of provisioning use cases (UCs 1x, 2x, 3x) and UC ST-5.3 relates to changes triggered by the deletion Use Case (UC 10). This assumes the prior set-up of the streams by the producer as per UC ST-5.1, the consumer executing UC ST-3.1 to set up / manage the reception of the streams and UC ST-2.1 to align with the streams, and the producer executing UCs ST-1.1 and ST-1.2 to manage the production of the streams.
Domain control: Virtualised resource lifecycle management service			
Manage subscription to lifecycle changes (if exposed)	n/a		
Provide notifications about lifecycle changes (if exposed)	n/a		
Domain data collection: Performance events service			
Configure monitoring	ONF TR-547 [32] ONF TR-548 [33]	TR-547 [32] UCs 13a, 13c TR-548 [33] see definition of fault events service	UC 13a defines the general procedure for subscription to notifications. ONF TR-547 [32]: UC13c defines parameters for the subscription to threshold crossing alerts. The present version of TAPI does not define how to configure the actual thresholds. These additional use cases will be available in the next version of ONF TR-547 [32]. ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. It supports the streaming of threshold crossing notifications as alarms (see the definition of alarm streaming in the fault events service).

Provide notifications	ONF TR-547 [32] ONF TR-548 [33]	TR-547 [32] UCs 13a, 13c UC 16b TR-548 [33] see definition of fault events service	ONF TR-547 [32]: To receive notifications, a prior subscription based on UC 13a / UC 13c is required. UC 13a also defines the procedure for notifications delivery. UC 16b defines notifications for threshold crossing alerts without specifying the actual thresholds. In other words, the PM metrics and their threshold values are not configurable in the present TAPI version, while the threshold crossing notification parameters can include the PM metric and its value, which crossed the threshold configured outside TAPI. ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. It supports the streaming of threshold crossing notifications as alarms (see the definition of alarm streaming in the fault events service).
Domain data collection: Performance measurements streaming service			
Configure measurements	n/a		
Provide streaming measurements	n/a		The present version of TAPI does not define measurements streaming but mentions live measurements and periodic measurements as future work in clauses 3.9.2.4 and 3.9.2.6 of ONF TR-548 [33].
Domain data collection: Performance measurements collection service			
Configure batch measurements	n/a		Use case mappings for performance data collection are not defined in the present version of TAPI but will be available in the next version of ONF TR-547 [32].
Provide batch availability notifications	n/a		The present version of TAPI does not define streaming of bulk measurements but mentions it as future work in clause 3.9.2.7 of ONF TR-548 [33].
Get batch measurements	TAPI SDK [34]		Performance data are represented as nodes embedded in the TAPI YANG models [34]. Use case mappings for performance data collection are not defined in the present version of TAPI but will be available in the next version of ONF TR-547 [32].
Domain data collection: Fault events service			
Configure monitoring	ONF TR-547 [32] ONF TR-548 [33]	TR-547: UCs 13a, 13b TR-548: UCs ST-0.2, ST-5.1	ONF TR-547 [32]: UC 13a defines the general procedure for subscription to notifications. UC13b defines parameters for the subscription to alarm event notifications.

			ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. It allows the management service producer to publish streams of alarms as per informative UC ST-5.1. These can be discovered and selected by the service consumer as per UC ST-0.2.
Provide notifications	ONF TR-547 [32] ONF TR-548 [33]	TR-547: UC 16a TR-548: UCs ST-3.2, ST-2.1 UC ST-5.1 UCs ST-1.1, ST-1.2	ONF TR-547 [32]: To receive notifications, a prior subscription based on UC 13a / UC13b is required. UC 13a also defines the procedure for notifications delivery. UC 16a defines notifications for alarm events. ONF TR-548 [33]: This specification defines optional mechanisms in TAPI which allow the management service producers to publish streams of any kind of changes related to the network state. It defines in informative use case ST-3.2 how to provide streams of alarms. This assumes the prior set-up of the streams by the producer as per UC ST-5.1, the consumer executing UC 3.2 to set up / manage the reception of the alarm streams and UC ST-2.1 to align with the streams, and the producer executing UCs ST-1.1 and ST-1.2 to manage the production of the streams.
Domain data collection: Security events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Log collection service (if exposed)			
Query logs	n/a		
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	n/a		
Request analysis result	n/a		
Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service (optional)			
Query data	n/a		
Store data	n/a		

6.4.4 Transport domain based on Layer 2 / Layer 3 VPNs

The work done around L2 and L3 services within IETF is under the scope of the Operations and Management Area Working Group.

For L2 VPNs, there are two main models: L2VPN Service Model (L2SM) and Layer 2 Virtual Private Network (L2VPN) services. IETF RFC 8466 [42] defines an L2VPN Service Model (L2SM) YANG data model that can be used between customers and service providers for ordering Layer 2 Virtual Private Network (L2VPN) services. L2NM (draft-ietf-opsawg-l2nm [i.15]) complements the L2SM by creating a network-centric view of the service.

For L3 VPNs, there are also two main models: L3VPN Service Model (L3SM) and Layer 3 Virtual Private Network (L3VPN) services. IETF RFC 8299 [39] defines an L3VPN Service Model (L3SM) YANG data model that can be used between customers and service providers for ordering Layer 3 Virtual Private Network (L3VPN) services. L3NM (IETF RFC 9182 [49]) complements the L3SM by creating a network-centric view of the service.

The "Operation" entries in table 6.4.4-1 assume that the RESTCONF protocol (see IETF RFC 8040 [38]) is used. The path and JSON payload of the operation depend on the actual YANG model.

Table 6.4.4-1: Mapping of ZSM MnSs and IETF management interfaces for Layer 2 / Layer 3 VPNs

Referenced ZSM MnS + capability	Spec ref	External organizations' APIs / operations	Description / comment
Domain orchestration: Managed services catalogue management service			
Manage service models	n/a		
Provide catalogue change notifications	n/a		
Request missing service catalogue entry	n/a		
Domain orchestration: Feasibility check service			
Check deployment feasibility	n/a		
Check and reserve (if supported)	n/a		
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	draft-ietf-opsawg-l2nm [i.15] IETF RFC 8466 [42] IETF RFC 9182 [49] IETF RFC 8299 [39]	Operation: POST Data models: L2NM: ietf-l2vpn-ntw [i.15] L2SM: ietf-l2vpn-svc [42] L3NM: ietf-l3vpn-ntw [49] L3SM: ietf-l3vpn-svc [39]	These models enable the instantiation of L2NM, L2SM, L3NM or L3SM services. Status fields allow to check the administrative and operational status of the service to validate if the service was created and what is its status.
Manage service lifecycle (scale service)	draft-ietf-opsawg-l2nm [i.15] IETF RFC 8466 [42] IETF RFC 9182 [49] IETF RFC 8299 [39]	Operation: PATCH Data models: L2NM: ietf-l2vpn-ntw [i.15] L2SM: ietf-l2vpn-svc [42] L3NM: ietf-l3vpn-ntw [49] L3SM: ietf-l3vpn-svc [39]	Svc-bandwidth, svc-pe-to-ce-bandwidth and svc-ce-to-pe-bandwidth allow the definition of the bandwidth in L2NM or L2SM services. Svc-output-bandwidth, svc-input-bandwidth, svc-pe-to-ce-bandwidth and svc-ce-to-pe-bandwidth allow the definition of the bandwidth in L3NM or L3SM services.
Manage service lifecycle (configure service)	draft-ietf-opsawg-l2nm [i.15] IETF RFC 8466 [42] IETF RFC 9182 [49] IETF RFC 8299 [39]	Operation: PATCH Data models: L2NM: ietf-l2vpn-ntw [i.15] L2SM: ietf-l2vpn-svc [42] L3NM: ietf-l3vpn-ntw [49] L3SM: ietf-l3vpn-svc [39]	

Manage service lifecycle (activate service)	draft-ietf-opsawg-l2nm [i.15] IETF RFC 9182 [49]	Operation: PATCH Data models: L2NM: ietf-l2vpn-ntw [i.15] L3NM: ietf-l3vpn-ntw [49]	The admin-status parameter allows to activate the service.
Manage service lifecycle (deactivate service)	draft-ietf-opsawg-l2nm [i.15]	Operation: PATCH Data models: L2NM: ietf-l2vpn-ntw [i.15] L3NM: ietf-l3vpn-ntw [49]	The admin-status parameter allows to deactivate the service.
Manage service lifecycle (terminate service)	draft-ietf-opsawg-l2nm [i.15] IETF RFC 8466 [42] IETF RFC 9182 [49] IETF RFC 8299 [39]	Operation: DELETE Data models: L2NM: ietf-l2vpn-ntw [i.15] L2SM: ietf-l2vpn-svc [42] L3NM: ietf-l3vpn-ntw [49] L3SM: ietf-l3vpn-svc [39]	
Execute workflow	n/a		
Manage subscriptions to lifecycle changes (if exposed)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45] draft-ietf-opsawg-l2nm [i.15] IETF RFC 8466 [42] IETF RFC 9182 [49] IETF RFC 8299 [39]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44] Data models for subscribed content: L2NM: ietf-l2vpn-ntw [i.15] L2SM: ietf-l2vpn-svc [42] L3NM: ietf-l3vpn-ntw [49] L3SM: ietf-l3vpn-svc [39]	The details of subscribe / notify are described in clause 6.4.1. Subscription to change notifications related to network resources and services will allow to receive notifications about new / modified / removed service instances and resources.
Provide notifications about lifecycle changes	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription.
Domain orchestration: Testing service			
Manage test specifications	n/a		
Test resources	n/a		
Query tests	n/a		

Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	draft-ietf-opsawg-l2nm [i.15] IETF RFC 8466 [42] IETF RFC 9182 [49] IETF RFC 8299 [39]	Operation: GET Data models: L2NM: ietf-l2vpn-ntw [i.15] L2SM: ietf-l2vpn-svc [42] L3NM: ietf-l3vpn-ntw [49] L3SM: ietf-l3vpn-svc [39]	Information about the service instances can be obtained using the GET method.
Configure notifications (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45] draft-ietf-opsawg-l2nm [i.15] IETF RFC 8466 [42] IETF RFC 9182 [49] IETF RFC 8299 [39]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44] Data models for subscribed content: L2NM: ietf-l2vpn-ntw [i.15] L2SM: ietf-l2vpn-svc [42] L3NM: ietf-l3vpn-ntw [49] L3SM: ietf-l3vpn-svc [39]	The details of subscribe / notify are described in clause 6.4.1. Subscription to change notifications related to network resources and services will allow to receive notifications about new / modified / removed service instances and resources.
Provide notifications about inventory changes (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription.
Domain orchestration: Domain topology information service			
Query topology information (if exposed)	IETF RFC 8944 [47] IETF RFC 8346 [41] draft-ietf-opsawg-sap [i.16]	Operation: GET Data models: ietf-l2-topology [47] ietf-l3-unicast-topology [41] ietf-sap-ntw [i.16]	IETF RFC 8944 [47] defines a data model for Layer 2 network topologies. IETF RFC 8346 [41] defines a data model for Layer 3 network topologies. Draft-ietf-opsawg-sap [i.16] defines the Service Attachment Points that are the network reference points to network services (L2SM, L2NM, L3SM, L3NM).
Configure notifications (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45] IETF RFC 8944 [47] IETF RFC 8346 [41] draft-ietf-opsawg-sap [i.16]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44] Data models for subscribed content: ietf-l2-topology [47] ietf-l3-unicast-topology [41] ietf-sap-ntw [i.16]	The details of subscribe / notify are described in clause 6.4.1. Subscriptions to change notifications related to topology data stores will allow to receive notifications about topology changes.

Provide notifications about topology changes (if supported)	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription creation.
Domain control: Virtualised resource lifecycle management service			
Manage subscription to lifecycle changes (if exposed)	n/a		
Provide notifications about lifecycle changes (if exposed)	n/a		
Domain data collection: Performance events service			
Configure monitoring	n/a		IETF RFC 8641 [44] only supports periodic and change notifications, but no threshold crossing notifications.
Provide notifications	n/a		
Domain data collection: Performance measurements streaming service			
Configure measurements	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45] draft-ietf-opsawg-yang-vpn-service-pm [i.17]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44] Data models for subscribed content: ietf-network-vpn-pm [i.17]	Draft-ietf-opsawg-yang-vpn-service-pm [i.17] defines a model for Performance Monitoring (PM) of both networks and VPN services that can be used to monitor and manage network performance on the topology at higher layer or the service topology between VPN sites. The details of subscribe / notify are described in clause 6.4.1. Subscriptions to periodic notifications related to the PM model elements in [i.17] will allow to receive at regular intervals notifications that carry the current values of a set of performance metrics selected at the time of subscription.
Provide streaming measurements	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription.
Domain data collection: Performance measurements collection service			
Configure batch measurements	n/a		

Provide batch availability notifications	n/a		
Get batch measurements	draft-ietf-opsawg-yang-vpn-service-pm [i.17]	Operation: GET Data model: ietf-network-vpn-pm [i.17]	IETF does not provide a mechanism for batch measurement collection. However, the current value of all PM metrics defined in [i.17] can be fetched at any time.
Domain data collection: Fault events service			
Configure monitoring	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45] IETF RFC 8466 [42]	Operation: POST / PATCH / DELETE Data models for subscription: ietf-subscribed-notifications [43] ietf-yang-push [44] Data models for subscribed content: L2SM: ietf-l2vpn-svc	IETF RFC 8466 [42] defines an object called "fault-alarm-defect-type" to monitor the errors in the Layer 2 VPN. For Layer 3 VPNs, no alarm mechanism has been defined. The details of subscribe / notify are described in clause 6.4.1. Subscriptions to change notifications related to the "fault-alarm-defect-type" object allow to receive alarm-related notifications.
Provide notifications	IETF RFC 8639 [43] IETF RFC 8641 [44] IETF RFC 8650 [45]	Operation: GET	The details of subscribe / notify are described in clause 6.4.1. IETF RFC 8650 [45] defines how notifications related to a subscription can be obtained using GET from a stream resource with an address that has been provided by the service producer upon subscription creation.
Domain data collection: Security events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Log collection service (if exposed)			
Query logs	n/a		
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	n/a		
Request analysis result	n/a		
Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service (optional)			
Query data	n/a		
Store data	n/a		

6.4.5 Transport slices

The present clause describes the IETF approach of integrating the management of transport slices (also known as IETF network slices) with E2E-level management entities. Transport slices are integrated with other network domains, based data models specified by the IETF. The protocols that work on data instances based on the model are typically not tightly specified.

With the increase of dynamism and complexity introduced into transport by network slice management, standards are being under development in the IETF to manage transport slices (called "IETF network slices") using interfaces defined in draft-ietf-teas-ietf-network-slices [i.6]. IETF is defining the NSC-NBI, a north-bound interface exposed by the IETF Network Slice Controller (NSC) towards E2E management entities such as the ZSM E2E service management domain. That interface allows to request and monitor IETF Network Slices. IETF is taking a model-driven approach (see draft-ietf-teas-ietf-network-slice-nbi-yang [i.7]) for that interface relying on YANG ([35] and [37]) where the data model for the domain NBI is specified. The protocol used to communicate the data structures is left unspecified, but some possible protocols including NETCONF [36], RESTCONF [38] and gRPC [i.5] / gNMI [i.4] are mentioned.

The main focus in the model is on the orchestration (create, read, update, delete) of IETF slices based on the instances of the IETF slice data model in [i.7] and on monitoring of a limited set of performance measurements. The monitoring of changes to nodes in the model is implementation specific.

Table 6.4.5-1: Mapping of ZSM MnSs and IETF management interfaces for transport slices

Referenced ZSMMnS + capability	Spec ref	External organizations' APIs / operations	Description / comment
Domain orchestration: Managed services catalogue management service			
Manage service models	n/a		
Provide catalogue change notifications	n/a		
Request missing service catalogue entry	n/a		
Domain orchestration: Feasibility check service			
Check deployment feasibility	n/a		Support for feasibility check is not defined in [i.6] but listed as an open issue.
Check and reserve (if supported)	n/a		
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Creation of a model node	Creation of a new transport slice node according to the defined data model instantiates a new IETF slice service instance. The protocol used for this request is unspecified.
Manage service lifecycle (scale service)	n/a		
Manage service lifecycle (configure service)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Update of a model node	Updating of a transport slice node according to the defined data model configures an IETF slice service instance. The protocol used for this request is unspecified.
Manage service lifecycle (activate service)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Update of the "admin-enabled" property of a model node	Setting the "admin-enabled" property of a transport slice node to "true" activates an IETF slice service instance. The protocol used for this request is unspecified.
Manage service lifecycle (deactivate service)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Update of the "admin-enabled" property of a model node	Setting the "admin-enabled" property of a transport slice node to "false" deactivates an IETF slice service instance. The protocol used for this request is unspecified.
Manage service lifecycle (terminate service)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Deletion of a model node	Deletion of a transport slice node according to the defined data model terminates an IETF slice service instance. The protocol used for this request is unspecified.
Execute workflow	n/a		
Manage subscriptions to lifecycle changes (if exposed)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Subscribe model changes	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can subscribe to notifications related to the content of model nodes that represent transport slice instances. See note.

Provide notifications about lifecycle changes	draft-teas-ietf-network-slice-nbi-yang [i.7]	Notify model changes	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can receive notifications related to the content of model nodes. See note. Receiving notifications requires a prior subscription.
Domain orchestration: Testing service			
Manage test specifications	n/a		
Test resources	n/a		
Query tests	n/a		
Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Query the model	Querying the content of nodes in the data model that represent transport slices, including "network-slice" nodes. The protocol used for querying is unspecified.
Configure notifications (if supported)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Subscribe model changes	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can subscribe to notifications related to the content of model nodes that represent transport slices, including "network-slice" nodes. See note.
Provide notifications about inventory changes (if supported)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Notify model changes	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can receive notifications related to the change of model nodes that represent transport slices, including "network-slice" nodes. See note. Receiving notifications requires a prior subscription.
Domain orchestration: Domain topology information service			
Query topology information (if exposed)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Query the model	Querying the content of nodes in the data model that represent transport slice topology, including "ns-endpoint" and "ns-connection" nodes. The protocol used for querying is unspecified.
Configure notifications (if supported)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Subscribe model changes	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can subscribe to notifications related to the content of model nodes that represent transport slice topology, including "ns-endpoint" and "ns-connection" nodes. See note.
Provide notifications about topology changes (if supported)	draft-teas-ietf-network-slice-nbi-yang [i.7]	Notify model changes	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can receive notifications related to the change of model nodes that represent transport slice topology, including "ns-endpoint" and "ns-connection" nodes. See note. Receiving notifications requires a prior subscription.

Domain control: Virtualised resource lifecycle management service			
Manage subscription to lifecycle changes (if exposed)	n/a		
Provide notifications about lifecycle changes (if exposed)	n/a		
Domain data collection: Performance events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Performance measurements streaming service			
Configure measurements	draft-teas-ietf-network-slice-nbi-yang [i.7]	Subscribe model content	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can subscribe to notifications related to the content of model nodes that represent monitored performance measurements. See note.
Provide streaming measurements	draft-teas-ietf-network-slice-nbi-yang [i.7]	Notify model content	Using a protocol that is not specified in draft-ietf-teas-ietf-network-slices [i.6] and optional to implement, the E2E service management domain can receive notifications related to the content of model nodes that represent monitored performance measurements. Receiving streaming measurements requires a prior subscription.
Domain data collection: Performance measurements collection service			
Configure batch measurements	n/a		
Provide batch availability notifications	n/a		
Get batch measurements	n/a		
Domain data collection: Fault events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Security events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Log collection service (if exposed)			
Query logs	n/a		
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	n/a		
Request analysis result	n/a		
Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service			
Query data	n/a		
Store data	n/a		
NOTE: By design the model can support subscriptions and notifications related to the content of every model node.			

6.5 Cloud domain

Table 6.5-1: Mapping of ZSM MnSs and NFV MANO interfaces in Cloud domain

Referenced ZSMMnS + capability	Spec ref	External organizations' APIs / operations	Description / comment
Domain orchestration: Managed services catalogue management service			
Manage service models	ETSI GS NFV-IFA 013 [3]	Query NSD Info Upload NSD Query VNF Package Info Upload VNF Package Query PNFD Info Upload PNFD	
Provide catalogue change notifications	ETSI GS NFV-IFA 013 [3]	NsdOnBoardingNotification NsdChangeNotification NsdDeletionNotification PnfdOnBoardingNotification PnfdDeletionNotification VnfPackageOnBoardingNotification VnfPackageChangeNotification	Subscriptions are needed to receive notifications. "NsdOnBoardingNotification", "PnfdOnBoardingNotification" and "VnfPackageOn-BoardingNotification" provide information related to a PNFD / NSD / VNF package that has been onboarded. "NsdChangeNotification" and "Vnf-PackageChangeNotification" provide information about changes to an NSD or VNF Package, or the deletion of a VNF package. "PnfdDeletionNotification" and "NsdDeletionNotification" provide information about the deletion of an NSD or PNFD Package.
Request missing service catalogue entry	n/a		
Domain orchestration: Feasibility check service			
Check deployment feasibility	ETSI GS NFV-IFA 013 [3]	Create NS Identifier Instantiate NS	When feasibility check is performed, Instantiate NS uses the ID of a (temporary) NS instance created by Create NS Identifier, so Instantiate NS is used with Create NS Identifier. Instantiate NS allows to request a feasibility check with or without reservation.
Check and reserve (if supported)	ETSI GS NFV-IFA 013 [3]	Create NS Identifier Instantiate NS	
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	ETSI GS NFV-IFA 013 [3]	Instantiate NS	
Manage service lifecycle (scale service)	ETSI GS NFV-IFA 013 [3]	Scale NS Update NS	Even though Update NS can also be used for NS scaling, the use of Scale NS is preferred for that purpose.
Manage service lifecycle (configure service)	ETSI GS NFV-IFA 013 [3]	Update NS	
Manage service lifecycle (activate service)	n/a		
Manage service lifecycle (deactivate service)	n/a		

Manage service lifecycle (terminate service)	ETSI GS NFV-IFA 013 [3]	Terminate NS	
Execute workflow	ETSI GS NFV-IFA 013 [3]	Scale NS Update NS Heal NS	
Manage subscriptions to lifecycle changes (if exposed)	ETSI GS NFV-IFA 013 [3]	Subscribe (NS LCM interface) Terminate subscription (NS LCM interface)	
Provide notifications about lifecycle changes	ETSI GS NFV-IFA 013 [3]	NsLcmOperationOccurrenceNotification	Subscriptions are needed to receive notifications. "NsLcmOperationOccurrenceNotification" provides information about an NS LCM operation and the changes it has performed on the NS instance.
Domain orchestration: Testing service			
Manage test specifications	n/a		
Test resources	n/a		
Query tests	n/a		
Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	ETSI GS NFV-IFA 013 [3]	Query NS Get Operation Status	"Query NS" allows to read information related to the current inventory. "Get Operation Status" allows to read inventory changes by an operation.
Configure notifications (if supported)	ETSI GS NFV-IFA 013 [3]	Subscribe (NS LCM interface) Terminate subscription (NS LCM interface)	
Provide notifications about inventory changes (if supported)	ETSI GS NFV-IFA 013 [3]	NsLcmOperationOccurrenceNotification	Subscriptions are needed to receive notifications. "NsLcmOperationOccurrenceNotification" provides information of inventory changes performed by a finished NS LCM operation.
Domain orchestration: Domain topology information service			
Query topology information (if exposed)	ETSI GS NFV-IFA 013 [3]	Query NS Get Operation Status	"Query NS" allows to read information related to the current topology. "Get Operation Status" allows to read topology changes performed by an operation.
Configure notifications (if supported)	ETSI GS NFV-IFA 013 [3]	Subscribe (NS LCM interface) Terminate subscription (NS LCM interface)	
Provide notifications about topology changes (if supported)	ETSI GS NFV-IFA 013 [3]	NsLcmOperationOccurrenceNotification	Subscriptions are needed to receive notifications. "NsLcmOperationOccurrenceNotification" provides information of topology changes performed by a finished NS LCM operation.

Domain control: Virtualised resource lifecycle management service			
Manage subscription to lifecycle changes (if exposed)	ETSI GS NFV-IFA 013 [3]	Subscribe (NS LCM interface) Terminate subscription (NS LCM interface)	
Provide notifications about lifecycle changes (if exposed)	ETSI GS NFV-IFA 013 [3]	NsLcmOperationOccurrenceNotification NsChangeNotification	Subscriptions are needed to receive notifications. "NsLcmOperationOccurrenceNotification" provides information about an NS LCM operation and the changes it has performed on the NS instance. "NsChangeNotification" provides information that a component of an NS instance (VNF instance, PNF instance, nested NS instance) is being changed or has been changed.
Domain data collection: Performance events service			
Configure monitoring	ETSI GS NFV-IFA 013 [3]	Create Threshold Subscribe (PM interface) Terminate subscription (PM interface) Delete Threshold	
Provide notifications	ETSI GS NFV-IFA 013 [3]	ThresholdCrossedNotification	Subscriptions are needed to receive notifications. "ThresholdCrossedNotification" provides information that a performance measurement has crossed a threshold.
Domain data collection: Performance measurements streaming service			
Configure measurements	n/a		
Provide streaming measurements	n/a		
Domain data collection: Performance measurements collection service			
Configure batch measurements	ETSI GS NFV-IFA 013 [3]	Create PM Job Subscribe (PM interface) Terminate subscription (PM interface) Delete PM Job	
Provide batch availability notifications	ETSI GS NFV-IFA 013 [3]	PerformanceInformationAvailableNotification	Subscriptions are needed to receive notifications. "PerformanceInformationAvailableNotification" provides information that a new batch of collected performance information is available and how it can be retrieved.

Get batch measurements	ETSI GS NFV-SOL 005 [5]	PerformanceReport	ETSI GS NFV-IFA 013 [3] does not define the delivery of the performance report. That can be mapped with the GET operation on the "Individual performance report" resource as defined in the stage 3 (see clause 7.4.4 of ETSI GS NFV-SOL 005 [5])
Domain data collection: Fault events service			
Configure monitoring	ETSI GS NFV-IFA 013 [3]	Subscribe (FM interface) Terminate subscription (FM interface)	
Provide notifications	ETSI GS NFV-IFA 013 [3]	AlarmNotification	Subscriptions are needed to receive notifications. "AlarmNotification" provides information related to an alarm.
Domain data collection: Security events service			
Configure monitoring	n/a		
Provide notifications	n/a		
Domain data collection: Log collection service (if exposed)			
Query logs	ETSI GS NFV-IFA 031 [4]	Service capability not mappable	ETSI GS NFV-IFA 031 [4] supports log collection, but it does not allow to retroactively query logs. Instead, it is assumed that log collection is requested by the service consumer in a subscribe / notify pattern. This means that if the E2E service management domain is interested in obtaining logging information, it needs to set up log collection jobs during service assurance set-up, and proactively receive and store log information once it is notified.
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	n/a		
Request analysis result	n/a		
Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service (optional)			
Query data	n/a		
Store data	n/a		

7 Gaps and commonalities

Table 7-1 provides a comparison of the different management domain NBIs, plus the TMF mapping, with respect to the supported ZSM services / ZSM service capabilities. The entry "x" means the capability is supported, "-" means the capability is not supported, and a number in parentheses means the capability is partially supported and details are given in a note. The reader is reminded that this overview relates to management services that are exposed at the NBI of the management domains towards the E2E service management domain. Absence of an MnS from this overview does not necessarily mean that the related functionality is not available inside the domain, only that it is not exposed at the NBI.

Service catalogue management is supported in NFV, TMF and Fixed access which is derived from TMF. 3GPP and Transport domains do not support it. In transport, the set of possible services is very limited; therefore, it is typically "hardcoded" in the model itself.

Feasibility checking is enabled in NFV, TMF and Fixed access which is derived from TMF.

All types of management domains support the *domain orchestration* service, with the minimum set of creating and terminating service instances supported in TAPI, and a larger variety of functionality supported in the other domain types.

Service testing is only supported by TMF and Fixed access which is derived from TMF.

Obtaining *inventory* information is supported by all types of management domains. Obtaining *topology* information is also widely supported, with the exception of TMF.

Virtualised resources lifecycle management is supported in NFV, in 3GPP and Fixed access which refer to NFV, and in TMF (for any kind of resources).

For *performance management* the landscape is diverse. In most transport domain NBIs, basic support is available to read performance information and to stream the values of performance measurements. The most complete PM support is available in 3GPP, NFV and TMF support a subset. Fixed access and IETF-based OTN currently have no NBI support for PM.

Fault management is also supported only in a subset of the domain NBIs, namely 3GPP, ONF-based OTNs, NFV and TMF. L2 transport networks support FM in the NBI, but not L3 transport networks, IETF-based OTNs, transport slices and Fixed access networks. In some domain types, security evets are supported that are reported using the same mechanisms as reporting faults.

Log collection is not supported by standardized MnSs at the NBI, with the exception of some rudimentary support in NFV. In current deployments, logging is the domain of software solutions rather than standards.

The *management of service health issues* is not supported in any of the NBIs analysed. This can be seen as an automation-specific evolution of fault management.

Analytics is an area of ongoing standardization activities. First results of these activities are available in 3GPP.

The *integration fabric* services are strictly speaking not part of the domain NBIs but they allow the cross-domain service communication and integration. De-facto software solutions dominate in this field, such as messaging frameworks and service meshes. The same applies to the *data persistence* service. Different kinds of open-source databases optimized for different use cases such as big data and time series are used in deployments to persist data of different types.

Some of the gaps are in the process of being filled by work in progress in the different SDOs.

Table 7-1: Comparison of the services and capabilities provided by the different domain NBIs

Group	Service	Capability	3GPP (6.2)	Fixed (6.3)	Transport (6.4)				NFV (6.5)	TMF (B.1)
					OTN IETF	OTN ONF	L2 / L3 VPN	T-Slices		
Domain Orchestration	Managed services catalogue management service	Manage service models	-	x	-	(3)	-	-	x	x
		Provide catalogue change notifications	-	x	-	-	-	-	x	x
		Request missing service catalogue entry	-	-	-	-	-	-	-	-
	Feasibility check service	Check deployment feasibility	(1)	x	x	-	-	-	x	x
		Check and reserve (if supported)	(1)	-	-	-	-	-	x	-
	Domain orchestration service	Manage service lifecycle (instantiate)	x	x	x	x	x	x	x	x
		Manage service lifecycle (scale)	x	-	x	-	x	-	x	x
		Manage service lifecycle (configure)	x	x	x	-	x	x	x	x
		Manage service lifecycle (activate)	x	x	x	(4)	x	x	-	x
		Manage service lifecycle (deactivate)	x	x	x	(4)	x	x	-	x
		Manage service lifecycle (terminate)	x	x	x	x	x	x	x	x
		Execute workflow	-	-	-	-	-	-	x	(9)
		Manage subscriptions to lifecycle changes	x	x	x	x	x	x	x	x
		Provide notifications about lifecycle changes	x	x	x	x	x	x	x	x
	Testing service	Manage test specifications	-	x	-	-	-	-	-	x
		Test resources	-	x	-	-	-	-	-	x
		Query tests	-	x	-	-	-	-	-	x
	Domain inventory information service	Query inventory of available resources	x	x	x	x	x	x	x	x
		Configure notifications	x	x	x	x	x	x	x	x
		Provide notifications about inventory changes	x	x	x	x	x	x	x	x
	Domain topology information service	Query topology information	x	x	x	x	x	x	x	-
		Configure notifications	x	x	x	x	x	x	x	-
		Provide notifications about topology changes	x	x	x	x	x	x	x	-

Group	Service	Capability	3GPP (6.2)	Fixed (6.3)	Transport (6.4)				NFV (6.5)	TMF B.1)
					OTN IETF	OTN ONF	L2 / L3 VPN	T-Slices		
Domain Control	Virtualised resource lifecycle management service	Manage subscriptions to lifecycle changes	x	x	-	-	-	-	x	x
		Provide notifications about lifecycle changes	x	x	-	-	-	-	x	x
Domain Data Collection	Performance events service	Configure monitoring	x	-	-	x	-	-	x	x
		Provide notifications	x	-	-	x	-	-	x	x
	Performance measurements streaming service	Configure measurements	x	-	-	-	x	x	-	-
		Provide streaming measurements	x	-	-	-	x	x	-	-
	Performance measurements collection service	Configure batch measurements	x	-	-	-	-	-	x	x
		Provide batch availability notifications	x	-	-	-	-	-	x	x
		Get batch measurements	x	-	-	(5)	(6)	-	x	x
	Fault events service	Configure monitoring	x	-	-	x	(7)	-	x	x
		Provide notifications	x	-	-	x	(7)	-	x	x
	Security events service	Configure monitoring	x	-	-	-	-	-	-	x
		Provide notifications	x	-	-	-	-	-	-	x
	Log collection service	Query logs	-	-	-	-	-	-	(8)	-
Domain Intelligence	Analytics services derived from Generic analytics service	Configure analytics	(2)	-	-	-	-	-	-	-
		Request analysis result	(2)	-	-	-	-	-	-	-
	Health issue reporting service	Configure service	-	-	-	-	-	-	-	-
		Provide health issue notifications	-	-	-	-	-	-	-	-

Group	Service	Capability	3GPP (6.2)	Fixed (6.3)	Transport (6.4)				NFV (6.5)	TMF (B.1)
					OTN IETF	OTN ONF	L2 / L3 VPN	T-Slices		
Integration Fabric	Management communication service	Manage channels	-	-	-	-	-	-	-	-
		Manage subscriptions	-	-	-	-	-	-	-	-
		Receive data	-	-	-	-	-	-	-	-
		Provide data	-	-	-	-	-	-	-	-
	Management services discovery service	Query service list	-	-	-	-	-	-	-	-
		Get service info	-	-	-	-	-	-	-	-
CDS	Data persistence service	Query data	-	-	-	-	-	-	-	-
		Store data	-	-	-	-	-	-	-	-

NOTE 1: A use case and procedure of network slice subnet feasibility check with reservation are defined in clauses 5.1.21 and 7.14 of ETSI TS 128 531 [7]. There is no related management service / API defined yet.
NOTE 2: This is work in progress. 3GPP Rel.17 includes the definition of the Management Data Analytics Service (MDAS). 3GPP TS 28.104 [i.3] defines requirements and the data consumed for performing a set of standardized analytics use cases in the 3GPP management plane. It can import data from the Network Data Analytics Function (NWDAF) (see ETSI TS 123 288 [i.2]) which allows requesting a set of pre-defined analytics for the control plane of the 3GPP Core domain.
NOTE 3: TAPI does not support a service catalogue service. However, the different provisioning use cases defined in sections 6.2 and 6.3 of ONF TR-547 [32] reflect the set of types of managed services that can be instantiated.
NOTE 4: Administrative state is represented in the TAPI YANG models. However, administrative state provisioning is not covered by a use case in the present version of TAPI.
NOTE 5: Performance data are represented as nodes embedded in the TAPI YANG models [34]. Use case mappings for performance data collection are not defined in the present version of TAPI but will be available in the next version of ONF TR-547 [32].
NOTE 6: IETF does not provide a mechanism for batch measurement collection. However, the current value of all PM metrics defined in IETF RFC 9182 [49] can be fetched at any time.
NOTE 7: Only for L2, not for L3.
NOTE 8: ETSI GS NFV-IFA 031 [4] supports log collection, but it does not allow to retroactively query logs. Instead, it is assumed that log collection is requested by the service consumer in a subscribe / notify pattern. This means that if the E2E service management domain is interested in obtaining logging information, it needs to set up log collection jobs during service assurance set-up, and proactively receive and store log information once it is notified.
NOTE 9: With the operation of "Create service order" in TMF641 [26], service order entity which is used to fulfil the workflow execution is created. The "execute workflow" ZSM service capability is applicable during the complete lifecycle of the service instance whereas TMF641 [26] is only applicable during service creation.

Annex A (normative): Management services

A.1 Overview

This annex defines additional management services (see clause A.2) and additional capabilities of management services that were defined in ETSI GS ZSM 002 [1] (see clause A.3).

A.2 Additional services

A.2.1 E2E services topology management service

The E2E services topology management service manages information about the topology of the services managed by the E2E service management domain. This service is provided only to consumers inside the E2E service management domain.

Each change to the topology is triggered as a side effect when the composition of the E2E service management domain is modified.

The service is further detailed in table A.2.1-1.

Table A.2.1-1: Service definition

Service name	E2E services topology management service
External visibility	OPTIONAL
Service capabilities	
Manage topology (M)	Manage (create, read, update, delete) topology information.

A.3 Additional service capabilities

A.3.1 Domain inventory information service

This clause extends the domain inventory information service by additional capabilities.

Table A.3.1-1: Additional capabilities definition

Service name	Domain inventory information service (see clause 6.5.5.2.5 of ETSI GS ZSM 002 [1])
Additional service capabilities	
Configure notifications (C)	Configure, optionally with a filter, when notifications about inventory changes are provided and how they are transmitted. Additionally, it may be possible to select the information to be provided in the notification. See note. Shall be supported if the "Provide notifications about inventory changes" capability is supported.
Provide notifications about inventory changes (O)	Provide notifications about changes to the inventory.
NOTE: If supported, such selection mechanism can be realized at various degrees of flexibility, e.g. selecting from predefined sets of information items, or individually selecting the information items to include.	

A.3.2 Domain topology information service

This clause extends the domain topology information service by additional capabilities.

Table A.3.2-1: Additional capabilities definition

Service name	Domain topology information service (see clause 6.5.5.2.7 of ETSI GS ZSM 002 [**1**])
Additional service capabilities	
Configure notifications (C)	Configure, optionally with a filter, when notifications about topology changes are provided and how they are transmitted. Additionally, it may be possible to select the information to be provided in the notification. See note. Shall be supported if the "Provide notifications about topology changes" capability is supported.
Provide notifications about topology changes (O)	Provide notifications about changes to the topology.
NOTE: If supported, such selection mechanism can be realized at various degrees of flexibility, e.g. selecting from predefined sets of information items, or individually selecting the information items to include.	

A.3.3 Managed services catalogue management service

This clause extends the Managed services catalogue management service in the management domain by additional capabilities.

Table A.3.3-1: Additional capabilities definition

Service name	Managed services catalogue management service (see clause 6.5.5.2.3 of ETSI GS ZSM 002 [1])
Additional service capabilities	
Request missing service catalogue entry (O)	Inform the management domain that a service consumer is intending to consume a particular managed service from it, for which no entry in the service catalogue exists. If the management domain or its owner reacts to this request it is expected that a service catalogue entry related to the managed service mentioned in the request will be made available, and the management domain will be enabled to create instances of that service.

Annex B (informative): Further northbound interfaces

B.1 Domain northbound interfaces specified by TMF Open API

Table B.1-1 shows the lists of interfaces defined by TMF Open API which can fulfil capabilities of ZSM management services in Radio access, Core, Transport and Fixed access management domains involved in executing E2E service lifecycle management procedures defined in clause 5.

Table B.1-1: Mapping of ZSM MnSs and TMF Open API

Referenced ZSMMnS + capability	Spec ref	External organizations' APIs / operations	Description / comment
Domain orchestration: Managed services catalogue management service			
Manage service models	TMF633 [22]	Service Catalog Management API	
Provide catalogue change notifications	TMF633 [22]	Service Catalog Management API	
Request missing service catalogue entry	n/a		
Domain orchestration: Feasibility check service			
Check deployment feasibility	TMF645 [28]	Service Qualification Management API	
Check and reserve	n/a		
Domain orchestration: Domain orchestration service			
Manage service lifecycle (instantiate service)	TMF641 [26] TMF640 [25] TMF638 [23]	Service Ordering Management API Service Activation and Configuration Management API Service Inventory Management API	With the operation of "Create service order" in TMF641, it is possible to create a service order entity. With the "Create Service" in TMF640 or TMF638, it is possible to create a new service instance.
Manage service lifecycle (scale service)	TMF640 [25] TMF638 [23]	Service Activation and Configuration Management API Service Inventory Management API	With the attribute "ServiceCharacteristic" of "Patch Service" in TMF640 or TMF638, it is possible to scale the service instance.
Manage service lifecycle (configure service)	TMF640 [25] TMF638 [23]	Service Activation and Configuration Management API Service Inventory Management API	With the "Patch Service" in TMF640 or TMF638, it is possible to configure the service instance.
Manage service lifecycle (activate service)	TMF640 [25] TMF638 [23]	Service Activation and Configuration Management API Service Inventory Management API	With the "Patch Service" in TMF640 or TMF638, it is possible to activate the service instance.
Manage service lifecycle (deactivate service)	TMF640 [25] TMF638 [23]	Service Activation and Configuration Management API Service Inventory Management API	With the "Patch Service" in TMF640 or TMF638, it is possible to deactivate the service instance.

Manage service lifecycle (terminate service)	TMF640 [25] TMF638 [23]	Service Activation and Configuration Management API Service Inventory Management API	With the "Delete Service" in TMF640 or TMF638, it is possible to terminate the service instance.
Execute workflow	TMF641 [26]	Service Ordering Management API	With the operation of "Create service order" in TMF641, service order entity which is used to fulfill the workflow execution is created. The "execute workflow" ZSM service capability is applicable during the complete lifecycle of the service instance whereas TMF641 is only applicable during service creation.
Manage subscriptions to lifecycle changes (if exposed)	TMF640 [25] TMF638 [23]	Service Activation and Configuration Management API Service Inventory Management API	
Provide notifications about lifecycle changes	TMF640 [25] TMF638 [23]	Service Activation and Configuration Management API Service Inventory Management API	
Domain orchestration: Testing service			
Manage test specifications	TMF653 [29]	Service Test Management API	
Test resources	TMF653 [29]	Service Test Management API	
Query tests	TMF653 [29]	Service Test Management API	
Domain orchestration: Domain inventory information service			
Query inventory of available resources (if exposed)	TMF638 [23]	Service Inventory Management API	
Configure notifications (if supported)	TMF638 [23]	Service Inventory Management API	
Provide notifications about inventory changes (if supported)	TMF638 [23]	Service Inventory Management API	
Domain orchestration: Domain topology information service			
Query topology information (if exposed)	n/a		
Configure notifications (if supported)	n/a		
Provide notifications about topology changes (if supported)	n/a		
Domain control: Virtualised resource lifecycle management service			
Manage subscriptions to lifecycle changes (if exposed)	TMF664 [31]	Resource Function Activation and Configuration API	
Provide notifications about lifecycle changes (if exposed)	TMF664 [31]	Resource Function Activation and Configuration API	
Domain data collection: Performance events service			
Configure monitoring	TMF642 [27] TMF657 [30]	Alarm Management API and Service Quality Management API	TMF657 Service Quality Management API can manage performance threshold as part of service level objective. When quality degradation occurs, it is notified to the consumer by TMF642. Therefore, TMF657 Service Quality Management API and TMF642 Alarm Management API are used together.
Provide notifications	TMF642 [27]	Alarm Management API	
Domain data collection: Performance measurements streaming service			
Configure measurements	n/a		
Provide streaming measurements	n/a		

Domain data collection: Performance measurements collection service			
Configure batch measurements	TMF628 [21]	Performance Management API	
Provide batch availability notifications	TMF628 [21]	Performance Management API	
Get batch measurements	TMF628 [21]	Performance Management API	
Domain data collection: Fault events service			
Configure monitoring	TMF642 [27]	Alarm Management API	
Provide notifications	TMF642 [27]	Alarm Management API	
Domain data collection: Security events service			
Configure monitoring	TMF642 [27]	Alarm Management API	
Provide notifications	TMF642 [27]	Alarm Management API	
Domain data collection: Log collection service (if exposed)			
Query logs	n/a		
Domain analytics: Analytics services derived from Generic analytics service (if exposed)			
Configure analytics	n/a		
Request analysis result	n/a		
Domain intelligence: Health issue reporting service			
Configure service (if exposed)	n/a		
Provide health issue notifications (if exposed)	n/a		
Integration fabric: Management communication service			
Manage channels	n/a		
Manage subscriptions	n/a		
Receive data	n/a		
Provide data	n/a		
Integration fabric: Management services discovery service			
Query service list	n/a		
Get service info	n/a		
Cross-domain data services: Data persistence service (optional)			
Query data	n/a		
Store data	n/a		

Annex C (informative): Change History

Date	Version	Information about changes
2019-10-23	0.1.0	Included contributions: - ZSM(19)000491r3_ZSM008_Description_of_optimization_in_LCM - ZSM(19)000516r1_ZSM008_-_Clause_4__lifecycle_management
2019-12-02	0.1.1	Included contributions: - ZSM(19)000574r2_ZSM008_Proposal_for_Mapping_to_scenarios_and_requirements
2020-01-21	0.1.3	Included contributions: - ZSM(19)000498r4_ZSM008_5_2_Communication_patterns.docx - ZSM(19)000497r3_ZSM008_4_2_Relation_to_other_functions.docx
2020-07-15	0.2.0	Included contributions: - ZSM(20)000158r1_ZSM008__4_1_Introduction_of_lifecycle_management_operations - ZSM(20)000159r1_ZSM008__4_1_Introduction_of_lifecycle_management_operations - ZSM(20)000160_ZSM008__4_1_Introduction_of_lifecycle_management_operations - ZSM(20)000163_ZSM008__4_2_3_Relationship_to_fault_management_functionaliti (EN included in clause 5.3 as the original clause does not exist anymore after restructuring) - ZSM(20)000235r1_ZSM008__Annex_A_Collection_of_ideas_for_ZSM008_topics - ZSM(20)000248r1_ZSM008_ToC_update - ZSM(20)000249r2_ZSM008__4_1_Introduction_of_lifecycle_management_operations - ZSM(20)000250r1_ZSM008__4_1_Introduction_of_lifecycle_management_operations - ZSM(20)000252r2_ZSM008_clause_4_Overview - ZSM(20)000254_ZSM008__4_3_Mapping_to_scenarios_and_requirements - ZSM(20)000272_ZSM008_terminology_fixes_ Editorials: - Aligned the spelling of "cross-domain" and the consistent use of the term "cross-domain service lifecycle management" - Dropped empty annexes and renumbered the remaining ones - Sorted and renumbered the references - Various paragraph formatting alignments.
2020-10-07	0.3.0	Included contributions: - ZSM(20)000280_ZSM008_clause_1_Scope - ZSM(20)000281r2_ZSM008_Onboarding_process - ZSM(20)000282r3_ZSM008_Service_instantiation_process - ZSM(20)000283r2_ZSM008_Service_activation_process - ZSM(20)000284r2_ZSM008_Service_decommisioning_process - ZSM(20)000297r2_ZSM008_Service_deactivation_process - ZSM(20)000298r2_ZSM008_Service_configuration_process - ZSM(20)000334_ZSM008_A_3_Collection_of_ideas - ZSM(20)000335_ZSM008_A_3_Collection_of_ideas - ZSM(20)000344r2_ZSM008_Add_domain_NBIs_in_figure_4_2 - ZSM(20)000372r1_ZSM008_Fulfilment_Overview_subclause Editorials: - Added abbreviation NBI - Consistent use of term "E2E service management domain"
2020-11-23	0.4.0	Included contributions: - ZSM(20)000383r2_ZSM008_Service_inventory - ZSM(20)000400r4_ZSM008_Service_quality_management - ZSM(20)000470_ZSM008_Updates_of_flows - ZSM(20)000472_ZSM008_align_terminology_for_domain_services - ZSM(20)000473r1_ZSM008_Moving_onboarding Editorials: - Aligned figure numbering

Date	Version	Information about changes
2021-01-22	0.5.0	Included contributions: - ZSM(20)000382r4_ZSM008_Service_problem_management - ZSM(20)000474r5_ZSM008_change_of_Fig_4-1_Management_processes_and_related_te - ZSM(20)000493r2_ZSM008_Service_assurance_tear-down - ZSM(20)000516r2_ZSM008_proposal_for_Clause_6_format_and_Annex - ZSM(21)000032r2_ZSM008_Include_Mgmt_Service_Groups Editorials: - Numbering, references, typos. - Removed duplicated paragraphs in clause 5.1.
2021-02-08	0.5.1	Included contributions: - ZSM(21)000008r2_ZSM008_revised_service_deactivation_procedure - ZSM(21)000041r1_ZSM008_applying_pattern_from_contribution_00032r2 Editorials: - Fixing Symbols and Terms clauses (clause 3) - Replacing "NOT … nor" by "neither … nor" (clause 4) - Fixing commas
2021-03-30	0.6.0	Included contributions: - ZSM(21)000106_ZSM008_Rapporteur_s_clean-up_of_V_0_5_1 - ZSM(21)000040r1_ZSM008_service_producer-initiated_assurance_procedures_align.docx Editorials: - consistent formatting and use of plural in Preconditions / Postconditions
2021-04-19	0.6.5	Included contributions: - ZSM(21)000037r1_ZSM008_removal_of_ENs - ZSM(21)000105r1_ZSM008_inventory_alignment - ZSM(21)000116r2_ZSM008_Add_mapping_to_clause_6_based_on_5_4_3_2_and_5_4_4_2 - ZSM(21)000137r1_ZSM008_addressing_EN_regarding_assurance_set-up_tear-down_on ZSM(21)000144r1_ZSM008_clause_6_update_template_with_services - ZSM(21)000148_ZSM008_Modification_to_5_4_3 - ZSM(21)000149_ZSM008_Additional_Change_to_5_4_4 Editorials: - Included PlantUML sources from the resources folder into this document for processing with the PlantUML Word plugin V 3.4, see https://plantuml.com/word
2021-06-07	0.7.0	Included contributions: - ZSM(21)000115r4_ZSM008_Add_mapping_to_clause_6_based_on_5_4_2_2_2_and_5_4_5 - ZSM(21)000136r1_ZSM008_addressing_EN_regarding__disassociation - ZSM(21)000157r3_ZSM008_Additional_management_services - ZSM(21)000158r2_ZSM008_onboarding_updates - ZSM(21)000168_ZSM008_clean_up_notifications_in_clause_6 - ZSM(21)000177_ZSM008_testing_optional - ZSM(21)000180_ZSM008_Add_TMF_mapping_on_sequences_related_to_data_collecti - ZSM(21)000181_ZSM008_Add_TMF_mapping_on_sequences_related_to_service_PM_an - ZSM(21)000182r2_ZSM008_Resolve_an_EN_of_clause_6 - ZSM(21)000193_ZSM008_global_of_use_of_term_service_instance - ZSM(21)000200r2_ZSM008_Add_Deactivation_related_to_the_TMF_mapping - ZSM(21)000201_ZSM008_Add_TMF_mapping_on_sequences_related_to_service_PM_an Editorials: - fixed a repetition of "the management domain" in bullet 9 of clause 5.3.2.2

Date	Version	Information about changes
2021-07-21	0.7.5	Included contributions: - ZSM(21)000205r2_ZSM008_fixing_issue_introduced_by_136r1 - ZSM(21)000212r5_ZSM008_Add_NFV_mapping_on_onboarding_process - ZSM(21)000213r3_ZSM008_Add_NFV_mapping_on_service_LCM - ZSM(21)000214r3_ZSM008_Add_NFV_mapping_on_inventory_topology_management - ZSM(21)000215r4_ZSM008_Add_NFV_mapping_on_information_collection_process - ZSM(21)000221r1_ZSM008_Apply_latest_table_format_to_6_3_to_6_6 - ZSM(21)000223_ZSM008__Text_modification_proposal_concerning_section_5_3_3 - ZSM(21)000261_ZSM008_Modify_the_description_of_Table_6_6-1
2021-09-13	0.8.0	Included contributions: - ZSM(21)000268_ZSM008_add_step_to_onboarding - ZSM(21)000272_ZSM008_Editorial_Change_to_5_3_6 - ZSM(21)000274r2_ZSM008_Additional_Change_to_5_3_7_and_Annex - ZSM(21)000300_ZSM008_fixing_references - ZSM(21)000301r2_ZSM008_NFV_mapping_fixes - ZSM(21)000302r1_ZSM008_Completing_the_NFV_mapping
2021-09-24	0.8.5	Included contributions: - ZSM(21)000307_ZSM008_addressing_NFV_domain_editor_s_note_on_notifications Editorials: - Fixed wrong numbering in onboarding flow
2021-11-22	0.9.0	Included contributions: - ZSM(21)000273r1_ZSM008_Modify_NFV_mapping_about_unsubscribe_operation - ZSM(21)000319r3_ZSM008_Clause_6_3GPP_mapping - ZSM(21)000321_ZSM008_Fixes_to_NFV_mapping - ZSM(21)000325r1_ZSM008_Fixes_to_Fig_4-2_and_removal_of_some_ENs_in_clause_4 - ZSM(21)000329r1_ZSM008_Fixes_to_inventory_update_procedure - ZSM(21)000339r4_ZSM008_Additional_Change_to_Service_deactivation - ZSM(21)000341r4_ZSM008_Additional_Change_to_Service_activation - ZSM(21)000386_ZSM008_fix_condition_of_service_instantiation - ZSM(21)000392r1_ZSM008_Add_NFV_mapping - ZSM(21)000408_ZSM008_fixing_step_12_in_5_4_2_2_2 Editorials: - Removed NOTEs in the references and merged statements with reference to the related 3GPP spec directly into reference text for improved readability. - Aligned use of "n/a" in clause 6. - Minor editorial (missing blanks, wrong numbering, activate -> activated) in the flows in 5.3.3 and 5.3.5.
2021-12-03	0.9.5	Included contributions: - ZSM(21)000401r1_ZSM008_adding_cross-domain_aspect_to_analytics - ZSM(21)000407r1_ZSM008_removing_Annex_A - ZSM(21)000411r1_ZSM008_delete_ENs ZSM(21)000415_ZSM008_resolve_EN_on_too_strict_error_condition - ZSM(21)000416_ZSM008_provide_content_for_clause_6_1 Editorials - Swapped Annexes A and B to have stable references, as Annex A will be deleted one day. - Applied the following pattern consistently: In the flows clauses, all flow step descriptions end with a dot and all entries in the list of services do not end with a dot. - Added step numbers for "Update E2E inventory" in clause 5.4.4.2 which was the only place where it did not exist.

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2021-12-20	0.10.0	Included contributions: - ZSM(21)000409r2_ZSM008_Clause_6_BBF_mapping - ZSM(21)000412r1_ZSM008_Revise_on_AnnexB_1 - ZSM(21)000413_ZSM008_address_EN_on_service_template - ZSM(21)000414_ZSM008_resolving_EN_on_service_state - ZSM(21)000421_ZSM008_fixes_to_flow_5_3_3_2 - ZSM(21)000422_ZSM008_remove_empty_models_clause - ZSM(21)000425_ZSM008_resolving_ENs_on_NFV_mapping - ZSM(21)000439r1_ZSM008_deletion_of_further_ENs - ZSM(21)000440_ZSM008_resolve_En_on_data_services - ZSM(21)000442r1_ZSM008_resolve_EN_on_use_of_IF Editorials: - Added abbreviations "IFA", "API" - Fixed the broken formatting in clauses 5.x - Removed the placeholder for terms in clause 3.1 - Removed duplicate occurrence of the word "service" (multiple places)
2022-01-25	0.11.0	Included contributions: - ZSM(21)000424_ZSM008_update_scope - ZSM(22)000006_ZSM008_addressing_editorial_ENs - ZSM(22)000058r1_ZSM008_Resolving_of_Editors_Note_in_5_3_4 Editorials: - changed year to 2022
2022-02-23	0.12.0	Included contributions: - ZSM(22)000004_ZSM008_Clause_6_x_Transport_slice_mapping - ZSM(22)000013r3_ZSM008_Update_TMF_Open_API_mapping_table - ZSM(22)000053r4_ZSM008_updating_Section_6_4_Transport_Domain - ZSM(22)000059_ZSM008_adding_missing_subscriptions - ZSM(22)000074_ZSM008_EN_removal ZSM(22)000079_ZSM008_Transport_clause_structure_update Editorials: - Minor formatting changes and edits for consistency - Added IETF RFC 9094 to the list of references as it was missing there, but referenced from the text in CR 053r4 - Added "TBD" in all table cells in 6.4.2 not filled by CR 053r4 - Changes for consistency of references - Added abbreviations OTN, TEAS, CCAMP, WG - Added version, "work in progress" statement and URI to internet drafts
2022-03-21	0.13.0	Included contributions: - ZSM(22)000100_ZSM008_Clause_6_Transport_Mapping_L2_L3 - ZSM(22)000101_ZSM008_Replacing_TBDs_fixed_access - ZSM(22)000108_ZSM008_Clause_6_4_2_Minor_change_for_notification_API_descri - ZSM(22)000112_ZSM008_Replacing_TBDs_optical_transport - ZSM(22)000113r1_ZSM008_Replacing_TBDs_3GPP - ZSM(22)000114r1_ZSM008_Clause_6_Transport_mapping_TAPI - ZSM(22)000116_ZSM008_editorial_revise - ZSM(22)000121_ZSM008_TMF633_domain_tables_fix - ZSM(22)000122_ZSM008_Address_EN_in_NFV_table - ZSM(22)000123_ZSM008_Removing_feasibility_check_in_6_4_3 Editorials: - Removed clause 6.4.x which has provided a template for transport NBI. As the set of transport NBIs is complete the template is no longer needed. - Reordered the references
2022-03-28	0.14.0	Proposed Stable draft. Included contributions: - ZSM(22)000002_ZSM008_clause_7_Gap_analysis
2022-04-30	0.14.1	Clean-up done by editHelp! and editorial changes by rapporteur.
2022-05-03	0.15.0	Stable draft. Included contributions:

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		- ZSM(22)000137_ZSM008_review_clause_6_4_2_OTN_IETF_address_EN_on_eth_topolo - ZSM(22)000138_ZSM008_review_clause_6_4_align_IETF_notifications - ZSM(22)000140_ZSM008_review_update_references - ZSM(22)000146_ZSM008_review_clause_6_4_2_OTN_IETF_remove_path - ZSM(22)000147_ZSM008_review_clause_1 - ZSM(22)000148r1_ZSM008_review_clause_4 - ZSM(22)000149r1_ZSM008_review_clause_5_1 - ZSM(22)000150_ZSM008_review_clause_5_2 - ZSM(22)000155r1_ZSM008_review_clause_6_4_2_OTN_IETF_update_on_inventory - ZSM(22)000159_ZSM008_review_clause_5_3_2 Editorials: - Corrected wrong step number and wrong use of plural in 5.4.3.2.2 - Corrected wrong use of singular in 5.4.3.2.1 - Aligned the start of all text lines flow diagrams to be lowercase
2022-05-18	0.16.0	Final draft Included contributions: - ZSM(22)000156r2_ZSM008_review_clause_6 - ZSM(22)000157_ZSM008_review_clause_7 - ZSM(22)000160_ZSM008_review_annex_B - ZSM(22)000161_ZSM008_review_clause_5_3_3_to_5_3_6 - ZSM(22)000162_ZSM008_review_clause_5_3_7 - ZSM(22)000163r2_ZSM008_review_clause_5_4_1_and_5_4_2 - ZSM(22)000164_ZSM008_review_clause_5_4_3 - ZSM(22)000165r1_ZSM008_review_clause_5_4_4 - ZSM(22)000166r1_ZSM008_review_clause_5_4_5 - ZSM(22)000186_ZSM008_addressing_rapporteur_s_note - ZSM(22)000190_ZSM008_adding_missing_scale - ZSM(22)000191r2_ZSM008_small_changes - ZSM(22)000196_ZSM008_Fixes_to_service_quality_management_and_service_probl - ZSM(22)000207_ZSM008_consistent_naming_of_integration_fabric - ZSM(22)000219_ZSM008_align_clause_5_4_3_with_changes_in_5_4_4_introduced_b - ZSM(22)000220_ZSM008_error_handling_general_statement - ZSM(22)000221_ZSM008_3GPP_feasibility_checks - ZSM(22)000222_ZSM008_Preconditions_consistency Editorials: - Updated Internet Drafts to latest version - Removed yellow mark-up - Added "skin rose" to all UML diagrams to cater for new PlantUML version - Reformatted selected UML diagrams to optimize font size

History

Document history		
V1.1.1	July 2022	Publication