

Smart, efficient and dynamic end-to-end 5G network slicing management



Network slicing, which is the cornerstone of 5G architecture, enables the support of diverse 5G services over a shared network infrastructure. Essentially, a network slice is a logical network that serves a defined business need, by means of a particular set of network capabilities and characteristics. A network slice spans across the RAN, Transport and Core networks containing all the required network resources, to enable the end-to-end service.

Network slicing enables mobile operators to provision dedicated network slices for specific services or customers. Operators that offer specialized services that address precisely the specific needs of customers with tailored technical, performance, regulatory, security or other requirements, can improve service performance, customer experience and ultimately customer satisfaction.

Network slices can be monetized by promoting Network Slice as a Service (NSaaS), as part of a service bundle that is included in offers for enterprise customers, and as a quality differentiator for consumer services. By tailoring services to specific customer segments, CSPs can monetize these services in terms of QoE, and thereby increase service value and charge premium service fees.

A network slice is composed of Network Slice Subnets (e.g. RAN, 5GC and Transport), which allow greater agility and efficiency in the utilization and management of the network resources. Each network slice subnet will include a group of network functions and their corresponding resources. A network slice subnet can serve single or multiple network slices.

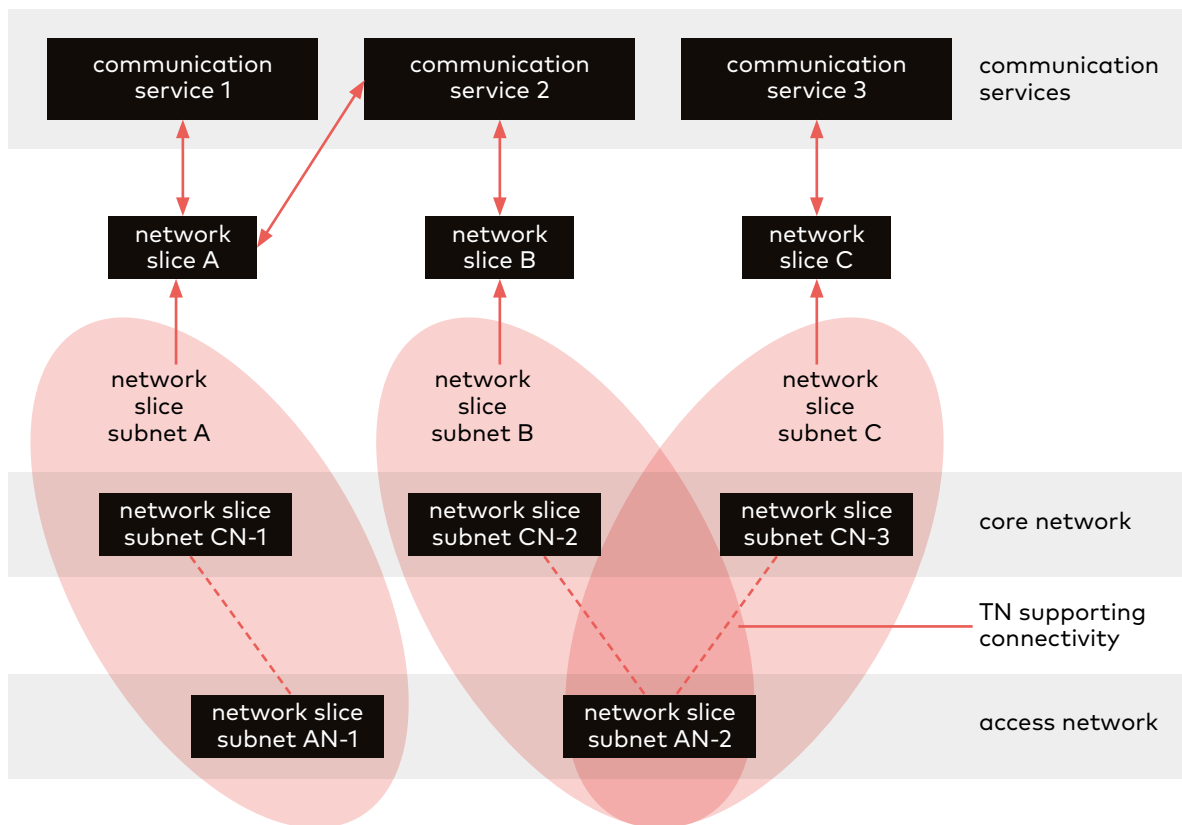


Figure 1. A variety of communication service instances provided by multiple Network Slice Instances (NSI) and Network Slice Subnet Instances (NSSI)

Source: 3GPP TS 28.530 v17.2.0 (2021-12)

Network slices utilize Network Functions (NFs) and resources across the various network segments from Access to Core (and in many cases also deployed on a public cloud); therefore, managing the lifecycle of network slice instances poses a major operational challenge for the mobile operator. An end-to-end perspective is crucial to meet the needs of diverse services, use cases, and business models. The 5G network and telco cloud infrastructure layer hosts the physical and virtual resources that are necessary to create network slice subnets. These include both virtualization software and hardware, which is comprised of memory, computing, storage, and networking resources.

Network Slice Lifecycle Management

Managing the lifecycle of network slices requires the modeling, deployment, instantiation, and ongoing maintenance and health checking of numerous NFs that are deployed in multiple and diverse virtual and physical environments. Furthermore, to gain maximum operational efficiency, NFs are instantiated and scaled in an automated, zero-touch operations mode. This enables 5G slices to deliver their promise of dynamic flexibility, agility and scalability, which in turn will allow provisioning the network slices, to enable them to satisfy various use cases and customer needs.

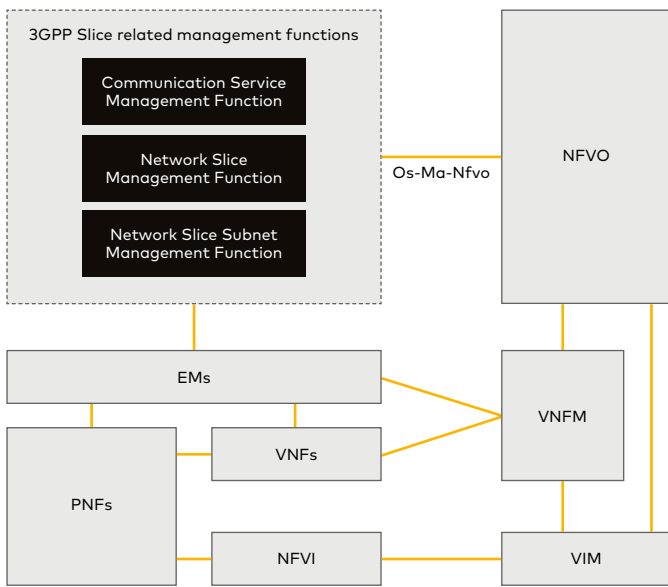


Figure 2. 3GPP Network Slice Management Functions Source: ETSI GR NFV-REL 010 V3.1.1 (2019-06)

The CSMF is responsible for translating the communication service-related requirements to network slice-related requirements. The NSMF is responsible for the management and orchestration of network slice instances, as well as the translation of the end-to-end slice requirements for the various subnet requirements, and the NSSMF is responsible for the management and orchestration of network slice subnet instances.

5G network slicing management will be based on SDN and NFV technologies and principles, which enable dynamic programmability and control. Mobile operators will adopt new methodologies that will enable them to automate network slice life cycle management that is based on the modeling of resources and services. The automation of network slice operations will be based on creating and designing service models and operational policies in advance. These will enable closed loop operations that are based on fault and performance monitoring, as well as providing the ability to utilize advanced analytics and machine learning, to maintain the service intent. Furthermore, this mode of operation will optimize the consumption of network and cloud resources, while ensuring the attainment of service and slice KPIs.



Amdocs 5G Slice Manager

Network slices will span across the RAN, Transport and Core networks and will utilize virtual, containerized and physical network functions that will be deployed to each network slice instance, depending on the specific service it serves. To gain maximum agility, these NFs can then be scaled on demand with changes in service and performance requirements. In this multi domain virtualized network, there is a need for a 5G slicing management entity that will coordinate the coexistence of network slices, and guarantee that the required resources are available for each one. Amdocs 5G Slice Manager fulfils this exact role. Amdocs 5G Slice Manager is responsible for network slice lifecycle management and is hierarchically positioned at the top of the network management architecture to coordinate the RAN, Transport and Core network slice subnet operations and services, across the network siloed operational domains.

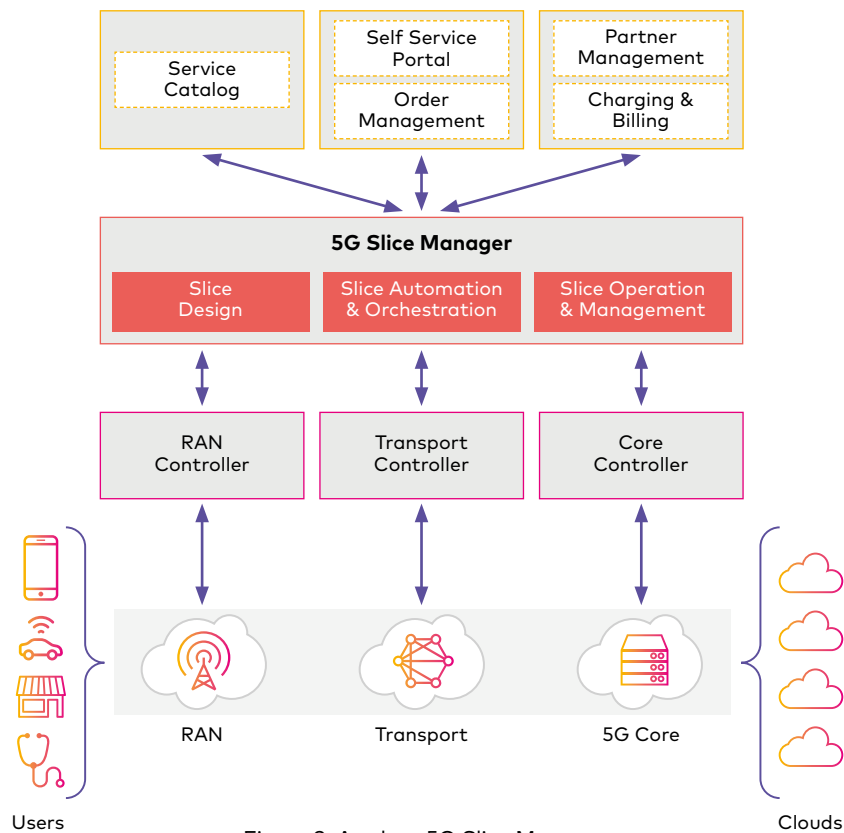


Figure 3. Amdocs 5G Slice Manager

5G requires adaptive, automated and real-time systems/processes that can tune the network to business needs. Amdocs 5G Slice Manager enables the automation of logical network segmentation with slice customization, logical network isolation and quality of service control in real time.

The 5G Slice Manager also serves as a charging triggering function that passes information about a slice's activation, utilization and performance to the charging function. This enables CSPs to revolutionize their monetization and business models possibilities, as they will be able to not only generate a subscriber-or session-based charging report, but much more comprehensive slice level reports, which include the slice or service, as well as its associated network resources, utilization and performance.

In the following sections we will review the various stages of managing the 5G network slice lifecycle using the Amdocs 5G Slice Manager.

Designing Network Slices

The process of creating network slices starts with the onboarding of network slice resources (network function, network services and all the accompanying artifacts) using the Slice Design module. Subsequently, the network slice is modeled. For example, by chaining various NFs, links and connection points to create specific network slice services.

The Amdocs' 5G Slice Manager solution is powered by the Linux Foundation's Open Networking Automation Platform (ONAP). It uses TOSCA modeling for the network slice building blocks, such as VNFs, CNFs, PNFs, and the network services themselves, as well as GSMA Generic Network Slice Templates (GST), thereby ensuring commonality, flexibility and reusability.

The Slice Design module contains a catalog of modeled (in advance) network functions and network services that can be easily reused, to create new network slices and services with unprecedented speed and promptness. A service instance is realized by one or more network slice instances (NSIs), which in turn might consist of network slice subnet instances (NSSIs).

The slice service business attributes, such as latency, throughput, supported UEs, and the maximum number of concurrent sessions, are distributed by the Slice Design module to the service catalog. These attributes include the performance, functionality and operational characteristics of the network slice. Exposing the network slice business attributes to the service catalog enables product designers and then product managers, to define products and sellable commercial offers, by adding descriptors that contain pricing, discounting, and promotion specifications.

For each service defined, the Slice Designer module associates definitions, processes, and policies for management and execution of this service. The BSS, OSS, and the Slice Manager integrate seamlessly via these shared definitions and models, to radically improve time-to-market for new services, products, and offers.

Usually, a service provider's ability to transform itself and develop new services or re-use existing services in new ways, is constrained by the speed of the network engineering tools to create, test, integrate and debug the cycle, which is typically a very manual, documentbased and time-consuming process. On the other hand, Amdocs Slice Designer enables service/slice creation automation, testing and debugging, packaging, and distribution, and is an important first step in shortening the service/slice development lifecycle and reducing engineering and IT costs.

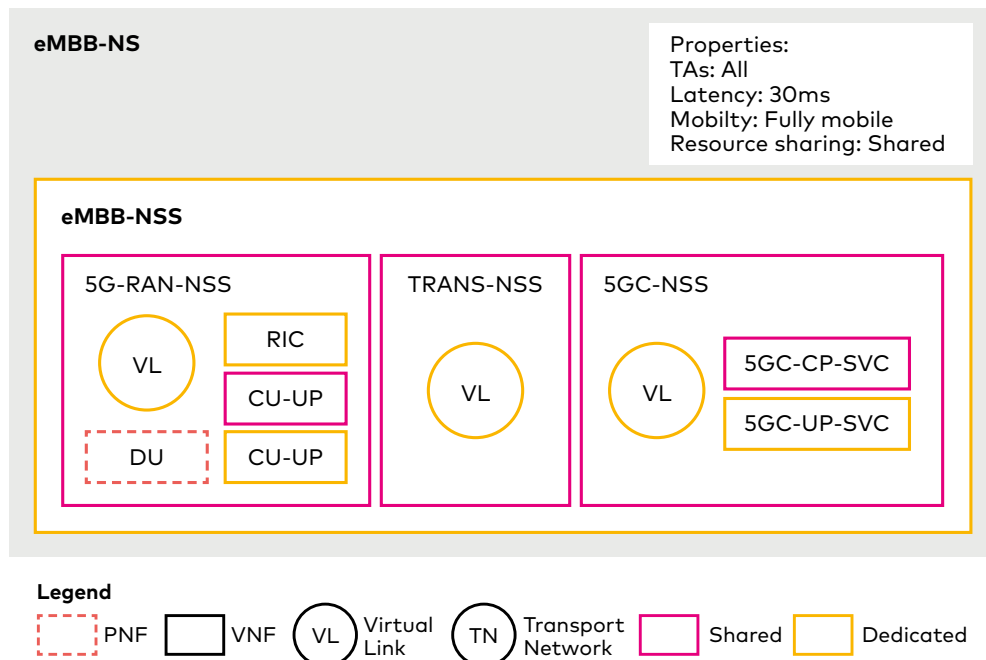


Figure 4. High-level Illustration View of Network Slice Modeling

The combination of network slicing templates with platform modularity and programmability helps to realize significantly shorter time to market, as well as cost savings when new network slices have to be provisioned. This is facilitated by the ability to reuse building blocks from existing network slices, or to replace building blocks with other NFs in the catalog, and perform any necessary changes, to meet the new network slice requirement. As new services are created within a dedicated network slice, the service creation time is simplified, and the isolated nature of network slices reduces the risk that the new service will impact any other service that shares the same resources.

Automating the network behavior and operations requires that policies be set during the slice design process and then enforced at run time. These policies are sets of conditions, requirements, constraints, attributes, or needs that must be provided, maintained, and/or enforced to enable service delivery, in accordance with its defined service characteristics and commitments to customers. Policies are set for each individual network function that is included in the network slices, and for the end-to-end network slice services.

In addition, service policies are defined and used during the service execution and activation operations, as well as policies for the slice closed loop and service assurance operations.

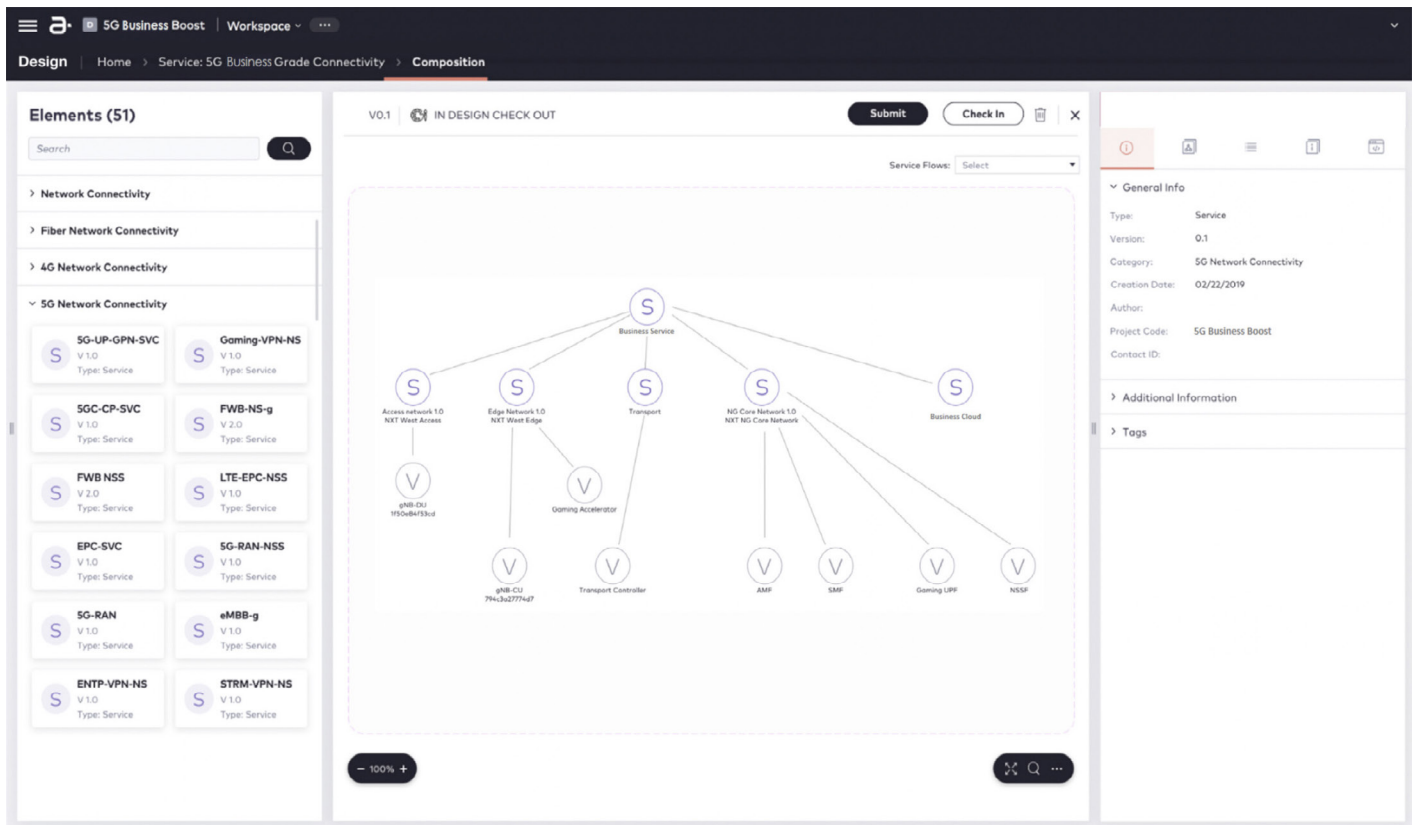


Figure 5. Illustration View of Network Slice Service Design

Continuous End-To-End Network Slicing Service Automation and Orchestration

Amdocs 5G Slice Manager receives requests from northbound BSS systems to deploy, activate, modify, upgrade and terminate network slices. The Slice Automation & Orchestration module of the Amdocs 5G Slice Manager is responsible for the instantiation of the Network Slice instance, the associated NFs, and their resources, to establish network slicing across the network domains. The Slice Automation & Orchestration module instantiates the necessary VNFs, CNFs, PNFs, network resources and connections end-to-end across the various network domains, to deploy the service into the network by interacting with each network domain, for example, RAN, Transport and Core infrastructure, and application controllers as required.

The Slice Automation & Orchestration module follows 3GPP technical specification guidelines for management of network slicing. The specific requirements of a network slice instance are provided to the Amdocs 5G Slice Manager using a Network Slice Type (NEST), which is a GST that is filled with the attribute values for the services that this network slice instance is expected to support.

As soon as the network slice activation is triggered, the Communication Service Management Function (CSMF) within Amdocs 5G Slice Manager receives the Communication Service-related requirements and converts them to network slice-related requirements, such as network type, network capacity, and QoS requirements. The CSMF then forwards the network slice requirements to the Network Slice Management Function (NSMF).

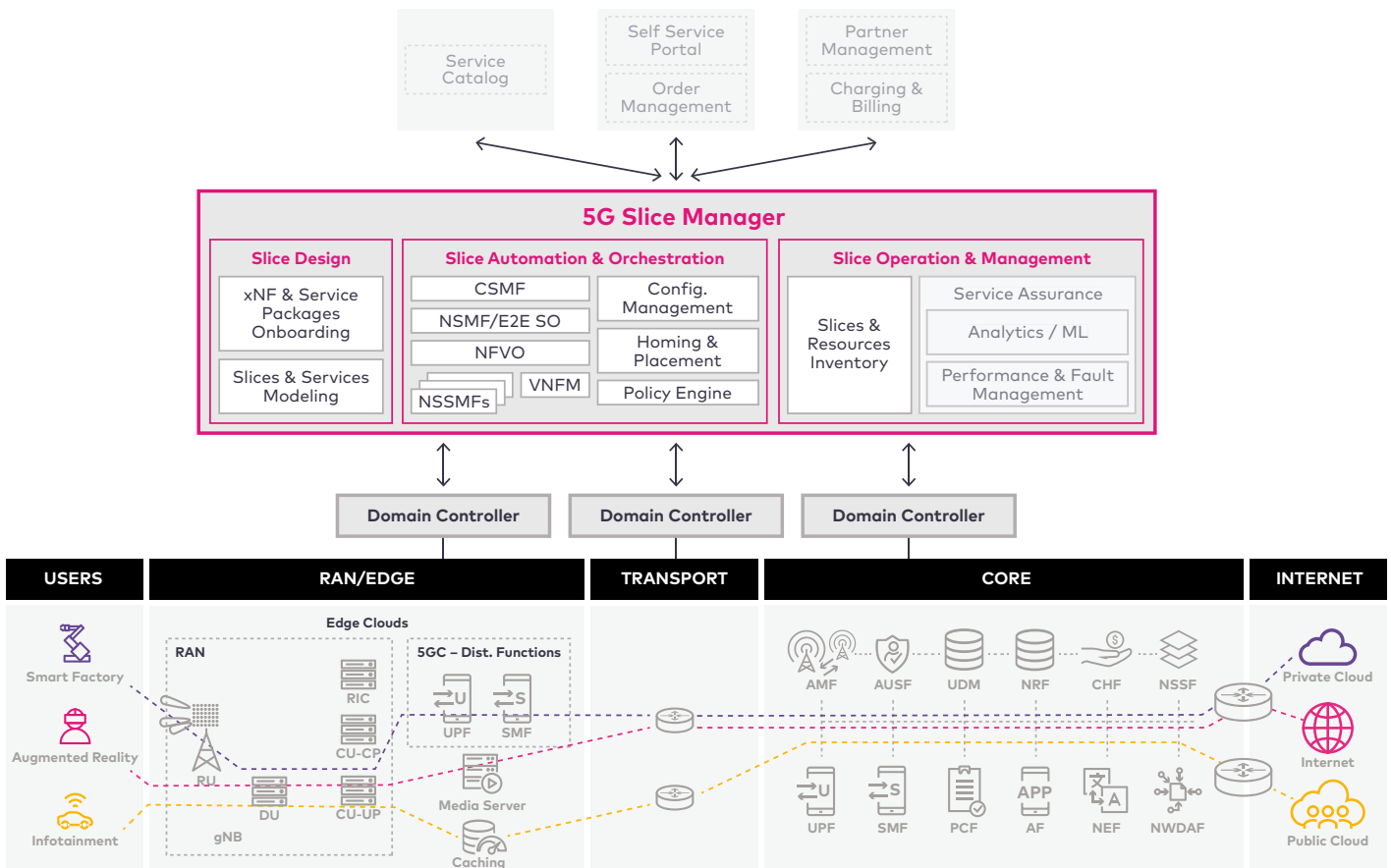


Figure 6. Amdocs' 5G Slice Manager – E2E Network Slice Lifecycle Management

The NSMF/E2E SO then initiates the instantiation of the network slice instance. The network slice configuration and deployment information are used to optimize xNF deployment, in line with defined criteria (as traffic KPIs, SLAs for cost, etc.) for a specific service implementation and ensures the workloads of xNFs properly utilize the underlying hardware processing, storage and networking capabilities. The establishment of network slices is achieved by executing an automated workflow to set up all the required network slice components, network connections, and resources, across all network and telco cloud domains.

Amdocs 5G Slice Manager might also include network domains, like Network Slice Subnet Management Functions (NSSMF), for example 5GC NSSMF, or it might integrate with existing NSSMFs that are included with the domain controller, for example, RAN NSSMFs. In both cases the 5G Slice Manager sends a request to the domain's NSSMFs, to configure corresponding domain functions with the specific network slice instance information.

The 5G Slice Manager is responsible to fulfill service business orders into efficient and effective network-oriented service implementation plans, by using predefined workflows and deployment optimization across the distributed network and cloud environments.

The 5G Slice Manager enforces and implements policy rules, to continuously assure that network services are up and running, in accordance with the defined criteria. The system policy engine triggers healing and scaling of resources across the network, to elastically adjust to demand variations, based on the specified design, as well as analytics and policies.

This enables the necessary response to ensure the service meets its committed service agreement. The Slice Automation & Orchestration module selectively adds and removes functions, services and resources with zero manual touch, by leveraging automated workflow processes. Consequently, the module deploys and performs ongoing management of end-to-end network slice services across all CSP network domains.

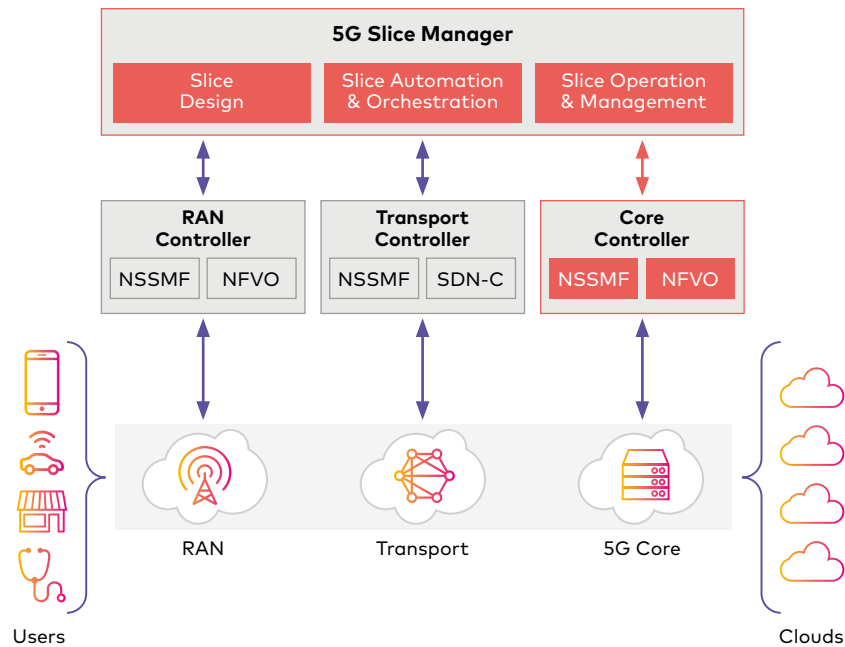


Figure 7. Amdocs' 5G Slice Manager Components as Part of the Core Controller

Real-Time 5G Network Slice Operations

The most important aspect of managing 5G network slicing, is the ability to guarantee the network slice KPIs throughout the slice's lifecycle. The Slice Operations & Management module is responsible for ongoing slice service assurance and closed loop operation. It monitors the behavior and performance of the various slices, by collecting NFs, infrastructure data and performance indications from the network domains and infrastructure controllers, EMS and NMS.

The solution's active hybrid inventory module enables vendor-agnostic, continuous monitoring and performance analysis of both the physical and virtualized network slice components. An analytics framework is responsible to analyze the performance data and events that are captured from the network, and to understand the state of network functions and the role each domain has in affecting the performance of the end-to-end slice. Based on massive data collection, statistical modeling, and AI/ML analysis, the system carries out performance prediction and provides early warnings of any degradation of slice performance and SLAs.

Upon the detection of a slice's KPI breach (such as throughput, packet loss, latency, and jitter), the NSMF triggers the appropriate actions required for network slice service assurance at all times, consistent with the pre-defined roles enforced by the system policy engine. Corrective actions might include healing and/or scaling of the resources to elastically adjust to demand variations, consistent with the specified design, analytics, and policies. This ensures that the required responses are provided, and the committed SLAs are met.



Furthermore, service providers can also automate the operational testing and assurance of the network slices, by provisioning a set of critical testing and assurance functions. For example, validating the performance of new slices, proactively monitoring service levels, and isolating faults.

Consequently, the end-to-end service orchestration and assurance automation maximize the efficient utilization of network resources and enables their adaptive, realtime responsiveness and tuning, to specific business and customer needs, in a timely and cost-efficient manner. This in turn allows controlling and guaranteeing network performance that satisfies QoS, SLAs and security requirements across all domains, thereby ensuring that 5G network slicing fulfills its true potential.





Unleash 5G Opportunities with Amdocs 5G Slice Manager

With virtual infrastructure and programmable networks, the granularity with which service providers can tailor solutions will make a substantial difference to their ability to monetize the network. Using network slicing, mobile operators could differentiate their service offerings and provide network-as-a-service, opening network capabilities to third-party vendors, and meet the wide range of 5G use cases that users, businesses and industry are expected to use.

Amdocs 5G Slice Manager, powered by Amdocs Intelligent Networking Suite, enables mobile operators to simplify and automate the creation and lifecycle management of network slices that spans over multiple network domains and benefit from an open and agile 5G network.

Open – Adoption of a distributed open architecture that leverages a multi-vendor eco-system provides service providers with increased agility, flexibility and improved efficiencies in running a mobile/5G network. Amdocs is pioneering open network solutions, based on open-source and industry standards such as ONAP, ORAN, ESTI/ MANO, TMF and MEF.

Amdocs 5G Slice Manager enables service providers to run a customer-centric network, infused with business-driven intelligence and automation, in all aspects of the end-to-end network slicing operations.

Monetized – 5G network slicing business and customercentric slice segmentation will create a paradigm shift in a CSP's monetization possibilities. Amdocs 5G Slice Manager integration with the CSP's ordering and charging systems, enhances the granularity and speed with which CSPs can support new business and monetization models, as well as introduce and deliver services. This in turn will substantially revolutionize their ability to unleash a whole new world of network services and monetization possibilities that can support complex B2C, B2B and B2B2x business models.

Amdocs 5G Slice Manager is aware of the network slices' resource consumption and can also serve as a charging triggering function that passes information about a slice's operations, as well as resource consumption, utilization and performance to the charging function in accordance with ETSI NFV-EVE008 and recent 3GPP Release 17 guidelines.

By enabling the CSP charging system to become aware of chargeable network slicing events, CSPs will be able to revolutionize their monetization and business model capabilities, as they will be able not only to generate a subscriber- or session-based charging report, but a much more comprehensive slice-level report covering:

- Operational events such as slice/service instantiation, termination, activation, de-activation, etc.
- Usage events such as dynamic resource consumption by slice/service/network function
- Performance and analytics events based on collection of network slice performance metrics

The Amdocs 5G Slice Manager solution is powered by the Linux Foundation's Open Networking Automation Platform (ONAP) and TOSCA-based templates that represent the VNFs, CNFs and PNFs across the different network domains, as well as their policy and service assurance configurations.

Amdocs 5G Slice Manager automates the process of provisioning and modifying network slices and services, ensuring that all the building blocks that constitute each network slice are deployed, consistent with the specific service requirements that the network slice is expected to provide.

Reusability and the adoption of a template-based approach to simplifying the creation of new slices will drive significant cost saving and will eliminate errors and accelerate time to market.

The solution's closed-loop service automation ensures these VNFs will scale on demand to accommodate changes in service and performance requirements. Amdocs' 5G Slice Manager coordinates the coexistence of multiple network slices and guarantees that the required network, radio and infrastructure resources are available for each one, from the RAN all the way to the Core.



Additional key benefits:



Reduced complexities and cost

Automated end-to-end lifecycle management of services across multiple domain-level controllers



Increased business agility

Vendor-agnostic, non-proprietary, open-source and standards-based solution, and use of open, standard-based APIs



Enhanced visibility and control

Federated and complete inventory view over all network elements, service order and fulfillment, tracking and visualization



Open and extendable

Comprehensive set of design tools and development SDKs supports multiple service types



Operational efficiency

Integrated AI/ML-based intelligent closed-loop assurance and optimization



Scalability and availability

Modular, cloud native, microservices-based architecture supports high availability and redundancy configurations





Amdocs Intelligent Networking Suite

Amdocs Intelligent Networking Suite

Amdocs Intelligent Networking Suite is a unified, yet modular service & network automation platform for the end-to-end service lifecycle management of hybrid network and cloud services, from design & creation to, orchestration, continuous monitoring and operation. The platform assures the end-to-end services and network traffic by orchestrating network service-related operational activities and policy management.

The Amdocs Intelligent Networking Suite supports all lines-of-business (LOBs), including enterprise/B2B, mobile, consumer broadband and multi-play, as well as NFV and 5G-based services.

Learn more about [Amdocs Intelligent Networking Suite](#)

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