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Voice over 5G: The ecosystem for voice networks

How APIs are revolutionizing the development of telco services

White paper

Voice is an essential service in Communications Service Provider (CSP) portfolios, either standalone or as an integral part of other services in 5G. Open, cloud-native architecture enables the rapid creation of new services through an extensive set of open APIs backed by a secure 5G exposure platform. Such an API-based ecosystem of new services will include voice as an important element.

This is the final in our series of six white papers exploring Voice over 5G (Vo5G). Here we explain how to create new services that include voice and the benefits they bring. We also outline 5G use cases incorporating voice for different market segments.

Contents

Introduction

5G will be introduced as non-standalone deployments for data services, followed by 5G New Radio (NR) standalone deployments for voice services. Voice based on the IP Multimedia Subsystem (IMS) will remain as a vital service and gain additional capabilities. Voice may be integrated as a component of new 5G services or become part of a bundled Communications Service Provider (CSP) package. Either way, CSPs can take advantage of 5G core openness and programmability through open Application Programming Interfaces (APIs) to create services for new vertical segments and enrich their consumer and enterprise offers.

An ecosystem of voice services that supports CSP, developer and telecom API vendors' business goals will help CSPs achieve a good Return on Investment (ROI) in their 5G deployments. When all stakeholders in the ecosystem cooperate openly, APIs enable agile service creation.

A robust and secure 5G Exposure Platform with a single API gateway is needed to support the creation of services. 3GPP release 15 introduced the Network Exposure Function (NEF). NEF is a 5G Network Function (NF) that securely exposes other 5G NF programmability, with all APIs in the distributed telco cloud.

This sixth white paper in the Nokia series on Voice over 5G (Vo5G) illustrates new use cases that integrate 5G voice as part of other services or as a bundled item in sophisticated CSP offers.

The 5G transformation of voice

More than a third of CSPs plan to use 5G to support new revenue streams[1]. Voice services deliver significant CSP revenue, yet customer expectations for flat-fee voice restricts its growth potential. Fortunately, CSPs can integrate or bundle voice with other services to develop new revenue streams, while also retaining standalone voice as a 'must-have' for customers.

Integrating services with 5G voice is founded on open APIs that enable 5G core functionality as a programmable asset to create services. Voice as a component can be tightly integrated into the services and manipulated with APIs. Third party elements can also be integrated to add value. Examples include translation services, or keyword detection systems to enable voice commands to control IoT devices. Such innovative services will enable CSPs to enter new market segments.

Another important element is the CSP's own- or third-party services bundled with voice. Voice does not have to be integrated with a service but can be combined with it. An example could be voice plus data, extending the conventional customer bundle to include 5G-based Fixed Wireless Access (FWA) in which the customer gets a highly reliable and clear voice over 5G service as well as high speed broadband.

It is also possible to create services with integrated voice components and then bundle them with different basic services.

New enterprise revenue streams

Today's enterprise communication networks support collaboration between employees regardless of their location and device. Many internal voice communication PBX or IP PBX solutions with Unified Communication tools support employee collaboration. For more information about the enterprise voice market, please read the Nokia white paper: "Voice over 5G: the enterprise opportunity for Communications Service Providers."

1 Analysys Mason: Best Practices for 5G transformation.

The catalyst for new enterprise voice services is 5G core programmability. APIs enable CSPs to attract new enterprise business with innovative services. Common APIs for service creation include:

- Access agnostic voice services programmable by Telephony Application Server (TAS) open APIs
- TAS API Business Centric Services for enterprises
- Subscriber data and status exposure
- Device provisioning APIs for enterprise self-management
- IoT management APIs

The 5G core network also enables end-to-end network slicing in which dedicated elements of the distributed cloud, transport and radio network are assigned to a single use case based on tight Service Level Agreements (SLAs). Dedicated enterprise services can be defined in an exclusive network slice. 5G core programmable assets can also be accessed in the network slice.

New IoT revenue streams

IoT use cases are diverse, from Low Power Wide Area (LPWA) applications, Massive IoT services like smart buildings or logistics tracking, to critical IoT services such as remote health care or industrial application and control. CSP revenue will come mainly from the connectivity of IoT devices and IoT application hosting.

Complex CSP IoT services can be developed and may include voice. The 5G programmable core can integrate voice assistants through APIs that can trigger any IoT related service. Similarly, IoT devices may communicate with users via IMS voice integrated with a speech server to make the service more user friendly. Intelligent IoT services like smart metering may use chatbots. The aim is to offer convenient voice-activated technology that is programmable.

New vertical markets

5G will help CSPs extend their services into new verticals. New CSP offers may contain 5G voice bundled with 5G services or as an integral part of the service, all tailored to each segment's profile and needs.

Figure 1. Examples of verticals addressed by new services including integrated 5G voice

New vertical	CSP offer	5G voice component
Consumer entertainment / event broadcasting	Event broadcasting from own device to friends	Voice service to connect users during broadcast
Consumer Gaming	Cloud-based game service streaming content to mobile terminal	Gamers voice connection during a game session
Massive IoT in Cloud Robotics	IoT provisioning, management and control service	Voice-guided analytics requests, voice-guided IoT management
LoRA IoT in smart metering	IoT provisioning, IoT analytics from smart meters	Voice-based activation of IoTs, voice-based information based on measured values
Healthcare	Remote emergency services: information provisioning of client's status	Mission-critical voice call connection services
AR/VR training companies	AR/VR bandwidth and content provisioning	Interactive voice communication during sessions

The enablers of programmable 5G voice services

In 5G networks, voice service is based on peer-to-peer IP connections, regardless of how it is deployed. 5G voice calls are established between IP and Session Initiation Protocol (SIP) capable terminals or other IP (SIP) capable entities like speech servers or IoT devices. In all cases, voice services are provided through the IMS.

5G voice services provided through the IMS core are based on the different deployment scenarios described in Nokia's second Voice over 5G white paper: Options for Deployment.

Voice over New Radio (VoNR) is enabled when the 5G core is in place and the IMS voice connection primarily uses 5G radio cells. VoNR as a standalone item offers extremely high quality, low latency and clear voice quality over the IMS core.

Partner ecosystem on the 5G platform to enable new voice services

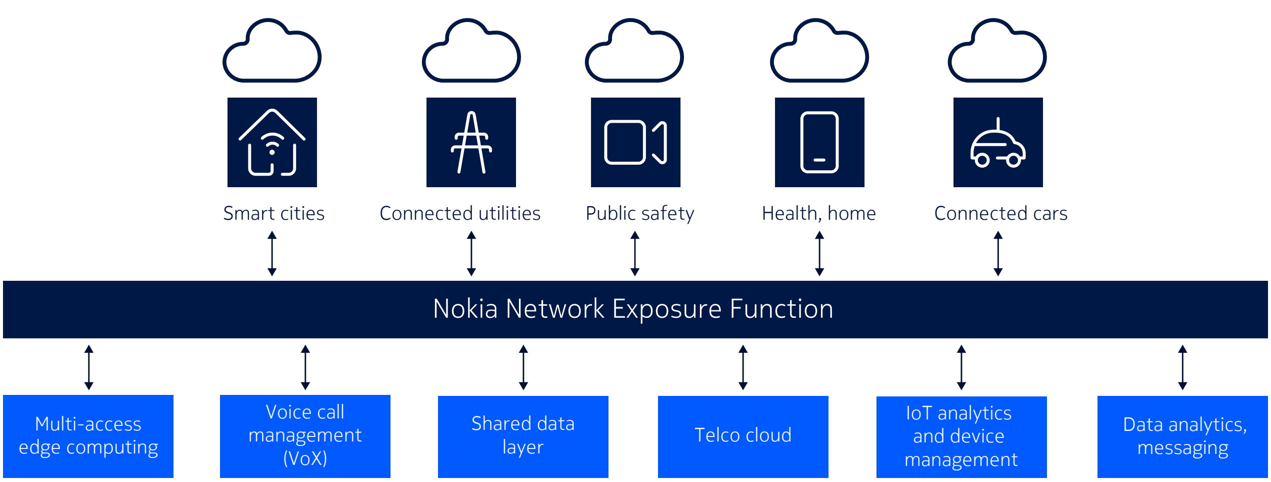
Open alliances like the Open Mobile Alliance (https://www.openmobilealliance.org/) provide recommendations on using APIs. According to the OMA model, core network service capabilities like location, identity, presence or network controls and payment services must be distributed via an exposure layer to different industry verticals.

Introducing new services to exploit monetization opportunities in a diverse range of new verticals requires developers to fully use the benefits of the programmable 5G core. Any open programmability elements available through open APIs can be combined to achieve the desired service profile.

A wide range of APIs is available for different purposes in Nokia's implementation of the OMA model. The current landscape of 5G APIs, beyond voice call management APIs, includes Multi Access Edge Computing (MEC), Shared Data Layer (SDL) exposure, Telco cloud infrastructure management, IoT analytics and device management and Data Analytics APIs.

New services may require the use of additional third-party resources, so the aggregating exposure platform needs to handle third party API integration. As well as providing a single secure API gateway, the same exposure framework must be able to tailor a set of mashup APIs for the different verticals to simplify development. The mashup APIs plus integration capability of third-party APIs and data sources are all available in Nokia NEF.

Figure 2. The breadth of the API ecosystem in 5G



Only a cloud-native core network can enable the rapid creation of services. The main benefits of creating services in the new 5G API ecosystem are:

- Fast-to-fail concept for agile service creation. Service incubation projects may embrace several third-party initiatives, some of which can fail without causing huge losses, while the more successful ones can continue and be developed further
- Third party developers can use APIs and core network capabilities to focus on service innovation
- CSPs may benefit from free or competitively priced programmer and developer resources for new services.

The telco application ecosystem has at least three main stakeholder types:

1. The CSP who owns the 5G network as a programmable asset and provides its capabilities to developers
2. The vendor who develops and implements the 5G programmable asset
3. The developers who may be from a third-party company or be employed by the CSP or vendor. The developer community can even be a mix of the above.

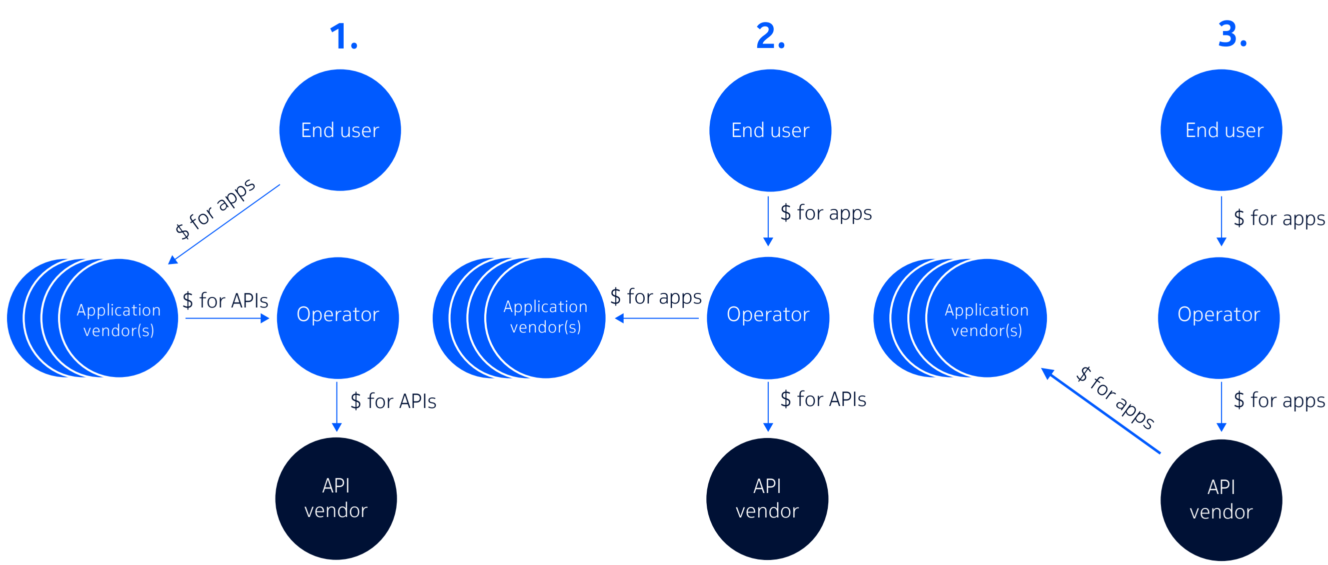
In the successful API ecosystem, each stakeholder's business objectives must be met. Nokia envisages three main models for telco applications monetization.

The first is the CSP wholesale model, in which App developers buy API capacity from CSPs and sell application-based services directly to end users. At the same time, the CSP buys API capability/capacity from a vendor which may be based on transaction, per subscriber API license or on average or peak rates of API use.

The second is an API retail business model for CSPs. This is a direct business relationship between the CSP and application developers. The CSP retails applications to end users and pays developers for the apps. Like the first model, the CSP buys API capability/capacity from a vendor.

The third model is API retail business models for service providers. This is an indirect business relationship between the CSP and the application developers. The CSP retails applications to end users and pays a vendor for the applications. Finally, the vendor shares the revenue with the application developers.

Figure 3. Business models in the telco API ecosystem



CSPs can address the opportunities and challenges that come with open APIs through a strategy that should cover:

- How APIs contribute to the CSP's service portfolio strategy
- How to use APIs for a CSP's internal purposes, for example analytics and operation automation
- How vendor diversity influences a CSP's API portfolio and its service strategy
- How the CSP balances internal API related development and open collaboration with third party developers.

Clear objectives for using APIs and a clear CSP service vision are the foundations of a new telco service ecosystem.

IMS core as key enabler of programmable voice services

A wide range of API sets may be involved for service creation with the main role of the IMS core to integrate voice services in multi access networks to enable new voice services.

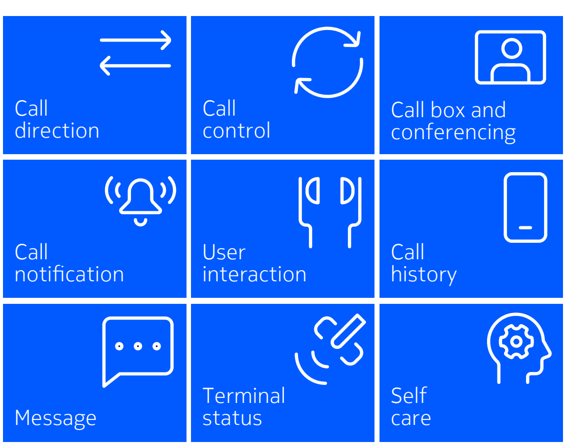
The IMS supports multiple types of Application Server (AS) in a layered design. ASs are not pure IMS entities, but functions on the top of IMS that provide value-added multimedia services. TAS provides multiple IMS application server roles to deliver high quality voice, video and messaging services for all mobile and fixed networks. It is typically deployed as an IMS-Application Server (IMS-AS) that interfaces with the network's IMS Call Session Control Function (CSCF). TAS as a key enabler of voice services includes all the voice call management APIs.

The TAS must have the following attributes for voice services:

- Unified platform to serve fixed-mobile-enterprise convergence for domain-independent services
- Fully cloud- and microservices-based architecture to reap cloud benefits
- An open development environment: new adjacent service creation is accelerated with standardized application interfaces and by engaging third party innovation.

The openness and programmability of the IMS core manifests itself in voice call management APIs enabled by the TAS. These APIs enable interventions during call establishment or to an ongoing voice call to provide rich customer centric services or to trigger third party applications according to subscriber actions like voice call initiation or termination.

Figure 4. Examples of voice call management open APIs



These open APIs enable new voice-based services and any new service with voice as a component. The APIs enable an IMS voice call to be manipulated by authenticated third party applications integrated with the TAS access functions like event notification or for interacting with the caller through media resource.

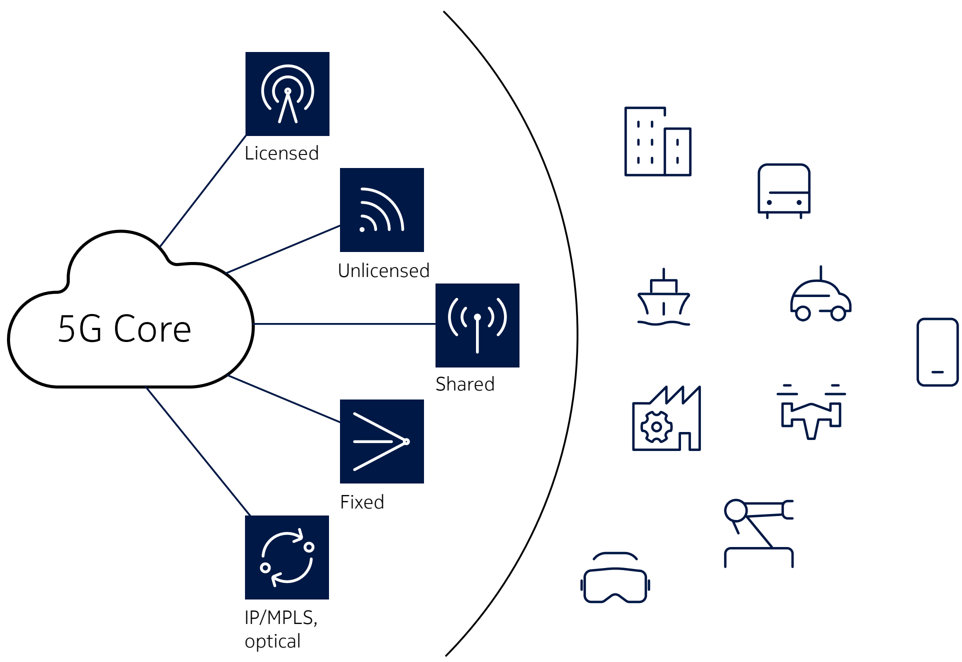
Similarly, TAS enables voice to become a component of a service. In this case, voice is not a standalone item but part of a sophisticated service. For example, a service event may trigger a voice call or short message service (SMS).

The access-agnostic 5G core as an enabler of voice services

A wide range of services can be provided, regardless of access technology. Access-independent telecommunications combines the following technologies:

- Licensed wireless access: supporting 4G and 5G
- Unlicensed wireless spectrum beyond Wi-Fi, including MulteFire and neutral host core, to address new vertical segment opportunities
- Concurrent and converged service delivery across fixed and wireless access, for increased capacity and service resilience.

Figure 5. Deployment flexibility enables fixed/wireless convergence



Over the Top (OTT) voice services using Voice over IP solutions only work with some access technologies. The access-agnostic 5G core with IMS-based voice services is the only solution to offer voice-based services over the full range of access technologies.

The programmable 5G core API ecosystem can take advantage of access-agnostic service opportunities by using voice call management APIs to manipulate and integrate voice services. The TAS must be capable of supporting standard communication services such as VoLTE or Vo5G, as well as providing differentiated offers in combination with other network functions like Unified Communications and Collaboration (UC&C), VoWifi, video communications, chatbots and contact center functionality.

Exposure framework in the 5G core

3GPP standardization defines exposure frameworks for developers to access programmable telco assets from any vendor. In 4G, 3GPP releases define the functions of an API management platform, with Release 13 and above setting requirements for the Service Capability Exposure Function (SCEF). This platform was developed for IoT-related API exposure, such as monitoring and notification between IoT application servers and user equipment.

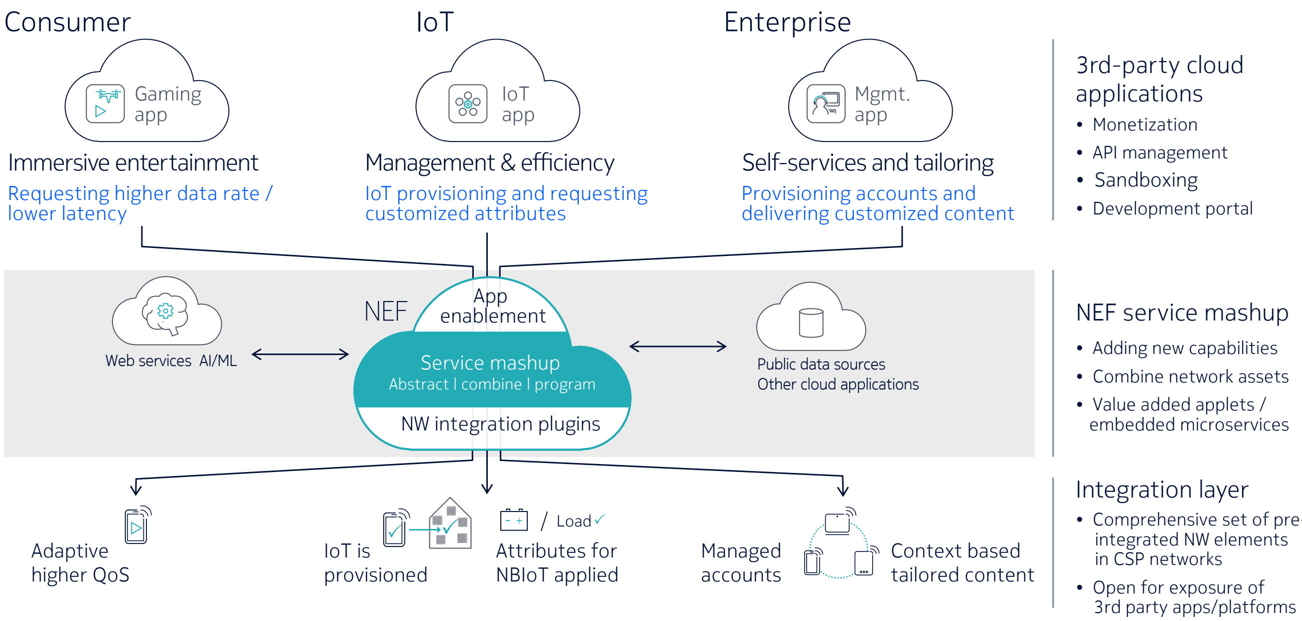
With the advent of 5G, 3GPP has defined a new API exposure platform. This provides greater flexibility and openness in 3GPP release 15 and beyond. The mandatory elements of the 5G exposure framework as defined by 3GPP include:

- Support 5G service-based architecture and expose network functions
- Guarantee 5G core stability with rate limitations
- Exposure of RESTful APIs
- Single API gateway function for all core APIs
- Monitoring and provisioning functions
- Exposing policy and charging functions
- Exposure of core network internal capabilities for analytics.

With these requirements, a robust and secure API gateway can provide access to the 5G core network APIs. The ideal 5G exposure framework must provide additional features such as:

- Backward compatibility with 4G exposure frameworks (SCEF) to use the installed base of 4G cloud applications and provide the runtime environment in 5G. This enables smooth upgrades to these applications to best use the advanced capabilities of the 5G core.
- Support for API plug-ins in the exposure platform's southbound interface. For CSPs to benefit from openness, a third party must be able to plug in and re-expose in the northbound interface (API Gateway) of the exposure platform. The plug-in facility allows exposure of a multivendor core with overlapping APIs.
- Service mashup and integration to combine APIs with third party public data sources or AI/ML web services. Integrating network resources and telco APIs allows the creation of tailor-made API sets for verticals. The NEF service mashup function transforms core APIs into services, meaning that developers may not need to learn all the related core APIs and SDKs. Instead, they benefit from customized service creation with much larger building blocks of API functions tailored to their type of services.

Figure 6. 5G Service capability exposure in practice



Nokia NEF has a cloud-native flexible architecture for integrating network interfaces and abstracting, composing and orchestrating networking events to create commercial service APIs[2].

The set of APIs under the exposure framework has a detailed description of Software Development Kits (SDKs) and example documentation. Documentation and its related links are best located in the API portal connected to the API exposure framework.

Business transformation use cases

The most common example of the use of APIs is the IMS core and TAS, enabling CSPs to provide additional services on the top of voice calls, such as call divert and call waiting.

More immersive services, so-called Value-Added Services (VAS), go beyond the standard service set. Examples of such services include call park, call pickup, VPN and group call services. VASs will have an important role in creating services for enterprises. TAS Business Centric Services (BCS) take advantage of BCS APIs to create voice-based applications for enterprises.

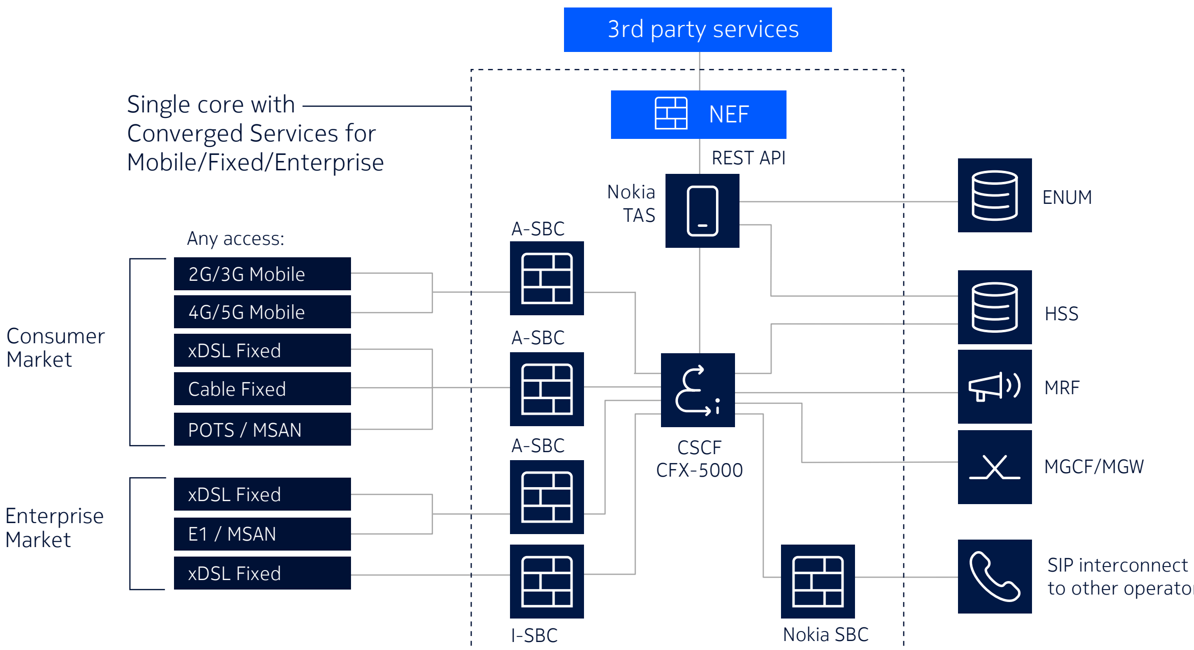
A variety of APIs enable CSPs to develop and offer 5G voice services tailored to the needs of enterprises. The following use cases are based on APIs like IoT management, MEC and analytics, all exposed by the secure 5G NEF.

2 NEF different functions availability are according to Nokia product roadmap.

Use case 1: adopt TAS business centric services for enterprise

Nokia TAS business-centric services are like PBXs or IP PBXs as first-generation VoIP solutions, but provide more flexibility and programmability thanks to a cloud-native architecture. CSP-hosted enterprise solutions can be tailored for different enterprise segments using 5G core access-agnostic features. This enables 5G voice services for enterprises to be provided over a range of licensed, unlicensed, and fixed access technologies, using one network for handling fixed and mobile, including VoNR. Nokia TAS web-based service development offers open APIs for the creation of services for enterprises.

Figure 7. Nokia IMS core fixed-mobile convergence



Use case 2: mission-critical voice communication

Agencies responsible for public safety, emergency medical services, or fire operations depend on mission-critical voice communication. CSPs currently offer mission-critical LTE, which provides mission-critical push to talk and full-duplex voice services alongside mission-critical video and data services. 5G will offer advanced features based mainly on end-to end network slicing across the distributed cloud, including MEC. When 3GPP release 16 deployments become available, 5G will enhance mission-critical LTE with tailor-made network slices. High quality 5G voice services will be an essential component of 5G mission-critical Push to talk or full-duplex voice services.

Use case 3: 5G voice bundled with 5G Fixed Wireless Access (FWA)

5G broadband connections offer clear, reliable voice services that can be bundled into a wider FWA package that enables homes and small businesses to benefit from multimedia applications requiring low latency and gigabit bandwidth. In Nokia's solution, multi-access gateways support different radio access technologies including 5G, 4G and Wi-Fi. CSPs can cost-effectively provide 5G voice services, or even mission-critical voice services, using this solution because no site visits are needed. 5G core programmability enables tailored enterprise voice services to be created, for example for small enterprises whose 5G broadband and voice connection is provided by FWA.

Use case 4: speech recognition and keyword detection-based services

This use case is a collection of services. The most common use being Keyword Detection Systems (KWDs), automatic speech recognition, and natural language generation and processing. Media Resource Function (MRF) capabilities in the IMS architecture enables media manipulation such as voice mixing in ongoing IMS voice calls.

KWD systems may trigger an event if a keyword is detected in a voice call. The keyword is programmable and can be anything in third party KWD systems, such as “Hey Siri” in Apple or “Alexa” in AWS applications. NEF third party MRF and KWD resources to be integrated in an IMS voice call to trigger a third-party applications event. This can be used to start other services such as online translation services or conference calls using the subscriber’s contact list.

The service possibilities are endless. The application developer and service designer decide which public data sources to use and what will be triggered by the speech recognition engine. With 5G, voice-related APIs are exposed by the NEF which makes it easy to integrate the required third-party elements.

Use case 5: personalized voice activated IoT services

Like use case 4, IoT voice activation in smart homes and smart workspaces is used during an IMS call to remotely control smart home assets. This calls for developers to design the service logic to initiate the required smart home or smart enterprise functions.

Use case 6: intelligent voice services - managing multiple personas with fixed mobile convergence

Multiple numbers and customized calling line identities are already commercially available in 4G VoLTE networks. A subscriber can select additional numbers for a subscription and assign them to different profiles like home, work and hobby, to make voice calls according to the actual profile.

Multiple devices can be added to the service, not just the user’s smartphone, but fixed lines, tablets and wearables. Incoming calls to multiple numbers are directed to a device by the intelligence of the service, while outgoing calls are customized with a different number selected from the profile with personalized caller identity. Mobile functionality can be handled in the mobile app to run in different smart devices.

These popular services allow a subscriber to conveniently manage voice services according to their work and personal time preferences or to their calendar. All these services can be realized with the programmable TAS through the IMS core network.

5G enables additional flexibility to further develop intelligent voice services. The access-agnostic 5G core enables these capabilities over any available access type like 4G and 5G, unlicensed wireless like Wi-Fi or MulteFire, or over fixed access.

Conclusion

As CSPs deploy 5G more widely across their networks, open programmability will become increasingly important and create a new platform for 5G voice services. At the heart of these services is the IMS core with its advanced TAS programmable capabilities enabling voice call management. The end-to-end distributed cloud will also require API exposure capabilities across the network, not only in the TAS.

These programmable assets open an endless variety of new service possibilities, and by combining service enabler APIs, new types of services can be offered to different market segments.

The Nokia Network Exposure Function provides a solid foundation for new 5G services that will use 5G capabilities to connect or integrate URLCC or eMBB use cases, and to take advantage of end-to-end 5G network slicing.

5G voice, with its reliability and clarity, can be used by CSPs either as a programmable element of a service or be simply bundled with other 5G services. Such services have great long-term promise to expand the CSP service portfolio and generate new revenue. Success for CSPs will come when they plan and execute their API strategy to exploit the maximum potential of the 5G voice ecosystem. Developers and vendors can also embrace the new possibilities by working openly together and making use of open APIs and the relevant Exposure Framework to support their innovation.

Abbreviations

3GPP	third Generation Partnership Project
4G	4th Generation [mobile radio]
5G	5th Generation [mobile radio]
5G Core	5G Core
Auth	Authentication
API	Application Program Interface
AR	Augmented Reality
AS	Application Server
AWS	Amazon Web Service
BCS	Business Centric Services
CSCF	Call Session Control Function
CSP	Communications Service Provider
eMBB	enhanced Mobile BroadBand
FWA	Fixed Wireless Access
GW	Gateway
IMS	IP Multimedia Subsystem
IoT	Internet of Things
IP	Internet Protocol
IP PBX	IP Private Branch Exchange
IT	Information Technology
KWD	Keyword Detection System
LPWA	Low Power Wide Area
LTE	Long Term Evolution
MEC	Multi Access Edge Computing
mIoT	massive Internet of Things
MRF	Media Resource Function
NEF	Network Exposure Function
NF	Network Function
NR	New Radio
NSA	Non-Standalone
OMA	Open Mobile Alliance
OSS	Operation Support System
OTT	Over the Top
PBX	Private Branch Exchange
ROI	Return on Investment
SA	Standalone
SCEF	Service Capability Exposure Function
SDK	Software Development Kit
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SME	Small Medium Enterprise
SMS	Short Message Service
TAS	Telephony Application Server
TCO	Total Cost of Ownership
UCC	Unified Communications and Collaboration
URLLC	Ultra-Reliable Low Latency Communications
VAS	Value Added Services
VoLTE	Voice over LTE
VoIP	Voice over Internet Protocol
Vo5G	Voice over 5th Generation [mobile radio]
VoNR	Voice over New Radio
VoWifi	Voice over Wi-Fi
VoX	Voice over X
VPN	Virtual Private Network
WiFi	Wireless Fidelity

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