Capitalizing On The Evolved Communications Experience

A Technical Paper prepared for SCTE•ISBE by

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Introduction

Almost 20 years after the first communication service providers began talking about "all IP" as a vision for network evolution, we have reached a stage were a vast majority of services are being delivered according to an architecture where IP is truly used end-to-end, including in the end-user devices, and at scale.

About 10 years ago, Android was introduced, helping to reduce the number of mainstream platforms in popular devices – most notably smart phones, tablets and TVs. Android quickly became an application development ecosystem, and a very open one, easy to integrate into various types of networks.

About 5 years ago, the industry took a few first vital steps towards communication services delivered from private clouds, which can be defined as using Network Function Virtualization, to deliver software only applications onto an independently provided cloud platform. These are just the first steps on a journey that will bring greatly enhanced automation, elasticity and flexibility in deployment, based on improved analytics and agility, as well as a much-needed performance improvement.

The upcoming introduction of 5G for wireless, will bring enterprises and consumers onto a common and shared all-IP network, providing both an internet and communication service experience that is much enhanced. This will be possible because of a highly distributed cloud, orchestrated to provide both enterprises and consumer segments and use cases, with the look and feel of running on their own (dedicated) network.

In this paper, we will be examining a set of communication use cases and trends which all can enhance and differentiate the end user experience, improve revenues, and reduce churn. Each of these have dependencies on one or more enablers from the four technology waves above, in order to be able to scale and multiply. Our objective is to drill down on these technical dependencies, with the objective to "show the path" to realizing them.

We have elected not to cover regulatory opportunities in this document, mainly because user experience is at the center of the theme, and user experience for mission critical and government services such as Wireless Priority Service (WPS), are driven by different factors than for consumers and non-government enterprises. It is understood that the regulatory opportunities right now are indeed very exciting and are certainly an increasingly important part of what the communication services industry needs to address moving forward. Perhaps, deserving of its own document.

It should be noted that this document is a technology inventory of trends, use cases, and dependencies. Not all of them apply to any one reader. Each vendor and each service provider will need to decide which enablers are relevant, and should also consider additional trends, use cases and enablers, applied to their specific situation.

Content

1. Consumer communciation trends and use cases

1.1. Companion Devices

During most of this decade, smart phones and home phones, have been joined by other popular device types such as tablets and wearables, and smart-home devices, into what is a growing ecosystem for communication and entertainment, providing enhanced features to the existing services. The new communication features are

a. Multi-Device, which is the ability to consume the service, on multiple devices including companion devices
b. Multi-Persona, which is the ability to use multiple identities such as phone numbers, on a single device, for example one work identity and one personal identity
c. Multi-User, which is the ability to share a common group identity, e.g. a family number, in addition to the personal identities of each group member

These capabilities greatly enhance the end user experience of the communication service and can in many cases increase usage of the service. Perhaps more importantly, service providers can find ways to differentiate, i.e. create a "stickiness", and thereby reduce the risk of churn.

Million	2017	2018	2019	2020	2021	2022	2023
Fitness & activity trackers	58.0	65.0	71.5	78.7	82.6	86.7	88.9
Smartwatches	29.5	45.5	56.9	71.1	85.3	102.4	117.7
Smart glasses & HMDs	0.2	1.5	3.2	5.1	7.7	10.0	11.9
Medical devices & mPERS	1.3	1.8	3.0	4.9	5.4	6.1	6.9
Others	2.0	3.0	4.5	6.5	9.0	11.0	13.0
Total	*91.0*	*116.8*	*139.1*	*166.2*	*189.9*	*216.2*	*238.5*
Cellular attach rate	6.7 %	13.9 %	17.2 %	20.4 %	22.8 %	25.8 %	28.4 %
Cellular device shipments	6.1	16.2	24.0	34.0	43.2	55.8	67.7

Figure 1 - Connected wearables shipments by device category (World 2017–2023).

Source: Connected Wearables, M2M Research Series 2019, Berg Insights

This trend will continue, driven by for example a projected strong growth in wearables shipped globally (figure 1), in particular wearables that are suitable for voice, like smart watches.

1.2. Personal Assistant / Smart Speaker

After its introduction just a few years ago, the smart speaker or personal assistant has been tremendously successful, particularly in North America. This device represents a shift to smart home, and a completely new type of user experience / life style. This device type integrates to the smart device ecosystem in the house, but it also very quickly became integrated to the smart phone and the home phone, for making and receiving calls, sending text messages, etc.

Smart Speakers come with their own phone number, so that you can communicate with telephony devices on public networks but is otherwise lacking in integration to the communication services providers.

Some communication service providers and smart speaker providers are now taking steps to further integrate their services, like in the example of Vodafone and Amazon.

(Reference 1)

This type of tighter integration provides several benefits:

- it removes the need for a separate new phone number, associated with the smart speaker
- other devices in the home can become companions to the smart speaker, and these can for example have simultaneous ringing with the smart speaker when the family number is called
- it can increase usage of all the services in the smart home
- it can reduce churn

As smart homes and smart speakers continue to evolve, we will certainly find new use cases for integration to communication services. Revenue connected to smart speakers is expected to grow at an average of 2B USD per year annually, and reach 12 B USD annually in 2023

(Reference 2)

It will be important to find added value for both the communication service provider and the smart home device vendors, so not all use cases will be sustainable.

1.3. Audio / Video Doorbells

Another recent and emerging communication device in the North American smart home is the connected audio / video door bell, with a similar growth projection as the smart speaker.

(Reference 3)

The communication aspects however, are quite different. Although many of these doorbells will not be by the front door, the primary value of this category of device is security of the home owner and their family. Also, the identity of at least one of the participants in a typical “doorbell call” is potentially unknown and inherently not trusted.

Perhaps therefore there really has not been any notable integration between the doorbell and the communication service providers. The doorbell provider typically provides a smart phone application, and the communication is handled over a pure internet channel between the smart phone app and the doorbell, remote controlled by the home owner.

However, in the broader context of a smart home, a market need for communication integration to this type of device could very well develop over the next few years, driven by for example the following needs;

- Video Quality. Video quality is one of the most important characteristics of the doorbell as a security device, and the improvement of video quality in the doorbells we expect to see in the next several years, may drive the need for a higher video Grade Of Service (GOS), which in term will drive the need for traffic prioritization, which communication service providers specialize in.
- Security itself. If the communication service provider also provides the security system and the video doorbell, then there are several other enhancements that can be made based on the trust relationship between the home owner and the service provider. An example of this is the possibility of a "grey list" of people with conditional access to the home, through for example biometrics, or digital credentials (bar codes).
- Another interesting ability which has already been applied, is to integrate the doorbell with a smart speaker (see section 1.2), which was showcased at Consumer Electronics Show this year (Reference 4). This type of integration / companionship could create additional value for communication services.
- Emergency services, which can be needed at the outdoor camera spot, by anyone, is a third potential use case that can be added. The communication provider is many times already providing this for the address of the doorbell, and it can be triggered by a button on the doorbell, of from the home owner smart phone.

Overall, the video doorbell, while not yet communication service provider integrated, deserves keeping an eye on, and behind the smart speaker it is perhaps the second most interesting point of integration, into the smart home, from a communication service perspective, looking forward.

1.4. Improved communications at venues

Many service providers, including cable operators, are today providing broadband, Wi-Fi and cellular coverage at venues, which have traditional suffered from poor connectivity and bandwidth. For this section, these service providers will be called "wireless" service providers. This is done as a business-to-business arrangement with the landlord/venue.

Whether the context is sports, music or other entertainment events, there is a growing trend of making use of this improved coverage, by opening a channel to the audience to improve their experience of the event. This can include social networking, voice, chat, group messaging, real time statistics, replays, back-stage contexts, alternative camera angles, different monetization strategies can be explored, including advertising.

Depending on who the venue, and content partners are, two business models are feasible or can be combined:

- Business-to-Business-to-Consumer (B2B2C)
  The wireless service provider participates in a joint model with the venue/content owner, to facilitate a complete set of services to the audience.
- Business-to-Consumer (B2C)

The wireless service provider can provide their communication, mobility and internet connectivity services directly to the audience member. This is sometimes referred to as a retail service.

B2C enriched / advanced messaging – an add on to Rich Communication Suite (RCS) messaging, can be leveraged by the wireless service provider, to provide an advertising channel to the audience member. Note that this is sometimes referred to as RCS Business Messaging.

For more on RCS Business Messaging see (Reference 5)

1.5. Fixed Wireless Access (FWA) with consumer Voice over IP (VoIP)

As the industry is rolling out FWA – a technology on the way to 5G introduction in mobile networks, there are also initiatives to provide this service using unlicensed spectrum in the 3.5 MHz frequency band, so called Citizens Broadband Radio Service (CBRS).

So far, the cable service providers have not engaged on this opportunity, but some of the wireline operators are exploring it. The reason is that there is no business case for replacing existing cable access, and it is more feasible to compete against Regional Bell Operating Companies (RBOCs), using the traditional cable access.

However, as the technology evolves, and as the industry spectrum situation becomes clearer across North America, FWA may again become feasible as an alternative to cable access, within territory of each cable operator.

If FWA becomes viable, an immediate question and concern will be whether the service provider should offer home phone service. Key questions and concerns will be:

- Voice and Internet should be supported in the same chipset, in the FWA modem, to improve business case over current situation
- Should voice be standardized, and aligned with the VoLTE service "without mobility", i.e. equivalent to Multi Media Telephony (MMTel) standards, and therefore be less aligned towards the voice service provided by the current Multiple System Operator (MSO) covered homes?
- What should be the value-added voice related services provided as part of the Quad Play?

2. Business communication trends and use cases

2.1. Enhanced voice call and WebRTC enrichment

Several service providers are looking to provide their business customers in the small and medium segment, with ways of enhancing existing voice services, which is being provided to the business by the service providers. These existing voice services being enhanced can be

a. mobile subscriptions for the employees, with 2G/3G Circuit Switched (CS) based voice, or Voice Over Long Term Evolution (VoLTE) for capable devices
b. Unified Commication (UC) service with support for VoIP on desk phones, computers, and potentially also to those same employee VoLTE enabled mobile devices (see section 2.2)

c. Customer support, for terminating traffic to the business from any device that is capable of Web RTC (Web based Real Time Communication).

The enhancements can be of two types:

1. For service a and b above, the service provider can provide pre-call, during-call, and post-call enrichment of the call, which includes a broad suite of messaging, photo and file sharing, group features. This generally requires an upgrade or a re-configuration of the core network, to support the necessary triggering functions, and an application server upgrade, or re-configuration to support the specific use cases.

   The Global System Mobile (GSM) Association (GSMA), has defined these services, based on RCS 2.0 (Reference 6), which is broadly supported among service providers.

2. For service c, co-browsing, can be introduced to enrich the voice call end user customer experience, across mobile devices, tablets and laptops. Co-browsing means that the customer support person and the customer can view the same web page, including the cursor/pointer, during the call. If needed, a co-edit capability can be added for e.g. jointly filling in forms.

   For a quick demo of co-browsing, see (Reference 7)

   As part of Hypertext Markup Language revision 5 (HTML5), the WebRTC standard provides real time communication between the customer support agent and the customer, including the use of a data channel, which can be used for the co-browsing, and other enrichment to the voice/video call. For more on this, please see (Reference 8), and the enabler section 3 (Technology Enablers).

   There is a lot to gain for a business by providing "in context" communication whether it is for the employees, or for the customers of the business. Both RCS enriched calling and the customer service with co-browsing solutions provides sustained relevance, can increases usage of existing services, and improve the ability to retain the business customer.

2.2. VoLTE for UC - Integration of VoLTE with Enterprise UC

For over a decade, service providers have been looking for a cost-efficient way of adding mobility to existing enterprise voice services, especially in the small to medium segment of businesses, where it is possible to bundle mobile subscriptions for the employees, into the overall business with the business.

This has proven difficult for the following main reasons:

- 2G/3G networks were lacking the standards to provide an integration to Business Voice and were limited to the Primary Rate interfaces between a Mobile Switching Center (MSC) and on-premise Private Branch eXchange (PBX), which did not support making the PBX service available on the mobile. A few "point solutions" did exist, most of which were not successful, mostly due to a poor end user experience.
- The IP Multimedia Subsystem (IMS)-standards had more support for hybrid services, but were aiming to support new services, as "add-ons" or extensions to a base IMS application, through so called "chaining" over the IMS Service Control (ISC) interface, between the application server and the IMS-core.

- Business VoIP, and VoLTE have not been standardized to complement each other, but rather have large overlaps in functionality. Subsequently, when you use ISC-chaining, interactions get complicate.
- ISC-chaining does not support having multiple Enterprise UC solutions integrated with the same IMS-core
- Some of the UC solutions are only available as cloud services (private, or public), and it is difficult to connect to those over the ISC-interface.

There are now new ways to possibly solve these issues, based on separating the two services into two IMS networks (could potentially still be served by one IMS), and handle this the same way we do when we interoperate between two VoIP networks, with a Network-to-Network Interface (NNI), and a Network Session Border Controller (N-SBC). The UC solution does not have to be IMS-based but can be based on the predecessor architecture – soft switching but needs to support Session Initiated Protocol (SIP).

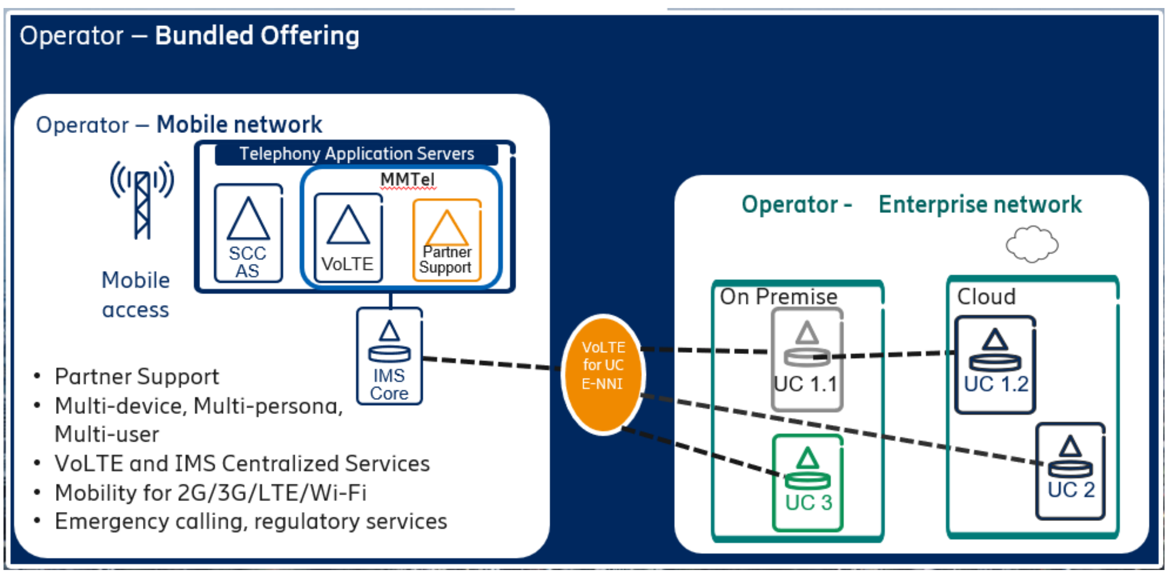

Figure 2 - NNI-based VoLTE for UC Source: Ericsson

Initial trials and a few production deployments have shown very promising results. In the service provider, there are often two different groups operating the UC service and the VoLTE service.

To summarize the market potential of VoLTE for UC:

- Provide a value added "UC on the road", on the mobile device, as a potential up-sell
- Reduce dependencies and complexities by splitting the solution into two domains, each with its own SIP-network, and thereby creating a "separation of concerns".
- Allow independent evolution of each service
- Solve any remaining interactions by negotiating / iterating a "new" NNI or Application Programing Interface (API)
- Can potentially also be used to collaborate between service providers where one provides business services and one VoLTE services

It is important for service providers to grow both their enterprise business and consumer business separately, and to find ways to do so in an efficient way.

As the service provider network expands and starts to serve a larger number of constituents or "tenants", such as enterprises, Mobile Virtual Network Operators (MVNOs), wholesale partners, the more modular and distinct each piece of the network (network slice) is, the easier it will to continue scaling the business.

2.3. Voice for Internet Of Things (IOT)

2.3.1. Introduction

The Internet Of Things represents a tremendous growth segment for several different types of service providers, including communication service providers. As an industry, we have all been engaged for several years, we have solutions that are live, and more to follow in the next 12 months.

In parallel, the industry business blueprint is still under construction, as various actors are trying to jointly build an ecosystem, determine our individual roles, how to be successful within that role, and more importantly how to stretch that success to the use cases and business.

In this section we will discuss some common themes and experiences of this first generation IOT, what services providers have done in terms of communication services. In the next couple of sections, we will investigate particularly interesting use cases with Voice for IOT Enterprise, and how service providers can sustain and grow "share of overall value".

We will intentionally skip the 2G and 3G based IOT-solutions, which at the time were labeled "Machine-to-Machine" (M2M). These were almost entirely sensor based and have evolved into what is now called "narrowband IOT". These devices are not voice capable and there is typically no need for voice at all.

Please also note that "smart home" developments are already covered in section 1.2 and 1.3 of this document, and are considered consumer communication services, so will not be covered further here.

2.3.2. Connected Cars

In this industry, the large global car Other Equipment Manufacturers (OEMs) are at the top of the value chain, and are looking for a standard set of capabilities – the very basic one being telematics / engine data channel - which can be deployed globally to support their network of factories and dealerships, including the following expected from communication service providers

- Concierge voice service for the vehicle and anyone in it
  The car is equipped with microphone, speaker and a concierge button, which can be pushed to get any help such as road side assistance or help with directions. This is typically a subscribed service.

- Emergency Service (eCall)
  An eCall can be initiated either by pushing a separate emergency button, or through the concierge service. It can also be initiated automatically, if the car is able to detect a crash. In either case, the call will be routed to a local Public Safety Answering Point (PSAP).

- Terminating call screening
  Callback of any kind to the car is only allowed from the PSAP and the Concierge service

Voice traffic is very low to the vehicles, and besides the three features above, there are a lot of features on traditional mobile soft switches, and IMS-cores that are not used.

The solution must be scaled down from a feature and capacity point of view and scaled up from a global reach and roaming point of view.

OEM (Other Equipment Manufacturer), MNO (Mobile Network Operators – providing Radio Access Network (RAN) in the different global regions), the Mobile Virtual Network Operator (MVNO) – the Service Provider, and perhaps a third-party host for some shared cloud-based capabilities (multi-tenant) must come together to make this service work everywhere.

Part of the requirements are regulatory, which means they represent an initial investment needed to get into the business.

In addition to the communication services, the Mobile Virtual Network Operator (MVNO) can take part in a retail service, where backseat passengers can purchase on-demand content from the MVNO. This is not a communication service, but a potential upside in the business case.

Worth mentioning is that there are alternative business models for the basic connected car above, where the driver builds their own ecosystem based on the open interface available as a standard on vehicles manufactured in the IOT-era. The service providers can potentially also address this space, but in vastly different (e.g. lower cost) ways.

2.3.3. Fleet Management

If we take a step northbound in the value chain, communication services providers can participate in Fleet Management, which is the scheduling, dispatch, service delivery, and payment part of small/medium businesses fleets of vehicles, which is a business towards the Enterprise owning the fleet, and not the car OEM. The Service Providers may provide all or just a few of the following:

- Connectivity and communication kits for each vehicle
- telematics
- geo-location, navigation
- fleet data collection
- dispatch / Push-To-Talk (PTT) – communication
- business messaging - communication
- machine learning

2.3.4. Elevators and Alarm Panels

From a functional point of view, this category of devices operates very similar to the connected car. A speaker and a microphone are present in the elevator or at an alarm panel by an un-manned door / gate. In an emergency, a single button call to a security officer / central location is made. These devices are typically of the type CATegory M1 (CAT-M1).

For a service provider point of view, this service is quite local to the geography where they are already present. Traffic is even lower from these devices than from the vehicles, so for any existing service provider voice infrastructure that is IP-based (IMS or soft switch), it may make sense to reuse it, if the devices supports the access network (Wi-Fi, GSM, CDMA 1x, LTE).

For anything else, that is non-existent, a common example is Subscriber Identity Module (SIM)-management, a centralized 3pp managed, multi-tenant solution should be considered to lower Total Cost of Ownership (TCO), especially if you look at this communication use case, as an isolated business case.

2.4. Augmented Reality (AR)

Augmented Reality, sometimes also referred to as Mixed Reality (MR), is expected to grow to a 14B USD business by 2022, as estimated by Forbes (Reference 9). Many of the use cases include "in-context" communication (see also section 2.1).

A good example of such solutions under trial, is "remote manufacturing".

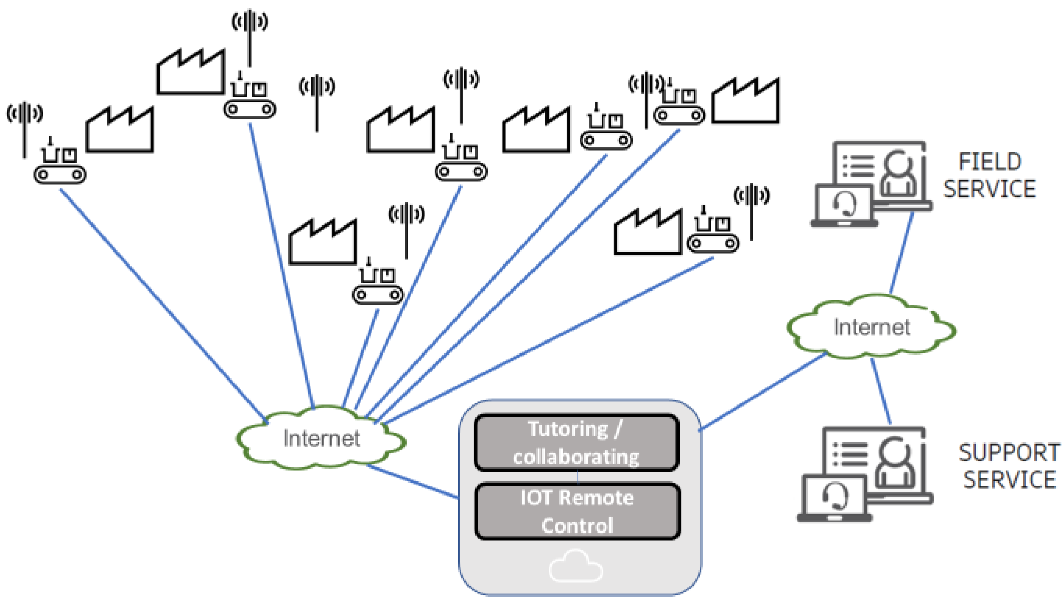

Figure 3 - Network architecture for remote manufacturing

Source: Ericsson

If an enterprise has factories in several geographic locations and has expensive and complex manufacturing machines in those locations, it is a common need to have a centralized a smaller group of experts (support service), to assist teaching and servicing field technicians on site in the factories.

Tutoring use case

During an audio / video session between a support engineer and a field technician, a support engineer is to be able to capture in real time, the status of a machine at a factory, using the service "IOT remote control", provided "as-a-service" by the service provider. The support engineer can then use the tutoring and collaboration service, to show the field technician the finding, by sharing the capture, and pointing to certain readings etc.

Remote control use case

The support engineer can also use the same services, to actively control the machine from remote, while the field technician can observe, both the machine "in reality" and the remote control being done, as it happens.

As we move towards 5G, new low latency services will be possible, based on a highly distributed cloud capability. For this use case, performance will improve in terms of latency, as it will be possible to push / distribute the cloud data center closer radio network at each factory.

Given that the factories and the machines are a sunk investment, the service provider here, has more "share of value" as this capability helps lower the overall TCO, as training relatively many remote technicians from a central location using relatively few experts.

2.5. Smart Speaker for business

We already covered smart speakers in section 1.2, but this device is also making its way into the enterprise. There are already enterprise versions of the smart speakers available, and integration to popular enterprise office software, including security and privacy systems is ongoing.

As we have already examined, the smart speakers have a natural fit with "in-context communication", including UC, as well as customer support scenarios. Other use cases will surely be based on conference rooms and other collaboration spaces.

Service providers will need to continue making sure that the smart speaker can be a companion to their offered services, and conversely smart speaker vendors need to make sure that other office devices can be companions of the smart speaker.

3. Specific Technology Dependencies

In this section, we will describe the specific enablers we need to realize the use cases and trends in sections 1 and 2. We will focus on the enablers that have not already been described in sections 1 and 2.

In section 4, we will describe common enablers, based on a conceptual blue print, to outline common needs across these use cases, that also depend on service provider scale, ambition and approach.

3.1. Consumer Communication Dependencies

Specific functional technology dependencies
Consumer

Dependency / Trend/ Use Case	EPC ePDG.TWAG & AAA-server	IMS-extensions for Multi-X	Secure Entitlement	IMS-extensions new video codecs	B2B2C APIs B2C APIs	RCS Business Messaging	Camera feed enablement	VoLTE + Internet in one chipset
Companion Device	✓	✓	✓					
Personal Assistant	✓	✓	✓					
Audio / Video Doorbells	✓	✓	✓	✓				
Improved communications at venues					✓	✓	✓	
FWA with Consumer VoIP								✓

Figure 4 - Dependencies on feature functionalities for the consumer trends and use cases

Source: Ericsson

Wi-Fi-calling, which is used by smartphones and traditional companion devices like tablets, requires additional capabilities in the Evolved Packet Core (EPC):

- Enhanced Packet Data Gateway (ePDG). This is a secure termination node for IP Security (IPsec) tunnels established by the User Equipment (UE), supporting untrusted Wi-Fi.
- Trusted Wireless Access Gateway (TWAG). This is a secure termination node for protocols like GPRS Tunneling Protocol (GTP), for trusted Wi-Fi.
- AAA-server. Provides Authentication Authorization and Accounting and interworks with the cellular Home Subscriber Server (HSS), for access to cellular services when on Wi-Fi.

The IMS-extensions for Multi-X, supports Multi Device, Multi Persona and Multi User, as defined in section 1.

Secure Entitlement Server (SES) is a solution that interworks with the UEs, to get provision them in the Core Network for the companion device services, which are different in each service provider.

Whenever we add higher quality video (in doorbells), we may need to add support for that codecs, in the core network, so that you can have interoperability with devices that do not support the new format.

The venue uses cases require the different stakeholders such as the landlord, a sports league, and the service provider, to jointly provide the services. This in turn requires Application Programmable Interfaces (APIs), between the partners to settle billing, usage, exchange content etc.

3.2. Business Communication Dependencies

Specific functional technology dependencies

Business

Dependency / Trend/ Use Case	IMS-based or IN-based in-call triggers	RCS 2.0 + enriched calling	In-context Web RTC IMS enablers	UC Partner extension on IMS	VoLTE for UC NNI-solution	Global SIM-management and connectivity	IMS/MSC support for Concierge + eCall	Fleet Management App Suite	Chipset support for VoLTE
Enhanced VoLTE call and Co-browsing	✓	✓	✓						
VoLTE for UC				✓	✓				
Voice for IOT Connected cars						✓	✓		
Voice for IOT Fleet Management							✓	✓	
Voice for IOT Elevators and Alarm Panels									✓
Augmented / Mixed Reality	✓		✓			✓			✓
Smart Speaker for Business (TBD)									

Figure 5 - Dependencies on feature functionalities for the consumer trends and use cases

Source: Ericsson

The Intelligent Network (IN) and IMS triggers are needed to trigger the enhanced service from a VoLTE call that has already been initiated.

There is a need for an operator owned RCS server, compliant to RCS 2.0 + enriched calling, to enrich a VoLTE call with messaging, carrying different media types such as hyperlink sharing and photo sharing.

The in-calling WebRTC with data channel, can be triggered from a WebRTC Gateway, which is often combined with a Session Border Controller (SBC), part of IMS, or it can be triggered from an ongoing call.

To implement VoLTE for UC, a UC-partner extension is needed as part of IMS, plus also a set of rules specified in an existing or new Network SBC (N-SBC), to implement a Network-to Network Interface (NNI), between the UC-network, and the VoLTE network.

For Connected Cars, if you as a service provider are aiming to provide global support for a car manufacturer, you will need a global SIM-management system, and connectivity to the various MNO RANs in the different geographies. The Service Provider will be an MVNO and will connect to the MNO RAN, using the VoLTE Roaming architecture for Home Routing.

Note that you can also choose to play only locally (e.g. US only), for a car manufacturer, depending on the spectrum situation, you can may also use the MVNO architecture, or you can be the MNO. You can also be MNO in some areas and MVNO (with MNO partner) in other areas.

4. Common technology dependencies

In this section, we will walk through the technology enablers that reside in the cloud platform. Many of them are "non-functional" meaning that they are not providing any applications and they are not enabling any voice calls or internet sessions. However, they manage, optimize, secure and organize the cloud.

These enablers support multiple use cases, but how many of them you need, also depend on your ambition level when building your service provider cloud.

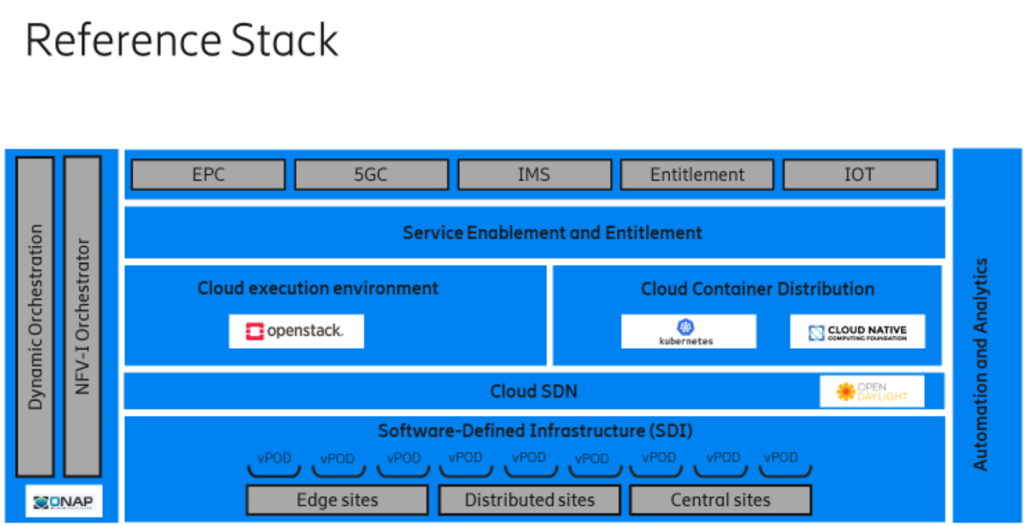

Figure 6 - Reference stack blueprint

Source: Ericsson

To guide this section, figure 6 represents a conceptual blueprint that can support the core network aspects that we are focused on in this document, showing the non-functional enablers combined in to conceptual "reference stack".

We will use this to figure to explain these dependencies.

4.1. Enablers Explained

4.1.1. NFV-I Orchestration and Cloud Execution Environment (CEE)

Cloud Execution Environment (CEE): CEE is an Infrastructure-as-a-Service (IaaS) solution. It is typically based on OpenStack, with additional features that expand its flexibility of use and meet the needs of communication service providers.

Openstack is an open source platform and has a wide participation in the service provider and IT space. Code is contributed by vendors to the service providers, and service providers themselves. The focus of the communication service providers has been on performance enhancement for our industry. This helps operators to avoid vendor lock in, benefit from the standard open interface and leverage on community fast evolvement.

The CEE is a software layer that manages the physical resources, which in the blueprint is called Software Defined Infrastructure (SDI). The resource managed are:

- Compute (CPUs)
- Memory
- Storage
- Networking / Switching

Openstack supports a set of APIs that can be used by the service provider to manage the cloud and the applications on it. An application / Virtual Network Function (VNF) can be on-boarded onto the cloud, instantiated (equivalent of installed in the physical world), and configured, and launched. Capacity can be expanded, or reduced, and the VNF can be upgraded, and decommissioned. There are also management APIs that provide performance statistics.

Network Function Virtualization Infrastructure (NFV-I) Orchestration entails performing these functions on a per application or VNF basis, continuously, and across several pods, as shown in figure 6. One data centre can have several p ods. Each is an instance of the cloud, but the orchestrator is used to combine PODs into a network level cloud. The cloud itself can spread across many sites. Each VNF typically comes with an Element Management Server (EMS), which in standards is called a specialized VNF manager (S-VNFM).

This element knows the context of alarms and performance counters for its VNF or set of VNFs. Northbound, the VNFM interfaces the Orchestrator and takes part in digital "work flows", that consists of instantiating, expanding, or contracting the VNFs, across the physical resources in each pod.

4.1.2. Automation and Analytics

The Orchestrator is providing automation of some basic tasks, but by using additional tooling we can automate more of the operations. By applying analytics of the performance of the cloud, we can also create Closed Loop Automation. A very good example of this is "self healing". This is a process whereby the cloud can detect a piece of hardware as mal-functioning, is able to quarantine it, identify the applications / VNFs impacted (currently suffering from capacity degradation), restore the lost capacity on a new (healthy) server, and expand the affected VNFs to restore the capacity.

The other type of automation that can be supported has to do with Continuous Integration / Continuous Deliver (CICD). Service providers are adding tooling to receive software releases from the VNF vendors in a purely digital way, by connecting the vendor CICD systems with the Service provider Systems. By doing this, new features can be delivering quicker. CICD also provides ability to run predefined test cases, so will an opportunity to verify that the system performs well, before taking the new software into service.

4.1.3. Service Enablement

This is the ecosystem support for the cloud, and this layer is responsible for exposing capabilities of under lying layers, towards application developers, using APIs. There will typically be several different service enablement components in this layer. Billing is perhaps the most obvious component. IOT may have one exposure component, and IN, and IMS have another one, and Entitlement can be a fourth component. Application providers from different industries will be able to put together the end user experience and complete it.

A good example of this type of application is developers of "in car camera feed (audio/video), for racing. APIs will need to be exposed from the enablement layer, to allow the application provider to tap into this feed from the platform. For optimal performance, this application should execute on premise at the race track, so should be distributed there.

4.1.4. Container Distribution

Most of the enablers described in this section uses a virtual abstraction that can run on physical hardware, called Virtual Machines (VMs). A rich ecosystem has formed around these. As we approach 5G, the industry is looking at containers, as the next evolution steps. The most famous container execution environment is called Kubernetes.

A container is more efficient than virtual machines, because it does not allow the applications / VNFs to bring their own Operating System (OS), labeled "guest OS", and load it on an underlying "host OS". This provides a lot of flexibility as you can put a variety of different software with different OSes on the same cloud, but has drawbacks when it comes to performance, since the guest OS loaded on each VM will use extra CPU-resources etc. In a container environment, there is no Guest OS, and all applications must agree to run on one and the same OS, the container OS; frequently Linux.

We will see clouds introduce support for 5G Applications using Containers, but several different combinations will exist.

Initially, both VM and Container will be supported as well as Containers on VMs. Later, as container distributions and orchestration mature, VMs may disappear. The IT industry has been using containers for some time, so experiences from that can be reused.

4.1.5. Dynamic Orchestration

Dynamic Orchestration is an extension of Cloud Orchestration, and can be delivered by the same product, or as separate products. Dynamic means adaptive, so able to partake in closed loop automation.

Whenever we need to orchestrate not only single VNF but complete groups of VNFs, then we talk about a network slice – something that is treated like a separate network, for instance the same common VoLTE IMS-core could serve multiple VoLTE for UC network slices (see section 2)

a) One for each UC vendor
b) One for each enterprise with the same UC vendor
c) One for each UC vendor and enterprise

Another important area for dynamic orchestration is multi-site / multi data-center deployments. This is key for the distributed cloud that is envisioned for 5G. We must be able to instantiate and orchestrate a virtualized and containerized network with sites distributed closer to the end users, to achieve the performance envisioned. To do that we need two main ingredients.

i) ability to orchestrate a network slice or group of VNFs across multiple sites
ii) ability to dynamically allocate and configure the transport network between the sites, using Software Defined Networking (SDN). This means that SDN is moving from just supporting each cloud data center or site, to supporting also the transport network.

SDN means that physical (e.g. fibre) capacity exists for example to a football stadium in over-capacity, but whenever the stadium is not used, then software capacity, including layer 3 virtual routing, that is needed to use the allocated physical capacity, is moved somewhere else.

Dynamic orchestration hence implies digital coordination with SDN-controllers, deployed as part of the SDN-layer in a larger data-center, must be part of the orchestration end-to-end. That way, when the football game is about to start, adequate capacity to support it can be moved there, as part of dynamic orchestration.

4.1.6. Cloud SDN

Cloud SDN simply implies both in-data center Software Defined Networking, and the site external SDN transport capability described in section 4.1.5, by means of an SDN-controller.

4.1.7. Distributed Cloud

Distributed Cloud means supporting a new type of site, further distributed than ever before, which the cloud can “spread” to, and were applications with extremely stringent requirements for low latency, can be orchestrated and configured dynamically. Sometimes the term Edge Compute is used for this as well, as described in section 4.15 and 4.1.6.

4.2. Service provider scale, ambition and approach

In this section, we will be reviewing some ambition levels among service providers, and how they map to the non-functional common enablers.

Common non-functional technology dependencies

Scale, ambition and approach

dependency / use case, scale, ambition or approach	NFV-I Orchestration + cloud execution env.	Automation and Analytics	Service Enablement	Container Distribution	Dynamic Orchestration	Cloud SDN	Distributed Cloud
Appliance operator or use case (network-in-a-box)	✓	✓					
Multi tenant operator, with cloud operations	✓	✓			✓		
5GC Multi tenant operator, with cloud operations	✓	✓		✓	✓	✓	✓

Figure 7 - Segmenting Service Providers across common enablers

Source: Ericsson

There is a high demand in the market for what is sometimes called Appliance, which means that it is a single tenant and single use deployment, which is static and hence does not need any dynamic orchestration.

Smaller service providers are often looking mainly for a smaller and more economic form factor and scale

But even larger operators are often interested in the ability to single out a use case, an enterprise, or a situation, and use an appliance, while we are waiting for advanced dynamic orchestration and network slicing, which is still a few years out.

Even after dynamic orchestration is out, there may be cases such as international deployments where the service provider is not present, or government critical infrastructure which simply cannot be shared, where appliance will still have a place.

Service Providers that choose the appliance model, still need cloud / NFV-I Orchestration and will also still need automation and analytics, but may not make use of the other enablers, as depicted in figure 7.

Cloud Operations, means running a separate organization just for the cloud platform described earlier in this section, taking full life cycle responsibility for that cloud platform, the vendors, and the open source software, and running it as a business separate from the application business. The cloud is distributed over multiple data centers, which brings the need for dynamic orchestration.

Those same service providers that are running cloud operations, are expected to start distributing further in the network in 5G time frame. No doubt, there will be some new service provider entering as well. In 5G timeframe, you will need a distributed cloud, so you will need almost all the enablers described earlier in section 4.

4.3. Advanced Use cases common enabler dependencies

In this section, we will be reviewing the more advanced use cases, and their dependency on common enablers.

Common non-functional technology dependencies
advanced communications use cases

dependency / use case, scale, ambition or approach	NFV-I Orchestration + cloud execution env.	Automation and Analytics	Service Enablement	Container Distribution	Dynamic Orchestration	Cloud SDN	Distributed Cloud
4G AR/MR	✓	✓	✓				
5G AR/MR	✓	✓	✓	✓	✓	✓	✓
Improved Communication at venues in 5G	✓	✓	✓	✓	✓	✓	✓
Enhanced Voice Call and Co-browsing	✓	✓	✓		✓		

Figure 8 - Common enablers across advanced use cases

Source: Ericsson

The use cases in this section, which have all been covered in section 1-3, are advanced mainly because they have dependency on low latency and therefore dependent on a distributed cloud and dynamic orchestration.

In 4G, some of these capabilities are not available.

Also noteworthy is that Service Enablement is needed for all of them, which means these are “ecosystem dependent”. Without an ability to expose APIs towards developers, a service provider will not be able to be successful in scaling and growing these businesses.

Conclusion

For sure, making a one-on-one voice call just to say hello, is a service in decline. Like many other “mainstream” services, it has been replaced with several interesting niches. Everyone is now watching separate TV-shows so there is no “common ground” at the proverbial “water cooler” anymore.

In some of the “voice niches”, voice communication has an increase in value and an increase in usage, across age-segments.

It is up to each communication service provider to seek those out, and to connect them with other user experience values that they add, in their current business.

Some of these are obvious – content and media, broadband service, mobility. Some are more subtle, but just as important – trust and privacy, security, emergency services.

In North America, just the increase in connectivity options and devices drive a lot more opportunities across consumer and enterprise segments.

A few factors stand out, when reviewing the use cases and technology enablers in this document, in terms of how to address growth based on user experience going forward:

1. **Eco-system is vital.** This is another important strength in the cable industry. It has always been an eco-system, and collaborative. APIs will need to be opened up, for the service provider to be relevant in some of the key ecosystems like the smart home, the smart business, and the smart venue

2. **Platform matters.** The platform is very different now. It is open source, it is a separate business, and it is multi-vendor, but it is fundamental in seeking out the right niches, and enabling several very different businesses, to choose a service provider, for instantiating their own network slice, on the multi-tenant cloud.
   Key platform Decisions:
   - Appliance or cloud operations?
   - Single tenant, or multi-tenant with dynamic orchestration?
   - Distributed cloud or not?

3. **The biggest competitor to one-on-one voice, is text messaging**, another service you can bring with you…now evolved to RCS Business Messaging, with an opportunity to introduce and advertising revenue stream. How can that be captured? How can the cable ecosystem add value?

4. **Communication is now in-context, which exponentially increases its value**. Remote Manufacturing is dependent on the voice/video communication, to provide tutoring and remote control. A concierge call, or eCall from a connected car has very high value, and gamers are preferring a separate voice call over in-game voice, which also survives switching from one game to another…so a very long call…. how can we open those doors?

Let's pick our battles, and let's not go at it alone, and let's evolve how we think about communication services.

Abbreviations

2G	2nd Generation wireless
3G	3rd Generation wireless
5G	5th Generation wireless
AAA	Authentication Authorization and Accounting server
API	Application Programming Interface
B2B2C	Business-To-Business-To-Consumer
B2C	Business-To-Consumer

CAT-M1	CATegory M1
CBRS	Citizens Broadband Radio Service
CDMA	Code Division Multiple Access
CDMA 1x	**1x** Evolution-Data Optimized is next gen CDMA with improved data speed
CEE	Cloud Execution Environment
CICD	Continuous Integration Continuous Delivery
CPU	Central Processing Unit
CS	Circuit Switched
eCall	Emergency call from a connected vehicle (speaker and microphone)
ePDG	Enhanced Packet Data Gateway
EMS	Element Management Server
EPC	Evolved Packet Core
FWA	Fixed Wireless Access
GoS	Grade of Service
GSM	Global System for Mobile
GSMA	GSM Association
HMD	Head Mounted Display
HSS	Home Subscriber Server
HTML5	Hypertext Markup Language revision 5
IMS	IP Multimedia Subsystem
ISC	IMS Service Control interface
IOT	Internet Of Things
IP	Internet Protocol
IPsec	IP security
IT	Information Technology
LTE	Long Term Evolution
M2M	Machine-To-Machine
MMTel	Multi Media Telephony
mPERS	Mobile Personal Emergency Response Device
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator
MSC	Mobile Switching Center
MSO	Multiple System Operator
NFV	Network Function Virtualization
NFV-I	NFV Infrastructure
NNI	Network-to-Network Interface
N-SBC	Network-to-network SBC
OEM	Other Equipment Manufacturer
PBX	Private Branch eXchange
PSAP	Public Safety Answering Point
PTT	Push-To-Talk
RAN	Radio Access Network
RBOC	Regional Bell Operating Company
RCS	Rich Communication Suite
SBC	Session Border Controller
SDI	Software Defined Infrastructure
SDN	Software Defined Networking
SES	Secure Entitlement Server
SIM	Subscriber Identity Module
SIP	Session Initiated Protocol
S-VNFM	Specific VNF-Manager
TCO	Total Cost of Ownership

TWAG	Trusted Wireless Access Gateway
UC	Unified Communication
UE	User Equipment
USD	US Dollar
VoIP	Voice over Internet Protocol
VoLTE	Voice over LTE
VNF	Virtual Network Function
VNF-M	VNF-Manager
VM	Virtual Machine
WebRTC	Web based Real Time Communication
Wi-Fi	Wireless Fidelity
WPS	Wireless Priority Service

Bibliography & References

- *Connected Wearables,* M2M Research Series 2019, Berg Insights
- Vodafone Press Release – Smart Speaker (Reference 1)
- MARKETSANDMARKETS.com Smart Speaker Market (Reference 2)
- marketwatch.com – Smart Doorbell market (Reference 3)
- digitaltrends.com – best video doorbells at CES 2019 (Reference 4)
- GSM-Association – RCS Business Messaging (Reference 5)
- GSM-Association – RCS 2.0 Enriched Calling Specification (Reference 6)
- Youtube demo – Telus Cloud Contact Center (Reference 7)
- Html5rocks.com – Tutorial on WebRTC with data channel (Reference 8)
- Forbes.com – Augmented Reality Market Projection (Reference 9)
- *The future of the SIM,* potential market and technology implications for the mobile ecosystem, GSM-Association (available on gsma.org)

