FRAMEWORK FOR NETWORK SIMPLIFICATION

An Operator View

V1.0

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FRAMEWORK FOR NETWORK SIMPLIFICATION – AN OPERATOR VIEW

by NGMN Alliance

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ABSTRACT

As mobile networks become ever more complex with every generation, Mobile Network Operators (MNOs) need to constantly strive to introduce simplification in how they create, deploy, expose and manage their differentiated service offerings for their customers. This publication identifies Cloud Native, Agentic and Generative AI, the exposure of federated network services and evolution in optical fibre technology as key technological trends driving network simplification. It further identifies the adoption of agile ways of working as a key non-technology enabler that will help MNOs deliver new services at pace. MNOs must overcome several challenges though before they can harvest the full simplification benefits of those enablers.

The focus of this publication is to summarise those challenges currently faced by MNOs and propose a high-level framework of how MNOs can evolve to a simplified network. It concludes with an illustration of how MNOs can prioritise an introduction of the enablers for network simplification using three representative scenarios of where an MNO may be in its evolution to a 5G network. Beyond this initial publication, NGMN will gather the experiences of its membership in overcoming challenges raised in this publication and share those experiences with the MNO community and the wider ecosystem, to help accelerate adoption of the identified enablers for network simplification.

01 INTRODUCTION

Mobile Network Operators (MNOs) today manage highly complex systems in an era of rapid technological evolution. As new generations of mobile networks emerge, MNOs must adapt to expanding use cases that extend cellular wide-area access beyond the traditional consumer services. Capabilities targeted for 5G and beyond aim to create highly flexible, on-demand virtual networks with dedicated resources, secure isolation, and guaranteed service characteristics for consumer and enterprise customers.

To support this flexible environment and diverse customer needs, the next-generation network architecture targets disaggregation at multiple levels — functional, compute, network, and storage. As a result, the complexity of network deployment, operations, and service delivery will increase significantly. Networks will need to be far more programmable to meet the Service Level Agreements (SLAs) required for these diverse, multi-stakeholder services.

However, MNOs' support infrastructure — including operational tools, processes, and organisational structures — predominantly remains unchanged. Against this backdrop of technological evolution and operational challenges, MNOs strive to reduce total cost of network ownership and operational complexity, while also achieving their energy sustainability objectives amid increasingly stringent regulatory environments.

The new mobile environment poses both challenges and opportunities. MNOs must transform towards a simplified network — in both architecture and operations — to address these challenges effectively and seize emerging growth opportunities.

This publication outlines the scope of the transformation MNOs must consider in achieving a simplified network. It examines (i) the key technological and non-technological focus areas relevant for MNOs to evolve towards a simpler, more efficient network and (ii) the challenges they face in realising these benefits.

SCOPE OF THIS DOCUMENT

This document focuses on identifying the key challenges MNOs must overcome in realising network simplification and provides a comprehensive view of where simplification can be achieved across multiple domains of the MNO network. The outcome is a high-level framework that can be used as reference by MNOs in their journey towards network simplification. Although BSS is an important area for MNO network simplification, it is not specifically addressed in this publication as BSS simplification is dealt by initiatives in other organisations, such as the TM Forum [1].

02 PATH TOWARDS NETWORK SIMPLIFICATION - TECHNOLOGY ADOPTION CHALLENGES

The path to a simplified network will be facilitated by the following key technological trends:

- **Evolution from virtualised to cloud native architecture**

  The shift from virtualisation to containerised, cloud-native architectures will further enhance agility, beyond cost savings and flexibility benefits of network virtualisation. Cloud-native deployments leverage service-based architecture with microservices and continuous integration/ continuous deployment (CI/CD) pipelines to improve scalability, resiliency and operational efficiency for RAN and Core.

- **Evolution from AI/ML based analytics to Agentic/ Generative AI driven network operations**

  Advances in Machine Learning (ML) and Deep Learning (DL) techniques have accelerated the transition from static, rule-based analytics to AI/ML-driven predictive and prescriptive analytics, addressing increasingly complex and dynamic network scenarios that were previously impractical to automate. However, with rapid progress in AI foundation models — particularly generative and agentic AI architectures — the mobile industry has the technology to further evolve towards a more autonomous mobile network.

- **Evolution in transport network technology**

  MNOs will need to focus their transport network evolution on maximising reuse of existing fibre connections with technologies like, for example, Dense Wavelength Division Multiplexing (DWDM) and on using the next generation of Passive Optical Networks (PONs) to support demands of small cells. Microwave and emerging satellite broadband technology may be used in locations which are hard to reach or costly to reach with fibre. For operators with fixed and mobile networks, Software Defined Networking and virtualisation will help them consolidate their transport networks and dynamically adjust their transport capacity needs.

- **Exposure of federated network services**

  Telco API standardisation will play a critical role in creating a new market for MNO network capabilities' exposure and monetisation. However, it is the federation or aggregation of those network services that will allow application developers to rely on a consistent framework that works across many markets, like how they engage with hyperscalers. An example is the GSMA Open Gateway initiative [2] which creates common APIs and publishes via the Common API Marketplace and Repositories Architecture (CAMARA) APIs Certification programme.

  Each domain of the MNO network can achieve simplification through adoption of one or more of those technological trends but there are challenges to overcome, which are outlined in the following section.

2.1 CHALLENGES WITH TECHNOLOGY ADOPTION

The mobile industry's architectural goals and target outcomes are well defined. However, successful technology adoption depends on constraints such as the availability of a stable product ecosystem - strongly influenced by domain specific constraints and MNOs migration path which is driven by incremental achievable goals.

A framework for understanding the targeted benefits and measuring it against the domain specific goals and constraints will help MNOs to evaluate their deployment choices based on their unique business and regulatory environments.

MNO networks are made up of three key domains (Radio, Core and Transport), each with its own network lifecycle and constraints. Moreover, those domains are typically managed independently within an MNO organisation and provide network services that are agglomerated to deliver customer facing services. An MNO looking for network simplification should consider the relevance of technology enablers for each of those domains and further understand the domain specific challenges to overcome in adoption of those enablers.

This section outlines the challenges NGMN Member MNOs are facing in radio, core and transport domains in adopting technology enablers which are meant to deliver network simplification benefits for the MNOs.

2.1.1 RAN Domain

RAN domain consists of the most critical and complex components, which traditionally adopted a closed architecture. RAN, by nature, follows a distributed architecture and covers diverse range of population and geographical areas. It is also the domain where it is more challenging to remove legacy technologies like 2G and 3G in the network due to the distributed nature of the radio network and reliance of some critical services on them.

Besides complexity in hardware consolidation, MNOs still face significant complexity in RAN network planning, site acquisition and capacity management, which are ongoing tasks for an MNO to support ever increasing traffic volumes. Alongside this, MNOs need to operate their radio network to maintain service continuity, optimise the performance of their radio network to maintain customer experience and minimise the vast amount of energy consumed in the RAN.

To address complexity in all those areas, MNOs are turning to the following technologies and initiatives:

- **Technology consolidation** through removal of legacy mobile technologies like 2G and 3G will lead to OSS simplification, reduce operational complexity and save energy.
- **Radio hardware consolidation** through adoption of multi-standard, multi-bands and multi-port antenna technologies reduces equipment footprint on base station sites, making site acquisition and radio network deployment easier.
- **RAN disaggregation and virtualisation** make it possible for MNOs to adopt a centralised RAN architecture with a prospect to eventually evolve to a Virtualised (Cloud) RAN architecture that will maximise resource utilisation in their network, reduce hardware costs and potentially save energy. Cloud software reference frameworks will further reduce the cloud RAN integration complexity.
- **Open RAN** promises further efficiencies by promoting the realisation of a multi-vendor RAN with fully open interfaces.
- **RAN slicing technologies** in 5G will help MNOs create differentiated services for their B2C and B2B customers.
- **Adoption of AI** will automate network planning and deployment tasks.
- **Migration to a digital OSS framework** adopting Cloud methodologies for lifecycle management and use of AI agents and copilots will automate optimisation of the RAN for energy consumption, network performance and automate radio network operations to maintain customer experience.
- **Digital twin technology** will lead to better optimisation outcomes with AI, support predictive maintenance and avoid network disruption.

As MNOs embrace those technologies, they are facing the following challenges that are slowing them down in achieving their objectives:

Challenges with RAN Cloudification

Purpose-built RAN elements remain highly optimised for performance and energy efficiency. While vRAN and ORAN offer greater flexibility, they can introduce integration challenges and performance gaps compared to traditional solutions. Disaggregation and cloud transformation in the RAN have so far faced some significant challenges:

- The stringent demands on RAN, particularly the layer 1, requires specific performance from the hardware (e.g. accelerators).
- It also places more stringent requirements on the cloud platform to deliver with latency budgets.
- RAN vendors would need to update the code for different hardware and cloud platforms from the proprietary silicon and operating systems used in current systems.
- Orchestration of the cloud platforms is more complex as it is distributed over potentially thousands of sites.
- The organisational structure, the culture and skills of the operational teams need to be different when moving to multiple vendors that deliver the RAN.
- Open RAN and virtualised RAN products in the market tend to support 4G and 5G , but not legacy technologies such as 2G and 3G. This acts as a barrier, preventing MNOs from evolving the network to virtualised RAN or Open RAN while they still need to maintain legacy technologies like 2G and 3G.
- The RAN ecosystem is dominated by a few vendors who have historically relied on optimised appliance-based architectures. While some vendors have adopted cloud architectures, other vendors' solutions on cloud RAN are slowly maturing, and hence are not offering the performance parity with the legacy platforms. As more MNOs migrate to cloud RAN solutions, the maturity of the ecosystem is expected to improve.

Use of reference Telco Cloud software frameworks is meant to alleviate some of the highlighted challenges with RAN Cloudification. However, their adoption has so far not gained much traction due to their own challenges:

- Vendor Network Functions are not fully compliant with those reference platforms, with vendors citing issues in delivering achievable performance when using a reference platform relative to proprietary infrastructure.
- MNOs have found it extremely difficult to port vendor workloads on internally defined Cloud-Native Network Functions (CNFs) to those reference platforms.
- Interoperability, standardisation, and conformance testing has been limited. MNOs still need to invest heavily on system integration.
- Currently, different cloud reference stacks are adopted among MNOs and there is still no consensus on a common framework.

Challenges with AI adoption in Radio Network

MNOs have historically used automation in many parts of the radio network, such as during deployment, configuration, optimisation, and operations. The NGMN Publication 'Automation and Autonomous System Architecture Framework' [3] and extension of this work in [4] have laid down the high-level framework and autonomic principles to evolve from a piecemeal adoption of AI towards the realisation of an autonomous system for mobile networks. MNOs aspiring to reach a higher level of autonomy in the radio network are facing the following challenges:

- **Data readiness**

  As highlighted in [5], MNOs are facing several data readiness challenges across all domains. Following are most relevant to adoption of AI in RAN:

  - Data tend to be organised in silos, stored within their respective network or customer domain or limited to a specific system. This is an issue for AI use case scenarios like network planning where sources of data beyond the network are required e.g. customer care data and data relevant to traffic forecasting.
  - MNOs may be reliant on network nodes or assets which are old, leading to data records that may not be in the right format or required quality for the adequate training of AI models. This affects effective adoption of AI for network planning, build and operations.
  - Customer personal data need to be pre-processed and/or anonymised to meet strict privacy laws applied in respective jurisdictions and, in some cases, stored and processed in limited geographies. This may limit MNO's flexibility in using AI for traffic forecast

purposes, which is essential for optimal radio network planning and operations.

- A typical network may be delivered by multiple vendors. They may use different data formats which had been compiled differently over the pre-AI era making automation of RAN operation processes more complex.

- **Adoption of digital twin Technology for the complex radio network**

  Due to the complexity of the radio network, it is unlikely that MNOs can build one digital twin covering all components of the network. One key challenge faced by MNOs will be how to align models trained over multiple twins so that they generate an accurate global inference for specific tasks that span across multiple digital twin components, as observed in [6].

- **Need to adapt generic AI models**

  AI models currently available are generic and may not fully address the needs of MNO use cases of AI. These models will need to be adapted to the MNO requirements, which requires availability of open-source models and expertise in AI modelling, together with an insight of the telco use cases. Some telcos are already investing in creating Telco LLMs or partnering with specialist AI providers.

- **Lack of fully open interfaces for AI enabled radio network optimisation**

  MNOs looking to optimise their radio networks with adoption of AI are today either using vendor provided solutions or adopting third party applications that make use of configurable parameters exposed via the vendor OSS to achieve the optimisation. The latter approach has been broadly successful in use cases like energy saving optimisation. However, for optimisations of radio network performance, MNOs are still mostly reliant on the AI solutions put in place by their radio network vendors. This limitation is preventing MNOs from adopting best-in-breed AI technologies to get the best performance out of their radio network.

- **Existing radio interfaces do not leverage AI by design**

  Even with the latest 5G radio technology, use of AI was not considered in the design and specifications of the 5G radio network. Vendors are continuously improving their radio network implementations with use of AI but always restricted by what is allowed by 3GPP specifications. To address this limitation, 3GPP have already studied the potential of using AI to improve the performance of the 5G advanced radio interface through better channel estimation and beam management [7]. The 6G radio interface is expected to be 'AI Native' from the initial release. Other fora, such as AI-RAN Alliance [8] and O-RAN ALLIANCE [9] are actively working to unlock the benefits of AI for the radio network

Challenges with Radio Hardware Consolidation

MNOs supporting multiple mobile generations and with fragmented spectrum assets are already benefiting from the adoption of multi-standard and multi-band radios. These technologies reduce the footprint of equipment on base station sites and simplify MNO operations. However, MNOs are still facing the following key challenges:

- Vendors tend to agglomerate low bands e.g., 700/800/900 MHz and mid band e.g., 1800/2100/2600 MHz into dual or triple band radios as these are the most common combinations of MNO spectrum deployed widely. However, many MNOs have acquired spectrum assets which fall outside of those combinations e.g., 1400 MHz, and 2300 MHz for which multi-band radios are not readily available. This is currently a key hurdle for those MNOs with non-common frequency assets looking to further consolidate radio hardware on their base station sites.

- Radio units with support of low and mid-band frequencies are not readily available in the market yet. This is preventing further consolidation of hardware on base station sites.

2.1.2 Core Network Domain

The focus of simplification in the core network domain is driven by MNO's desire to:

- Implement an infrastructure that allows for dynamic scaling of core network resources aligned with fluctuating capacity needs.
- Introduce flexibility in creating differentiated network service offerings.
- Support ad hoc and distributed deployment of core network functions close to the customer for B2B services.
- Reduce the operational complexity for managing this diverse set of services.

MNOs are considering the following technologies to achieve core network simplification:

- **Core network cloudification** will support MNOs in realising a scalable infrastructure and automate the lifecycle management of both the infrastructure and Core Network functions. It will further help MNOs to consolidate 4G and 5G network functions on a common infrastructure and evolve that infrastructure to ultimately support 6G core network functions.
- **The 5G Service Based Architecture (SBA)** will support service scalability, network function reusability and interoperability among network functions; these will make it easier for MNOs to orchestrate and slice their core network resources to deliver differentiated services and support services at the network edge.
- **AI capabilities** will further help MNOs to realise an optimised scaling of core network resources according to network capacity needs and service specific needs and reduce the operational complexity to deliver service assurance for a diverse set of services.
- **3GPP Network Data Analytics Function (NWDAF)** network function in the core network will provide the data readiness foundation necessary for adoption of AI based analytics within the core network domain.

MNOs looking to adopt those technological advances are facing several challenges, which are outlined in this section.

Challenges with Core Network Cloudification

The path towards core network cloudification is expected to be simpler than for RAN due to less stringent performance requirements and core networks having already gone through a virtualisation phase with NFV architectures. Nonetheless, Cloud adoption in the core still faces challenges that are in some respects common with RAN and in other respects, specific to the core network domain.

Key challenges for Core Network Cloudification are:

- Slow development of standardised, universal Cloud Management and Orchestration (MANO) layers has led to a fragmented ecosystem with early adopters implementing either proprietary Cloud solutions or NFV architectures. The cost to evolve from such solutions to standardised cloud platforms is significant.
- Many network vendors have taken the initiative to develop their own proprietary cloud stack. MNOs looking to support their preferred vendor network functions will have less flexibility to adopt a reference cloud software framework and it will be difficult to port vendor network functions to other cloud environments.
- Even if an MNO succeeds in adopting an open cloud infrastructure, the multi-vendor environment requires that MNOs put in place robust change management procedures to effectively manage resource allocation and lifecycle of software network functions in the multi-vendor environment.
- MNO buildings hosting legacy telephony may require significant investment to uplift power, cooling and accommodation to support the infrastructure required to deploy cloud cores.

Dealing with Legacy OSS/BSS

An established MNO evolving their network from legacy (2G/3G) towards 5G would likely have OSS/BSS supporting a mixed network with diverse cloud capabilities. The key challenges facing such MNOs are:

- The network element management systems for legacy technologies must coexist with the cloud orchestration systems until such time when

legacy technologies are sunset or migrated to a cloud native environment.

- MNOs may be running multiple OSS/BSS systems to support a multitude of legacy services over their core network. Those services may have been acquired through commercial merger and acquisition activities, and they may even each have their own OSS/BSS stacks. Consequently, any MNO looking at core network simplification will have to do so considering this reality of having multiple - and sometimes service specific - OSS/BSS systems to interwork with.

Core Network Architecture Challenges

The 5G core network architecture has become more flexible and distributed relative to earlier mobile generations with a fully centralised core. Even though user plane is gradually being placed at the edge to provide local traffic offloading, the 5G core architecture remains predominantly centralised from a management and control perspective.

Operators looking to monetise 5G will need their network to be adaptable to a diverse set of industry vertical requirements, for example, in terms of network performance, data sovereignty and network reliability.

Under the centralised control and management model, a single node or few nodes will need to provide ultra-high capacity, and any failure at those nodes will affect a vast number of users, thereby increasing the reliability and complexity challenges on the network. Moreover, MNOs looking to satisfy stringent reliability and data sovereignty requirements of specific industry verticals, typically resort to a deployment of Standalone Non-Public Networks (SNPN), which must be regarded as 'untrusted' networks from an architecture perspective. This leads to high complexity in both, integration of those networks into the MNO's security domains, and their operation.

A distributed core architecture where an MNO can determine, on a per customer basis, what network functions to deploy close to or on customer premises to satisfy their requirements would allow MNOs to treat all their enterprise network deployments as 'trusted' network entities. This will simplify both integration of those network entities to MNO's security domains and their management.

However, a distributed architecture will itself bring new challenges for MNOs to manage the physical and cyber security of numerous local data centres and realise a coordinated lifecycle management of the infrastructure and network functions software using a Cloud Native paradigm.

Challenges with AI Adoption in the Core

AI solutions need to collect and analyse a vast amount of data to deliver effective autonomy in core network use cases. MNOs have so far relied on proprietary solutions to provide data curation of the vast set of data they collect in their network. Lack of standardisation in data collection procedures, data formatting and analysis have slowed down progress in adoption of AI in the core network domain. Introduction by 3GPP of the Network Data Analytics Function (NWDAF) will help alleviate some of the issues with readiness of network data in the core network domain for AI use cases. However, NWDAF still does not address the wider issue of data readiness for uses cases requiring non-network related data.

Beyond data readiness the following challenges remain:

- **Lack of AI ready core network architecture**

  MNOs need a core network architecture design that efficiently supports AI processes and operations. MNOs are currently facing the challenge of retrofitting automation into their existing networks as an afterthought rather than supporting AI automation by design. This may lead to unnecessary inefficiencies in their network. With the evolution to 5G Advanced, 3GPP has initiated studies in Release 18 to address several architectural aspects relating to the AI/ML operations over a 5G system [10] (splitting, distribution, federation), AI/ML model transfer between device and network [11] and other aspects relating to AI/ML management [12]. This is a first step towards supporting AI automation by design, also serving as a foundation for the 6G system architecture.

- **Security and regulatory requirements for core cloudification limiting full benefits of AI in core**

  One key simplification benefit of using AI in the core is to help MNOs dynamically adapt the resource requirements in the core network

according to the AI inferred capacity needs. However, such flexibility can only be achieved if the core network is already deployed on cloud infrastructure. Ideally, MNOs would like to leverage a third-party cloud infrastructure e.g. hyperscaler solution to avoid deploying private data centre infrastructure. However, security and regulatory limitations currently restrict how much of their core network load MNOs can deploy in public cloud infrastructures. Moreover, latency performance considerations limit what type of core network functions MNOs can deploy in cloud.

From a service deployment perspective though, cloudification of core will allow MNOs to use AI to efficiently orchestrate core network resources to meet service requirements, no matter if the Cloud Core is deployed in a customer data centre or private cloud.

2.1.3 Transport Network Domain

A primary challenge an MNO has in transforming transport network architectures is the multitude of suppliers, wholesale providers and vendors that may be providing the transport service. A consistent transformation programme therefore may be difficult to implement. Transport solutions may be using legacy solutions, such as some microwave systems with supplier support diminishing.

Security is another key challenge. As regulators and governments are focusing more on enhancing network resilience and security, the transport networks need audits and upgrades (e.g., PKI management). With emergence of Quantum computing and the risk this poses to existing encryption technologies, MNOs are already having to plan for introduction of quantum secure cryptographic solutions in their transport network (even though realisation of practical quantum computing is still years away).

2.1.4 Service Creation and management domain

Service creation will need to leverage the MNO's service orchestration capabilities and management of those services will increasingly rely on adoption of AI capabilities for operation of differentiated services. Technology maturity in those two areas is a key MNO challenge but within the MNO control to deliver. However, ecosystem alignment on service exposure capabilities will take more time to mature as MNOs address the following challenges:

- **Current low level of standardised Telco network APIs available to application developers' community**

  This challenge has been partly addressed in recent years by Telcos' cooperation with GSMA Open Gateway initiative [13] and the Linux Foundation CAMARA project [14] which has further developed the GSMA framework into API definitions and reference implementations. New commercial initiatives like, for example ,ADUNA [15] (a joint venture between Ericsson and twelve global telecommunication service providers) have recently emerged to serve the role of telco API aggregator with the aim to provide streamlined access of the CAMARA APIs to the application development community.

  Even though such developments are evidence of good progress in the emergence of aligned network APIs for service creation, wide adoption of those APIs still faces the following challenges:

- There is fragmentation in which set of APIs (even though standardised) is being implemented by MNOs, leading to inconsistent availability of any specific API that a developer may need.

- Business models showing monetisation potential of network APIs have not been fully developed and validated yet.

- Aggregation of Telco APIs by aggregators is growing but still limited in their reach of service provider APIs to become global (especially the smaller ones).

- Even though APIs are standardised, they may still require further simplification for developers to consume them (a role which may be fulfilled by the aggregators).

- **Translation Engine as the missing link**

The technology required for translating the Telco API intent (e.g. CAMARA APIs in Northbound Interface-NBI) into a series of AI/ML powered set of actions that include services and network

orchestration, down to automated network resources configuration, is called Translation Function (or engine). This is a complex subject topic which may require significant investment from telcos, not just in hardware/software components but also in people skills and supporting systems (OSS/BSS) interfaces.

The translation function is designed to bridge differences in API semantics, data formats, and protocols between MNOs and developers. It supports data transformation, normalisation, and mapping, enabling interoperability across diverse telco environments. This function is crucial for achieving API harmonisation across MNOs, allowing developers to integrate once and deploy globally without needing to handle operator-specific variations.

As the demand for Telco APIs continues an upward trajectory [19], MNOs will need to prioritise which network capabilities they will develop first and run the collaborative trials that would further enhance the confidence of federated services becoming a step closer to their implementation and monetisation. This is a good way forward in de-risking investments into the technology required, especially for network capability exposure, such as "Quality on Demand", "Traffic Influence" APIs and alike.

2.2 NON-TECHNOLOGY ORIENTED CHALLENGES

MNOs looking for network simplification must look beyond adoption of technological enablers and focus also on the non-technological challenges they need to address to become successful in their transformation to a simplified network. The key issues identified are:

- **Resistance to organisational change and contractual limitations**

  As MNOs move towards adoption of a cloud native paradigm, it is critical that they move away from a waterfall project methodology to a more agile way of working to deliver innovative services to their customers with improved customer satisfaction, delivery efficiency and productivity [20]. However, they are facing the following challenges in their organisational transformation:

  - MNOs have traditionally been risk-averse, since failure can have significant adverse impacts on their customers and hence their business, which goes against the agile philosophy.
  - Many MNOs rely on managed services from vendors for operations and maintenance. They need to rely on their vendors to adopt agile practices since revision of existing contracts to enforce an agile way of working might be challenging. MNOs are increasingly entering infrastructure sharing agreements which may limit how quickly they can adapt the infrastructure to deliver new services at pace.

- **High upfront investment for enabling technologies**

  Even though one key driver for network simplification is to drive down operating costs, introduction of enabling technologies like cloud and AI can themselves have high implementation costs and thus become a barrier to network simplification. It is also not proven that through adoption of those enabler technologies, MNOs will achieve efficiencies that will offset their high upfront investments and hence provide a positive return for their business.

- **Lack of skills may slow adoption of enabling technologies**

  MNOs looking to drive down operational complexity will need to upgrade the skillset of their workforce so that they can make effective use of key technologies like cloud and AI.

- **Adoption of AI may impact MNO sustainability agenda**

  MNOs are likely to improve the energy efficiency of their radio network through the effective use of AI to match network capacity to traffic demand. However, AI processing consumes energy. For an MNO aspiring to reach TM Forum Level 4 automation or above [1], they will need to take into consideration their potential increased energy consumption in adoption of AI against the benefits they get in using AI for network simplification.

03 PROPOSED FRAMEWORK FOR EVOLUTION TOWARDS A SIMPLIFIED NETWORK

MNOs looking to achieve network simplification will need to be selective and prioritise adoption of technology and non-technology enablers that help with achieving this objective. In doing so, they first need to understand the simplification benefits that those enablers can bring, and more importantly, which domain(s) of their network will benefit the most. The next step for an MNO to consider is the complexity and challenges summarised in this publication that they need to overcome when trying to achieve simplification benefits out of those enabler technologies. NGMN is planning to consult its membership to gather experiences on how MNOs are overcoming the challenges of implementing those technologies in the respective domains to help with simplification. Finally, the prioritisation of enablers for network simplification and the domains where they should be applied also depends on the MNO's state of network evolution and the context in which they are operating.

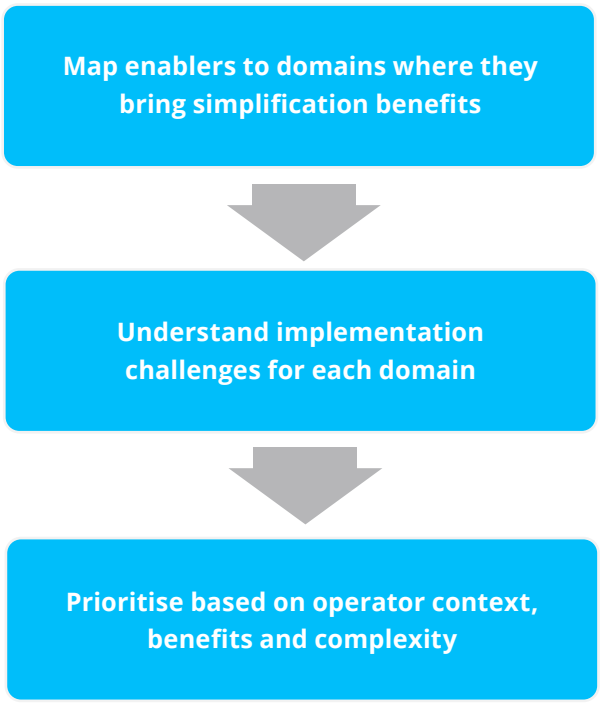

Figure 1: Stepwise approach towards network simplification

As an example, we identified three common scenarios for the state of an MNO's network to demonstrate how an MNO choice of enablers to adopt and the domains to prioritise for network simplification will differ depending on the state of their network evolution:

Advanced 5G-stage operator: We identify an advanced 5G-stage MNO as one which has deployed a cloud native 5G core with extensive 5G roll out in the RAN. This MNO is already offering 5G SA data services in parts of the network but still maintains a 4G network for data and voice. Many such MNOs may still be supporting legacy 2G/3G services.

Key considerations for prioritisation

MNOs who have evolved their network to support 5G SA core will have already made a choice on the underlying cloud infrastructure used for their dual mode 4G/5G core on a common cloud infrastructure. Hence, these enablers would already be in place.

As a high priority, MNOs in this stage should consider implementing the enablers for service creation and service assurance. Depending on the MNOs individual objectives and strategies, they may consider building on foundational capabilities like slicing support in RAN, core and transport domains to implement cross domain orchestration for differentiated services delivery, implement a framework to expose those services via open APIs, put in place translation engines, consider adoption of AI for intent-based operations and adapt their organisational structure to an agile way of working. Within the core network domain, data readiness with NWDAF and AI adoption for core operations will also be high priority for service assurance of differentiated services. For operators with a strategy to leverage their infrastructure to deploy private network instances across verticals, it could be advantageous for them to further plan

evolution towards a more distributed core network architecture enabling customisable and dynamic deployments of localised network functions. In the transport domain, MNOs should accelerate roll out of fibre technology with high priority to match 5G radio capacity.

Within the RAN, MNOs should remove legacy 2G/3G, simplify their OSS and put data readiness in place for adoption of AI for RAN operations and RAN optimization with high priority. Since those MNOs have already gone through a network transformation with 5G, other enablers like radio hardware consolidation, adoption of AI for network planning should be lower priority.

Mid 5G-stage operator: A mid 5G-stage MNO is one rolling out 5G NSA while planning to upgrade to cloud native 5G Core for 5G SA services. A significant proportion of subscribers are still served on 4G radio, with the MNO driving adoption of VoLTE to reduce dependency on legacy 2G/3G network for voice.

Key considerations for prioritisation:

Many MNOs globally are currently at this stage of their network evolution. 5G radio network roll out requires extensive network planning and MNOs may want to first focus on data readiness for use of AI to simplify network planning processes. Decommissioning legacy 2G/3G services would be a secondary priority for them, especially if they are still reliant on those technologies to deliver voice services in parts of their network.

Within the core network, the primary focus will be on choosing the right infrastructure stack for the 5G cloud core and hardware consolidation for 4G and 5G core network functions. Monetisation of 5G using technology enablers for service creation would be a secondary consideration, as such MNOs focus on laying the foundations of a 5G SA network for differentiated services creation. MNOs in this scenario should actively look at organisational transformation to adopt agile ways of working if they have not yet started on this journey yet.

Early 5G-stage operator: Finally, an early 5G-stage MNO would have a network that is primarily LTE based, with such MNO looking to roll out 5G NSA. This MNO is still heavily reliant on 2G/3G to support voice services.

Key considerations for prioritisation:

MNOs looking to upgrade their network to 5G should primarily focus on making the right technology choices for their 5G network evolution. Within the RAN, they should focus with high priority on radio hardware consolidation and adoption of AI for network planning so that they reduce complexity of their 5G rollout. Alongside this, they should accelerate transformation of their transport network to adopt fibre technology and initiate organisation transformation to an agile way of working, if not already in place.

Within the core network domain, MNOs may still be running monolithic vendor hardware and software for their core network systems or already running their 4G core network functions as Virtualised Network Functions (VNFs) on COTS hardware. For MNOs still using monolithic vendor systems, this is an opportunity to skip the adoption of Virtual Network Function (VNF) based core network functions and adopt a cloudified dual 4G and 5G Core network built on 5G service based architecture principles and standards.

Table 1 outlines the key technology enablers for network simplification, identifies the primary drivers they address and highlights the domains MNOs should prioritise. It is presented against the three MNO scenarios, as discussed above. The High (H), Medium (M) and Low (L) prioritisation in the table are indicative and only intended to express a relative priority of the enablers for a specific type of MNO with typical restraints, such as with budgets and skills i.e., the priority should be considered vertically along the table. No meaning should be attached to the priority levels across scenarios i.e., horizontally along the table.

Each technological enabler was assessed for maturity and may have been deprioritised if alternative enablers were deemed to offer more immediate benefits. Finally, 'N/A' is used where it is expected that the MNO in the respective scenario is already deemed to have the capability in place or there is likely to be an absence of foundational capabilities which does not make implementation of the enabler viable for such MNO.

$	Reduce Total Cost of Ownership (TCO)	☻	Supports customer experience improvement
	New service creation & network monetisation		Reduces Network Operations[1] complexity
		H	High focus priority for operator
	Supports the operator's sustainability agenda	M	Medium focus priority for operator
		L	Low focus priority for operator

Domain and Enabler Technology	Simplification Drivers					Operator 5G Network Evolution Stage		
	$			☻		Advanced	Mid-Stage	Early Stage
RAN								
Legacy shutdown	*		*		*	H	M	L
OSS Simplification	*			*	*	H	M	M
Radio Hardware consolidation	*		*		*	M	M	H
RAN virtualisation or Open RAN	*	*	*	*	*	M	M	L
RAN slicing		*		*		H	M	L
AI Network planning	*		*	*		M	H	H
AI RAN Operations	*		*	*	*	H	M	M
AI RAN Optimisation	*		*	*	*	H	M	M
Digital Twin for RAN	*			*	*	M	L	N/A
Core								
Core Network Cloudification for 5G	*	*	*	*	*	N/A	H	H
Core HW consolidation	*		*		*	N/A	H	M
Core network orchestration & slicing		*		*		H	M	L
NWDAF for analytics	*			*	*	H	M	L
AI for Core Operations	*		*	*	*	H	M	L
Evolution to distributed core architecture	*	*		*	*	M	L	L
Transport								
Remove legacy transport technologies	*		*	*	*	M	M	M
Evolution to Software Defined Networking	*	*			*	M	M	L
Adoption of fibre technology	*	*	*	*		H	H	H
Transport network Orchestration &slicing		*		*		M	M	L
Service Creation								
Cross domain service orchestration		*			*	H	L	L
Deploy open standard APIs		*		*	*	H	L	L
Deploy translation function		*				H	L	L
AI service assurance		*		*	*	H	L	L
Organisational transformation with Agile		*		*		H	H	H

Table 1: Domain prioritisation and focus areas for operator in advanced, mid-stage and early-stage of 5G adoption

[1] Network Operations encompasses network planning, build and/or in-life operation activities

04 CONCLUSIONS

MNOs looking to minimise their network TCO and developing new services over 5G should consider network simplification as a key pillar driving their network evolution strategy.

In this publication, NGMN proposes a three-step approach which can serve as a framework for MNOs looking to evolve to a simplified network:

- The first step brings to the fore the key trends in technology evolution that MNOs must harness to introduce simplification in their network. Cloud adoption and AI are identified as key technologies to reduce TCO and operational complexity in radio and core network domains of the MNO. Alongside those, technologies to realise federated network services, which are key to support network monetisation, are identified. Beyond technology enablers, the publication highlights the importance of organisational transformation, primarily facilitated by agile ways of working, to help MNOs deliver services at pace.

- The second identified step is for MNOs to get insight into the challenges they will face in adopting identified enablers for network simplification. This publication has identified those key challenges.

- As a third step, MNOs must prioritise adoption of technology enablers and the domains where they will be applied depending on their context and state of network evolution. The publication has identified three common MNO archetypes based on their 5G-network deployment maturity and presented how each may evaluate the technological enablers and identify the ones which deliver the most benefit via prioritisation. Ultimately, MNOs will also need to make their decisions considering factors that go beyond the state of their network evolution, such as market dynamics. The framework presented in this document should be consumed as a guideline only.

As a follow up to this publication, NGMN aims to gather the experiences of its full membership to overcome the challenges outlined in this publication and how the identified technology enablers can practically support simplification benefits in multiple domains of the MNO network.

05 LIST OF ABBREVIATIONS

3GPP	Third Generation Partnership Project
AI	Artificial Intelligence
API	Application Programming Interface
B2B	Business to Business
B2C	Business to Consumer
BSS	Business Support System
CAMARA	Common API Marketplace and Repositories Architecture
CD	Continuous deployment
CI	Continuous integration
CNF	Cloud Native Network Function
COTs	Commercial off the Shelf
DL	Deep Learning
DWDM	Dense Wavelength Division Multiplexing
GSMA	Global System for Mobile Communications Association
MANO	Management and Orchestration Layer
LLM	Large Language Models
LTE	Long Term Evolution (3GPP)
MEC	Multi-Access Edge Computing
ML	Machine Learning
MNO	Mobile Network Operator
MOCN	Multi Operator Core Network
MORAN	Multi Operator Radio Access Network
NBI	Northbound Interface
NFV	Network Function Virtualization

NPN	Non-Public Network
NWDAF	Network Data Analytics Function
OSS	Operations Support System
PKI	Public Key Infrastructure
PNI-NPN	Public Network Integrated Non-Public Network
RAN	Radio Access Network
SAfe	Scaled Agile Framework
SBA	Service Based Architecture
SDO	Standards Development Organisation
SLA	Service Level Agreement
SON	Self-Organizing Networks
TCO	Total Cost of Ownership
TMF	Tele Management Forum
TSA	Telecoms Security Act
URLLC	Ultra Reliable Low Latency Communication
ZTP	Zero Touch Provisioning

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07 FIGURES AND TABLES

Figure 1

Table1

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NEXT GENERATION MOBILE NETWORKS ALLIANCE

NGMN - Next Generation Mobile Networks Alliance - is a global, operator-driven organisation established by leading international mobile network operators (MNOs). As a global alliance of operators, vendors, and academia, NGMN provides industry guidance to enable innovative, sustainable and affordable next-generation mobile network infrastructure.

Key focus areas include Mastering the Route to Disaggregation, Green Future Networks, and 6G, while supporting the full implementation of 5G. NGMN drives global alignment of technology standards, fosters collaboration with industry organisations and ensures efficient, project-driven processes to address the evolving demands of the telecommunications ecosystem.

VISION

The vision of NGMN is to provide impactful industry guidance to achieve innovative, sustainable and affordable mobile telecommunication services to meet the requirements of operators and address the demands and expectations of end users. Key focus areas include Mastering the Route to Disaggregation, Green Future Networks and 6G, while supporting the full implementation of 5G.

MISSION

The mission of NGMN is:

- To evaluate and drive technology evolution towards the three **Strategic Focus Topics:**
  - **Mastering to the Route to Disaggregation:**

    Leading in the development of open, disaggregated, virtualised and cloud native solutions
  - **Green Future Networks:**

    Developing sustainable and environmentally conscious solutions
  - **6G:**

    Providing guidance and key requirements for design considerations and network architecture evolution
- To define precise functional and non-functional requirements for the next generation of mobile networks
- To provide guidance to equipment developers, standardisation bodies, and collaborative partners, leading to the implementation of a cost-effective network evolution
- To serve as a platform for information exchange within the industry, addressing urgent concerns, sharing experiences, and learning from technological challenges
- To identify and eliminate obstacles hindering the successful implementation of appealing mobile services.