



6G ARCHITECTURE AND MIGRATION OPTIONS –

An Operator View



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6G ARCHITECTURE AND MIGRATION OPTIONS – AN OPERATOR VIEW

by NGMN Alliance

Disclaimer	This document is an initial version. NGMN Members plan to evolve it in the coming months, in line with ongoing standardisation developments and emerging insights.
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CONTENTS

EXECUTIVE SUMMARY	4
KEY MESSAGES	5
01 INTRODUCTION	6
02 MIGRATION OPTIONS	7
2.1 Review of Migration Options	7
2.2 Multi-RAT Spectrum Sharing (MRSS)	7
2.3 Alternative Migration Options	8
2.4 6G Readiness of RAN Hardware	9
03 CONCLUSION & STANDARDISATION FOCUS AREAS	10
04 REFERENCES	11
05 LIST OF ABBREVIATIONS	12
ACKNOWLEDGEMENTS	13

EXECUTIVE SUMMARY

The transition from 5G to 6G represents a critical opportunity to simplify network architectures, reduce long-term costs and operational complexity, and ensure a smooth and scalable migration path. Experience from 5G deployment has shown that excessive optionality, fragmented architectural choices, and late convergence on migration approaches significantly hinder time-to-market, result in diverged implementations in the market, lead to partial solutions that need to be later upgraded at significant cost, and dilute the real benefits of a new generation.

This document examines candidate 6G architecture and migration options for the RAN and core network with the objective of narrowing choices early, minimising unnecessary complexity, and enabling a cost-effective evolution from existing 5G networks. In particular, it discusses Multi-RAT Spectrum Sharing (MRSS) as the primary migration mechanism, alongside alternative approaches such as Dual Connectivity and Dual Stack solutions, highlighting their respective benefits, risks, and implications for user experience, cost, and ecosystem impact.

While flexibility is needed to address diverse deployment scenarios, the number of migration options should be strictly limited to avoid fragmentation across devices, networks, and vendor implementations. Migration solutions must ensure that early 6G deployments deliver tangible performance gains compared to 5G-Advanced, without creating barriers to later evolution towards full 6G capability.

The document also discusses broader architectural considerations, including multi-vendor support, and hardware readiness. These aspects are critical enablers for long-term innovation but must be addressed in a way that is consistent with simplified migration and operational efficiency.

NGMN believes that the forthcoming 6G study period is the decisive window to establish these foundations. The recommendations in this document are therefore intended to guide prioritisation and focus within 3GPP during the initial phase of 6G standardisation.

KEY MESSAGES

The following key messages are provided as NGMN operator guidance for 3GPP study priorities during the June–September 2026 timeframe of the 6G study phase:

1. Converge early on a primary 6G migration approach - Narrow down migration options as early as possible, with MRSS as the baseline solution, to limit fragmentation and reduce long-term complexity across UEs, RAN and core networks.
2. Focus MRSS study on real performance and implementation feasibility - Prioritise work on MRSS efficiency (including control channel overhead, dynamic allocation between 5G and 6G users, dynamic baseband resource sharing, support for both FDD and TDD carriers, plus support for 6G - carrier aggregation) to clarify how smooth 6G migration can be using MRSS.
3. Migration solutions must ensure that early 6G deployments are not worse than a 5G-Advanced baseline in terms of user throughput, latency, cost and operational complexity.
4. Alternative approaches (e.g. Dual Connectivity or Dual Stack solutions) should only be pursued if they address well-defined deployment gaps that MRSS cannot satisfy, noting that NGMN operators are in favour of limiting the number of these alternative approaches.
5. Align architecture decisions with hardware reality and cost - Early 6G RAT design choices should enable realistic assessments of hardware reuse, upgrade paths and “6G-ready” deployments.
6. Ensure architectural choices enable scalable, multi-vendor ecosystems - Migration and architecture solutions should explicitly support multi-vendor integration, cloud-based deployments and long-term operational efficiency.
7. Ensure device capabilities do not restrict 6G migration design – Standardisation activities should prioritise early alignment on realistic device requirements, including support for high-order carrier aggregation across multiple carrier combinations, to ensure that 6G services can deliver tangible performance benefits for both customers and operators from day one of deployment.

01 INTRODUCTION

5G's deployment was hindered by architectural complexity featuring a smorgasbord of multiple migration options. Five different architecture options were specified which were intended to assist migration, including options for two different core networks and, in some cases Dual Connectivity between 5G NR and 4G LTE RANs. Only two options were finally implemented. The first was an NSA option connecting to the 4G EPC with Dual Connectivity support, giving 5G access to 4G spectrum with the aim of enabling a competitive user throughput rate to 4G. The second was a SA option connecting to the new 5G Core (5GC) but not supporting Dual Connectivity. Although Dynamic Spectrum Sharing (DSS) was supported, performance and cost issues restricted its use. Many Mobile Network Operators (MNOs) have found it difficult to migrate from NSA to SA in order to realise the associated 5GC-based features, as none of the options that were actually implemented simultaneously included a 5GC while also supporting Dual Connectivity. It should be noted that some MNOs may struggle to identify clear value to migrate to 5G SA, after initially deploying 5G NSA.

This approach should be avoided in 6G. For 6G to succeed, simplification must be a core design principle from the beginning. Any additional complexity needs to be well justified, at least, on the back of strong performance gains grounded in the holistic assessment criteria laid out in the Radio Performance Assessment Framework [1]. As NGMN is positioned to guide the industry towards harmonised 6G standards by considering benefits of customers, this work addresses key outstanding topics of debate in 6G standardisation where consensus is most needed:

Objectives of this Document

- Study and narrow down 6G architecture options to simplify networks and reduce complexity.
- Evaluate migration strategies (e.g., Multi-RAT Spectrum Sharing (MRSS), Dual Connectivity, Dual Stack) by analysing current networks and future deployment needs - balancing time-to-market, cost, user experience and operational efficiency for 6G adoption.

02 MIGRATION OPTIONS

IMT-2030 aims to provide new and enhanced capabilities beyond those of IMT-2020. These new capabilities extend beyond communication services to include intelligence such as AI and sensing, with the aim of establishing a new approach to how MNOs monetise networks and opening up new opportunities for their customers.

The important lesson to learn from **5G** is to ensure **a smooth and cost-effective migration path** to full 6G capabilities while **minimising the complexity and fragmentation** caused by specifying options not likely to provide value to customers.

2.1 REVIEW OF MIGRATION OPTIONS

While Multi-RAT Spectrum Sharing (MRSS) is already considered as a migration option in 3GPP's 6G study item, NGMN understands that decisions are expected in September 2026 on whether additional migration options should be included. The main alternatives typically fall into the categories of Dual Connectivity architectures and Dual Stack deployments. Each migration option presents distinct advantages and disadvantages. However, it is essential to limit the number of supported options in order to minimise market fragmentation, system complexity, and cost.

For 6G to be justified, it must deliver clear and tangible performance and efficiency gains alongside improvements in cost and energy consumption compared to existing technologies. While the preferred outcome from NGMN's perspective would be convergence on a single migration option, it may be necessary to identify a secondary, less-preferred option to ensure that viable solutions exist across the full range of deployment scenarios.

Given that the detailed technical and architectural implications of these options are still under investigation, it is important at this stage to highlight potential opportunities and risks and

ensure that these are actively addressed during the 6G study phase.

Common considerations across all migration options include:

- **Smooth migration:** Introduction of 6G should enable measurable performance benefits for the ecosystem without degrading the user experience of existing 5G services. As the device base evolves over time, the network must be sufficiently flexible to adapt resource allocation to changing demand between 5G and 6G.
- **Low-band spectrum availability:** A minimum amount of coverage spectrum is required to support wide-area service for any new RAT, significantly influencing feasible migration paths.
- **New spectrum availability:** The extent to which new dedicated spectrum can be made available for 6G, for example in bands around 7GHz in many regions, is a key factor in early deployment strategies.
- **Multi-vendor support:** Migration options should support a multi-vendor ecosystem in order to enhance supply-chain resilience and enable competitive deployment at scale. One of the standardisation interests should be to natively facilitate a multi-vendor ecosystem with interoperability.
- **Coexistence with legacy:** Considering the long lifetime of existing IoT devices based on LTE network, 6G shall support coexistence with NB-IoT (all deployment modes), eMTC, LTE Cat.1, LTE Cat 1bis, and LTE Cat.4 via semi-statically configured resource reservation in the frequency and time domain.

2.2 MULTI-RAT SPECTRUM SHARING (MRSS)

The migration option currently agreed for transitioning from legacy networks is **Multi-RAT Spectrum sharing (MRSS)**. This provides 6G with flexible **access to the 5G spectrum** so that competitive user throughput and performance is achieved for 6G even in locations where a large amount of new spectrum (e.g. spectrum around 7 GHz) is unavailable, not useable (EMF limits), or too costly to deploy.

Currently **MRSS is the most widely supported migration option**, as it has a limited impact on UEs and networks. However, in many locations where 6G will be introduced, **an extensive use of MRSS** over much of the existing spectrum will be required in order that 6G offers competitive user throughputs to 5G, and this creates some challenges to providing a smooth migration.

MRSS performance needs to be enhanced compared to 4G-5G DSS to reach higher efficiency. Fortunately, this looks feasible as 5G had a lean carrier design without the substantial Cell-specific Reference Signal overhead that was needed for 4G. However, it will be important that MRSS implementation supports fine-granular sharing of all control channel overheads. Dedicating one symbol per slot to the PDCCH of each technology would be unacceptable given that it would need to be applied over many spectrum bands.

While 6G carrier aggregation will be essential from day one whatever the migration strategy will be, the use of MRSS will require **high order carrier aggregation across a wide range of carrier combinations, including combinations** of legacy and new spectrum bands. This capability is essential for 6G introduction so it can typically expect at least the same level of carrier aggregation supported in 5G SA networks prior to 6G introduction.

MRSS support **in both FDD and TDD spectrum** will also be needed.

MRSS implementations should consider a **sharing of baseband processing resources between 5G and 6G** so that baseband processing resources don't need to be dimensioned separately for 6G on

top of those needed for 5G. Separate dimensioning of 4G and 5G baseband resources is typically needed with DSS implementations, causing additional hardware deployment constraints, increased energy consumption and lack of flexibility to balance 4G vs 5G demand dynamically. If such baseband resource sharing is supported, it should be done in a dynamic way so that users of either technology can be provided with competitive user throughputs, accessing the shared spectrum in a sufficiently timely way so as not to impact user experience.

Finally, MRSS should be deployable over a large number of spectrum bands without high up-front costs for operators. A widespread use of DSS has been hindered due to a combination of high initial costs and lack of performance benefits that justify investment. This is a matter for MNOs and their suppliers but would appear nonetheless critical to successful implementation of the MRSS-based migration option.

MRSS offers an architecturally simple 6G, but if the issues raised above are not addressed there is a risk that the same problems encountered with migration from 5G NSA to 5G SA are repeated at 6G introduction.

2.3 ALTERNATIVE MIGRATION OPTIONS

Dual Connectivity and Dual Stack are alternative options to MRSS. 3GPP should give consideration to studying one or more of these options because they may be required as fallback if the deployment of MRSS is expected to significantly reduce 5G performance or substantially increase network cost (e.g. dedicated baseband resources needed for 6G). While NGMN operators see the benefit of studying one or more alternative options, there was no consensus on proposing to 3GPP to remove specific alternative options at this stage.

NGMN notes that MRSS usage is complementary to the Dual Connectivity and the Dual Stack options as it provides a means of supporting a 6G carrier in parallel with a 5G carrier on existing spectrum. An

advantage of these alternative options is that they can help to limit the amount of spectrum needing to be shared using MRSS.

2.4 6G READINESS OF RAN HARDWARE

The advantages of a software-based migration to 6G without any hardware change are obvious. The NGMN position paper [2] previously proposed a backwards-compatible 6G evolution without hardware refresh. Since the position paper was published, 3GPP has agreed to study a non-backwards compatible new 6G RAT. The deployment of a new RAT needs to be justified by significant benefits. Operators would prefer that such a new RAT can be implemented on hardware that is already deployed at the time of 6G launch. Requirements for new hardware to be deployed at 6G launch for existing frequency bands need to be well-justified (e.g., providing much higher efficiency).

NGMN understands that the RAN Plenary #112 meeting in June 2026 aims to settle the fundamental physical layer basis for the new 6G RAT. This should enable an assessment determining which existing hardware supports 6G, and if it is well-justified, allowing 6G hardware design to start so that optimised “6G-ready” hardware can be deployed in advance of the commercial 6G service start, depending on an MNO individual commercial decision (noting that this may be some time after the 6G 3GPP specifications are completed no earlier than March 2029).

It should be noted from the previous discussion that extra baseband resource may be needed to support MRSS if MRSS does not support baseband sharing.

In conclusion, making network hardware 6G ready in advance of 6G service introduction is an important means of providing a smooth migration to 6G. But it is too early to define definitive requirements as there are likely to be complicated dependencies of performance gain on deployed hardware. What matters in the end

is to ensure that sufficient benefit arises from 6G introduction to justify the costs of migration, including the potential costs of deploying new hardware. NGMN has proposed the Radio Performance Assessment Framework [1] to benchmark the performance gains of a new RAT over an equivalent 5G-Advanced based evolution, so that the performance gain can be compared to the migration costs. NGMN notes that in the years following 6G launch, further evolution is to be expected and that future-ready specifications to avoid later hardware changes to the extent possible would be welcomed.

03 CONCLUSION & STANDARDISATION FOCUS AREAS

The transition from 5G to 6G represents a unique opportunity to address architectural complexity in a holistic way and establish a more sustainable evolution path for mobile networks. Experience from 5G has shown that excessive optionality on migration choices can significantly delay the realisation of benefits from a new generation, while increasing long-term cost and operational burden.

Migration solutions must be designed to deliver tangible benefits over a 5G-Advanced baseline from the first commercial 6G deployments, while enabling a smooth and credible evolution towards a full 6G capability. Avoiding short-term compromises that create long-term architectural dependency will be critical to ensuring that 6G can mature efficiently and at scale.

Multi-RAT Spectrum Sharing (MRSS) provides a promising migration path for 6G deployment, but only if its performance, efficiency and implementation characteristics are addressed realistically and without imposing undue complexity on networks or devices. Where additional migration options are considered necessary, they should be tightly constrained, technically and/ or operationally justified, and aligned with a long-term vision focused on 6G capabilities rather than prolonged reliance on legacy systems.

Beyond migration mechanisms, the practical success of 6G will depend on early consideration of device capabilities, hardware readiness, spectrum availability, and operational feasibility. These factors must be treated as key architectural considerations in order to ensure that 6G deployments can demonstrate meaningful value for customers and avoid fragmentation across the ecosystem.

04 REFERENCES

- [1] NGMN, NGMN Radio Performance Assessment Framework, Dec 2024, https://www.ngmn.org/wp-content/uploads/241018_Radio-Performance_Assessment_Framework_V1.0.pdf
- [2] NGMN, 6G Position Statement, Sep 2023, https://www.ngmn.org/wp-content/uploads/NGMN_6G_Position_Statement.pdf

05 LIST OF ABBREVIATIONS

3GPP	3rd Generation Partnership Project
AI	Artificial Intelligence
CN	Core Network
DSS	Dynamic Spectrum Sharing
DU	Distributed Unit
EMF	Electromagnetic Fields
eMTC	enhanced Machine-TypeCommunication
EPC	Enhanced Packet Core
FDD	Frequency Division Duplex
GPU	Graphics Processing Unit
IMT	International Mobile Telecommunications
LTE	Long Term Evolution
NB-IoT	Narrowband Internet of Things
MNO	Mobile Network Operator
MRSS	Multi-RAT Spectrum Sharing
NGMN	Next Generation Mobile Network Alliance e.V.
NSA	Non-Standalone
PDCCH	Physical Downlink Control Channel
RAN	Radio Access Network
RAT	Radio Access Technology
RU	Radio Unit
SA	Standalone
SIM	Subscriber Identity Module
TDD	Time Division Duplex
UE	User Equipment

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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, moving towards agentic AI-based operating models.
 - **Green Future Networks:**

Building 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.