EUROCONTROL

High Level
Network Concept of Operations
CONOPS 2029

Approved by the Network Management Board - 5 July 2022

SUPPORTING EUROPEAN AVIATION

FOUNDING MEMBER OF sesar JOINT UNDERTAKING

NETWORK MANAGER

High Level Network Concept of Operations (CONOPS)

2029

Edition Number	:	1.0
Edition Date	:	05.07.2022
Status	:	Released Issue
Intended for	:	Publication

Network Manager Directorate

DOCUMENT CHARACTERISTICS

TITLE			
High Level Network Concept of Operations (CONOPS) 2029			
Edition Number:	1.0	**Edition Date:**	05.07.2022

Abstract

This High Level Network Concept of Operation (CONOPS) 2029 has been developed in line with the content and direction of the Network Strategy Plan (NSP) 2020-2029 (approved through Commission Implementing Decision (EU) 2019/2167 of 17.12.2019), as high level operational target of the activities towards implementation of the NSP. Release no. 2 of this document, then titled “High Level Network Operational Framework 2029”, was approved by the NMB in their 27th meeting on 2 April 2020 (after agreements by NETOPS and NDOP). This version retitled as “High Level Network Concept of Operation (CONOPS) 2029” was approved by NMB/34 on 5 July 2022 (after agreements by NETOPS and NDOP).

Keywords

Operations	Strategy	FUA	ATFCM
Target Concept	Development	Airports	ATC
Network Management	NMD	FRA	ANSPs
2029	Network Operations	CTM	Airspace Users

Authors

NMD/ACD

Contact(s) Person	Tel	Unit
Ivan Pendacanski	+32 272 94737	NMD/ACD/STR

STATUS, AUDIENCE AND ACCESSIBILITY

Status		Intended for		Accessible via	
Working Draft	☐	General Public	☐	Intranet	☐
Draft	☐	NMD Stakeholders	☑	Extranet	☑
Proposed Issue	☐	Restricted Audience	☐	Internet (www.eurocontrol.int)	☑
Released Issue	☑	*Electronic copies of this document can be downloaded from :*			

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	REASON FOR CHANGE	PAGES AFFECTED
0.1	09/08/2021	First draft for internal consultation - draft team only	All
0.2	25/08/2021	Internal coordination	All
0.3	03/09/2021	Further internal coordination	All
0.4	27/09/2021	Introduction of High Level roadmap	All
0.5	07/10/2021	Major update of performance chapter	All
0.7	17/11/2021	Integration of comments received during the workshop	All
0.8	09/03/2022	First draft for external consultation	All
0.9	26/04/2022	Comments received via NM cooperative arrangements (NETOPS and AOT)	All
1.0	5/07/2022	Approved edition by NMB	

Publications

EUROCONTROL Headquarters

96 Rue de la Fusée

B-1130 BRUSSELS

Tel: +32 (0)2 729 1152

Fax: +32 (0)2 729 5149

E-mail: publications@eurocontrol.int

Contents

Table of Figures

High Level Network Concept of Operations 2029

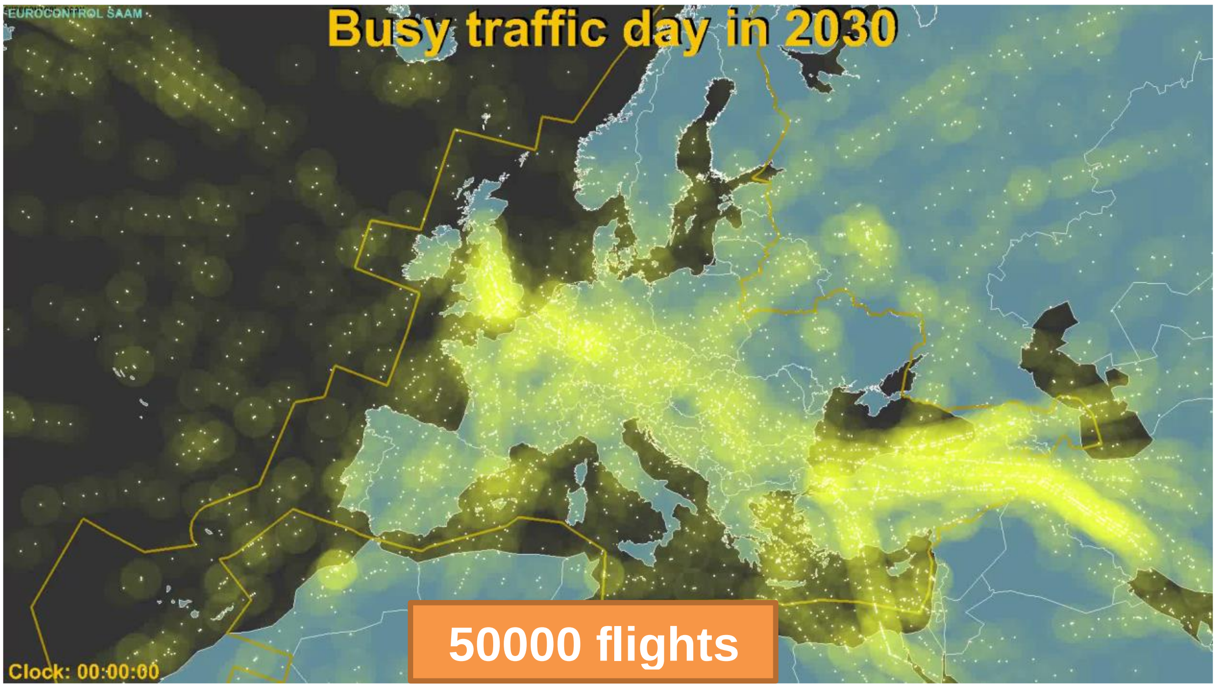
Foreword

This High Level Network Concept of Operations describes the European network operations as envisaged by 2029. As such, this document is defined to enable meeting the Single European Sky (SES) Performance Targets for Reference Period (RP) 3 and 4 which addresses the period 2020-2029.

This High Level Network Concept of Operations intends to operationalise the Network Strategy Plan (NSP). The 2029 vision is built on current network operations, on the strategic direction and objectives defined in the Network Strategy Plan (NSP) 2020-2029 approved through European Commission Decision (EU) No 2019/2167 of 17 December 2019, and supports the implementation of improvements as defined in the ATM Master Plan and the Common Project One (CP1) Implementing Regulation No 2021/116. As such, the aspiration level of this CONOPS is the same as in the NSP, including and going beyond CP1 IR. Through alignment with the NSP and CP1 IR, this High Level Network Concept of Operations is in line with the SESAR ATM Master Plan Essential Operational Changes and ICAO ASBUs. The objective of this High Level Network Operational Concept is to serve as a common high level view for all operational actors on the target for operating the network in 2029. Further, it provides a basis to ensure all improvement activities are in place to achieve the required performance over and above what can be achieved using current and new ATM network methods, processes and enabling system support.

This High Level Network Operational Concept, while delivering safer ATM operations, aims to reduce existing ATM constraints to Airspace Users, exploiting existing and emerging aircraft and ground system capabilities (both ground-ground and air-ground), and exploiting opportunities in the Single European Sky context. Its major purpose is to support Airspace Users, Airport Operators and ANSPs in meeting their business objectives by increasing cost-efficiency through improved network performance, notably capacity and flight efficiency.

The European ATM network needs to accommodate around 50 000 flights per day in a peak day in 2029, which is an approximate increase of 50% compared with the 2019 traffic demand. This will ensure that even unexpectedly strong traffic growth can be accommodated. In order to cope with this traffic demand, the European ATM Network needs to be substantially improved in terms of capacity, flight efficiency predictability, cost-effectiveness and sustainability. The European ATM Network will ensure and equitable access to all Operational Stakeholder. The Network shall maintain the same level of safety with the increased amount of traffic and address resilience and upwards/downwards scalability and societal needs.



The High Level Network Concept of Operations relies on a paradigm shift from airspace-based operations to (business/mission) trajectory-based operations in which all flights' trajectories interact from the strategic into the tactical phases. In order to manage the predicted traffic demand in 2029 and achieve improvements in major performance areas, some essential building blocks need to be put in place, as follows:

- Full dynamicity of airspace organisation and utilisation;
- Cross border airspace structures and delegation of ATS provision, where and when required;
- Enhanced Air-Ground data exchanges (including ATN B2);
- Full implementation of FF-ICE/R1 services and initial integration of FF-ICE/R2 services;
- Continuous trajectory synchronisation and information sharing from the planning horizon into the flight execution phase;
- Full sharing of relevant flight information with all Network Actors
- Full scalability and resilience

In order to achieve the implementation of the essential building blocks of the High Level Network CONOPS the development of the network human capital is also required. This needs to be achieved in a collaborative, coordinated and expeditious manner. It needs to take into account availability and flexibility of resources, network services, all operational stakeholders' interests and commitment towards achieving the common goals of the Network CONOPS. The ATM staff shall be well trained, competent, in order to explore the full potential of interoperability, delegations of ATS provision and flexible airspace structures. Staff competencies will remain paramount in achieving operational efficiency without compromising on safety. Flexible rostering tools will enable better management of available resources and their availability when is needed (coupling rostering tools with traffic complexity).

In a world of uncertainty, an essential element for the performance of the ATM network is the capability to scale, not only up, but also down. Scalability solutions need to support efficiently both the normal growing traffic levels, as well as crisis situations that lead to less traffic.

Operationally, the solution for scalability includes the capability to delegate the provision of ATS services between centers. To achieve this, the harmonisation of procedures and the standardisation of systems is required, so that controllers of a center can take over the traffic of another center without disruption. This requires also a more global approach to training and certification. The harmonisation of procedures is one of the aspects addressed in the Operational Excellence Programme.

The European ATM network will provide enhanced resilience to air transport operations. Enhanced collaborative decision making shall be implemented to let airspace users chose the best option in case of capacity constraints. The capability to delegate service provision between centers, not only brings scalability and elasticity at human resources level but also improves reliability: it allows to deal with staff shortages and infrastructure issues (physical site unavailability, system outage, cyberattacks, network unavailability, etc.). ATC centers can be the backup of one another with the capability to handover traffic with minimal disruption, bringing safety to higher levels.

In terms of technical infrastructure, modern cloud based and cyber-secure solutions offer scalability and also elasticity, allowing resources to be dynamically added or removed when needed. Such solutions need to be adopted. ATM Data Service Providers (ADSP) is a complementary solution, providing a set of services to one or more ATC, and addressing in that way the ATC infrastructure scalability problem. ADSPs may rely on a cloud infrastructure, after the addressing the important certification issues regarding ATM functionalities.

The **vision** of this High Level Network CONOPS is to improve the prediction of traffic demand and available capacity, permitting the European ATM Network to gradually transition from Demand/Capacity forecast to demand /capacity planning.

Finally, to support the expected levels of traffic in the next decades, regional optimisation of Air Traffic Management is not enough: a global approach is needed. As ATM modernisation programmes are developed around the world, it is important to set-up harmonised ATM working practices and standards, in support of global optimisation.

Therefore, this CONOPS looks beyond the European context in support of the ICAO concept of “network of networks”. The complex structure of the European airspace and the high density of traffic require innovative solutions, optimising the air traffic management in Europe, while interfacing and supporting the other regions. The evolutions foreseen in this CONOPS put Europe in a leading position to drive ATM modernisation and support the global ATFCM vision.

It should be noted that the implementation of the Network CONOPS is closely tied and it depends on the provisions of the regulatory basis and SESAR validation work. The Network CONOPS document will be updated is case of significant changes of regulations, standards and SESAR validation results.

Summary

This high level Network Concept of Operations intends to operationalise the Network Strategy Plan (NSP). While delivering safe ATM operations, the Network Concept of Operations aims to reduce existing ATM constraints to Airspace Users, reduce environmental impact and facilitate greener trajectories. It takes advantage of existing and emerging aircraft and ground/space based system capabilities (both ground-ground and air-ground), and exploits opportunities in the Single European Sky context. Its major purpose is to support Airspace Users, Airport Operators and ANSPs in meeting their business objectives by increasing cost-efficiency through improved network performance, notably capacity, flight efficiency and reduction of environmental impact.

To support the expected levels of traffic in the next decades, regional optimisation of Air Traffic Management is not enough: a global approach is needed. As ATM modernisation programmes are developed around the world, aiming for an increased automation, it is important to set-up harmonised ATM working practices and standards, in support of global optimisation.

This CONOPS looks beyond the European context in support of the ICAO concept of “network of networks”. The complex structure of the European airspace and the high density of traffic require innovative solutions, optimising the air traffic management in Europe, while interfacing and supporting the other regions. The evolutions foreseen in this CONOPS put Europe in a leading position to drive ATM modernisation and support the global ATFM vision.

This CONOPS includes five Direction of Changes (DoC):

Optimised Network Design and Utilisation

Free Route Airspace (FRA) is in use in the European airspace, ensuring connectivity with TMA and extending beyond the national boundaries by cross-border FRA. ATC sectors will be consolidated and will evolve towards cross-border and dynamic solutions, as required to match traffic demand. Dynamic Airspace Management and Airspace Configurations (DAC), together with Dynamic Mobile Areas, will be optimised and will meet both civil and military airspace requirements. Both civil and military demand will evolve, with different requirements of airspace utilisation, to cope with new generation(s) of manned and unmanned aircraft and more frequent combined air operations, including the use of unmanned technologies and new operational networks. All of them will need an evolving approach to airspace structures, to be managed with advanced flexible solutions

TMA can be dynamically extended, and is optimised using Performance Based Navigation (PBN) based procedures and Continuous Descent and Climb Operations (CDO/CCO). Unmanned remotely operated aircraft (drones), and operations at higher altitudes (above FL600) are effectively integrated into network operations. Full digitalisation of the aeronautical data chain and its associated processes will enable the provision of accurate and continuously updated AIM data according to the dynamicity of the operations.

Optimum Capacity and Flight Efficiency Planning

Aiming to meet user’s business needs, capacity is delivered where and when needed, while ensuring flight efficiency, based on expected demand and operational context. Where needed, ATFCM measures are established with full operational stakeholders’ coordination, considering AU prioritisation, and are minimised through ATFCM measures reconciliation. Through the Network Operations Plan (NOP), focus is maintained on planning and implementation of improvements to properly deliver required en-route and airport capacity. Major ATM transition projects are coordinated across the network to ensure synchronised deployments. AU flight preferences and priorities will be supported by User Driven Priority Process (UDPP) including automated multi-ATFCM slot swapping.

Trajectory and Cooperative Traffic Management

At network level, ATFCM will be managed on the basis of end-to-end 4D business/mission trajectories, provided by AUs using the FF-ICE flight plan (eFPL). Early flight plan information is available for network preparation, allowing ATFCM optimisation and negotiation before the eFPL is filed. Operational Air Traffic (OAT) flight plans will deliver military ATM demand pertinent to military IFR operations in controlled airspace, which will be further integrated into ATM network operations, thereby providing some missing pieces of information needed for a complete traffic demand picture. Flight plans will be updated in-flight, following optimisation and negotiation similar to the pre-departure coordination process. Trajectory prediction will be improved by the integration of Extended Project Profile (EPP) data at local and regional level. Airspace users operations will benefit from the harmonisation of VFR operations and centralisation of VFR fight planning at regional level. ATFCM will move to Flow Centric operations through cooperative traffic management mitigating imbalances from a network performance perspective and through Integrated Network-ATC Planning (INAP). It includes the allocation of target times for airspace volumes and airports to mitigate imbalances and to optimise arrival sequencing, including their use in support of extended arrival management procedures. Operations are based on cooperative traffic management procedures for the operational use of targeted measures, on continuous sharing of real-time traffic information and on collaborative decision making process between all actors.

Airport and TMA - Network Integration

Airport operations will be fully integrated in the network, aiming for On-Time Performance (OTP), supported by local airport Demand Capacity Balancing (DCB) functions that interact with network ATFCM. Optimisation at local level includes the integration of AMAN and DMAN processes, including the management of target times of arrival. To enhance arrival predictability en-route ATC will have the means to support extended arrival management into multiple airports. Local Airport Operation Plans (AOP) will be integrated with the Network via AOP/NOP interfaces for shared operational planning and real-time data exchange.

Network Components/system and CNS infrastructure

In order to facilitate the implementation of operational improvements and accelerate the digitalisation of the network, the network actors will support the following evolutions of their systems and infrastructure by 2029 (with some initial steps stemming from the OEP and the CP1 IR being already completed by 2025):

➢ **A fully digitalised network**

- The digital transformation of the Network supported by iNM, offering an ATM network operating with fully end-to-end cloud-based digital processes with safe and secure digital services, including EAD. iNM will allow NM to build a fully accurate and dynamic view of the demand and the capacity, enabling the NM role as trajectory coordinator in all phases of the flight.
- SWIM-based Air-Ground and civil-military information exchange to ensure a sound common view as basis for coordination and collaborative decision making.
- Increased ATC virtualisation through the gradual implementation of Virtual ATC centres.
- Further enhancement of aeronautical information management including fully implemented digital NOTAM.
- Some ATM Data Service Providers will be operating and providing services around Europe.

- Global interoperability will be improved through standardised interfaces for ATM information exchanges, allowing seamless ATM operations for all operational stakeholders.

➢ **The wide scale enhancements of existing local and network system components**

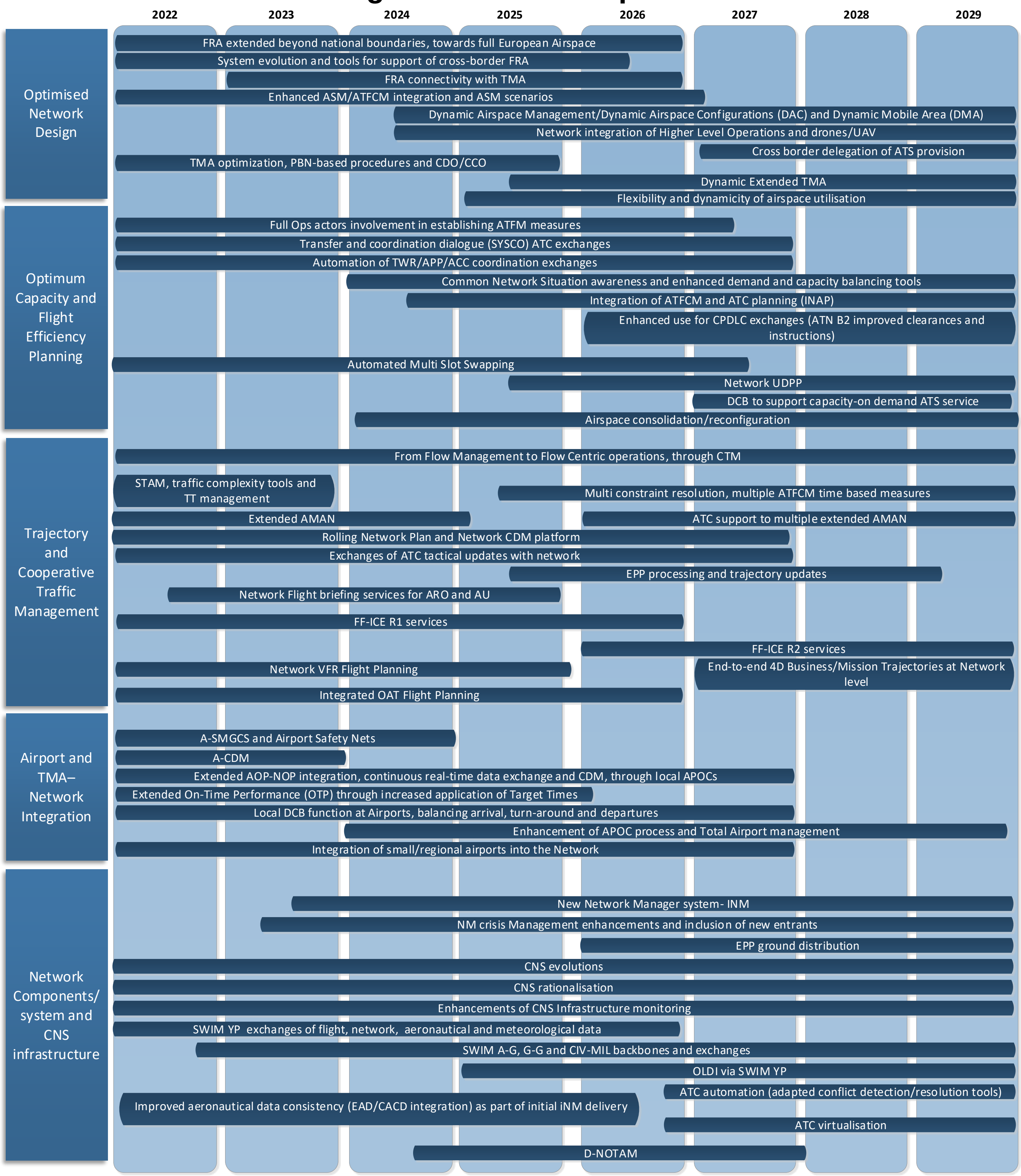
- The ATC automation will be enhanced by adapted conflict detection/resolution tools which include airspace and LoA constraints.
- The ground distribution of EPP data is operational and the systems of all Network actors are able to process this data.
- The NM systems capabilities extended to support the operations of new entrants.

➢ **Changes of CNS infrastructural components, such as:**

- The CNS infrastructure will evolve towards a performance-based service-oriented approach. CNS services will be provided by a number of recent and global technologies supported by a backbone of legacy and modernised technologies (i.e. the Minimum Operational Networks providing backup and support to the new technologies).
- Higher levels of automation and connectivity will deliver a more efficient and integrated CNS infrastructure and associated Radio Spectrum that will support the operational concepts described in this CONOPS (including the new entrants' operational needs).
- Enhancements to the CNS monitoring and Network Performance monitoring tools will improve detection, mitigation and prediction of failures/interferences impacting the network, increasing therefore its resilience. These monitoring tools will further be used to support the pre-tactical and tactical network operations phase.
- Improved civil-military interoperability and data sharing between ATM and military.

Due to the complexity and the number of stakeholders involved, this Network Concept of Operations provides a high level description of how the expected evolutions will support advanced operations, as well as the major changes expected in the roles and responsibilities of the different stakeholders. Detailed information will be provided by the CONOPS of the different projects addressing the expected evolutions in each identified direction of change.

High Level Roadmap



CHAPTER 1 – Introduction

Vision

In 2025, Network Operations will see a mixture of capabilities of ATM actors, varying from current capabilities to the more advanced ones. Network operations will be built on the application of best practices of different operational stakeholders and apply them in different combinations of capabilities and optimise stakeholders' performance.

In 2029, Network Operations will support the achievement of "a European ATM network serving European aviation and passengers in a safe, secure, predictable, operationally efficient, environmentally friendly and cost-efficient manner through close cooperation with all operational stakeholders". Network operations will ensure the full integration of new entrants and will have engaged on a full digital transformation.

The Network Manager, supported by appropriate governance mechanisms, will drive operations and technological evolution in partnership with all operational stakeholders, through Cooperative Decision Making and common network information and data.

Purpose

This High Level Network Concept of Operations describes the European network operations as envisaged by 2029 and ensures the **operationalisation** of the Network Strategy Plan. As such, this High Level Network Concept of Operations is defined to enable meeting the Single European Sky (SES) Performance Targets for Reference Period (RP) 3 and 4 (when defined, agreed and published by the European Commission) which addresses the period 2021-2029.

The High Level Network Concept of Operations, while delivering safe, more sustainable and scalable ATM operations, aims primarily to further reduce existing ATM constraints, taking advantage of existing and emerging air and ground system capabilities, and exploiting opportunities in the Single European Sky (SES) context. Its purpose is to increase operational performance, notably airspace capacity and flight efficiency, and to support Network Operational Stakeholders in meeting their business objectives and their performance targets).

More precisely, the 2029 CONOPS is built on current European network operations, on the strategic direction and objectives, as defined in the **Network Strategy Plan (NSP)** 2020-2029 approved through Commission Implementing Decision (EU) No 2019/2167 of 17 December 2019, and supports the implementation of improvements as defined in the **Common Project One (CP1) -** Commission Implementing Regulation **No 2021/116**. As such, the aspiration level of this CONOPS is the same as in the NSP, including and going beyond CP1 IR. Through alignment with the NSP and CP1 IR, this CONOPS is consistent with the SESAR ATM Master Plan Essential Operational Changes and ICAO ASBUs. The objective of this CONOPS is to serve as a common high level view for all operational actors on the target for operating the network in 2029.

It develops, from an operational perspective, how the **Network Strategy Plan 2020 – 2029's** strategic objectives (SOs) can be achieved <u>taking full account of the recent and foreseen network operational and technical evolutions</u> context - in particular the SES framework, the network digital transformation, the COVID 19 crisis and its recovery through sustainability actions and improved operational scalability, and new entrants.

Further, it provides a basis to ensure all improvement activities are in place to achieve the required performance over and above what can be achieved using current and new ATM network methods, processes and enabling system support.

The document also addresses the major changes in **Roles and Responsibilities** of the main Network Actors at horizon 2029. More detailed description of the Roles and Responsibilities of the relevant Stakeholders will be provided by the CONOPS of the different projects addressing the expected evolutions in each identified direction of change. Annex B identifies the high level impact of the changes.

CONOPS Scope

The CONOPS is aligned with the Strategic Objectives (SOs) of the **NSP** 2020-2029 (see diagram below), and focusses on the operations oriented SOs 1-7, while also addressing relevant operational and technical aspects of the other SOs. The societal impact SOs 8 -10 are addressed through separate actions except for SO 9/1 (optimisation of flight trajectory) and 9/3 (innovative concept of operations and new air transport vehicles) which are fully part of this CONOPS.

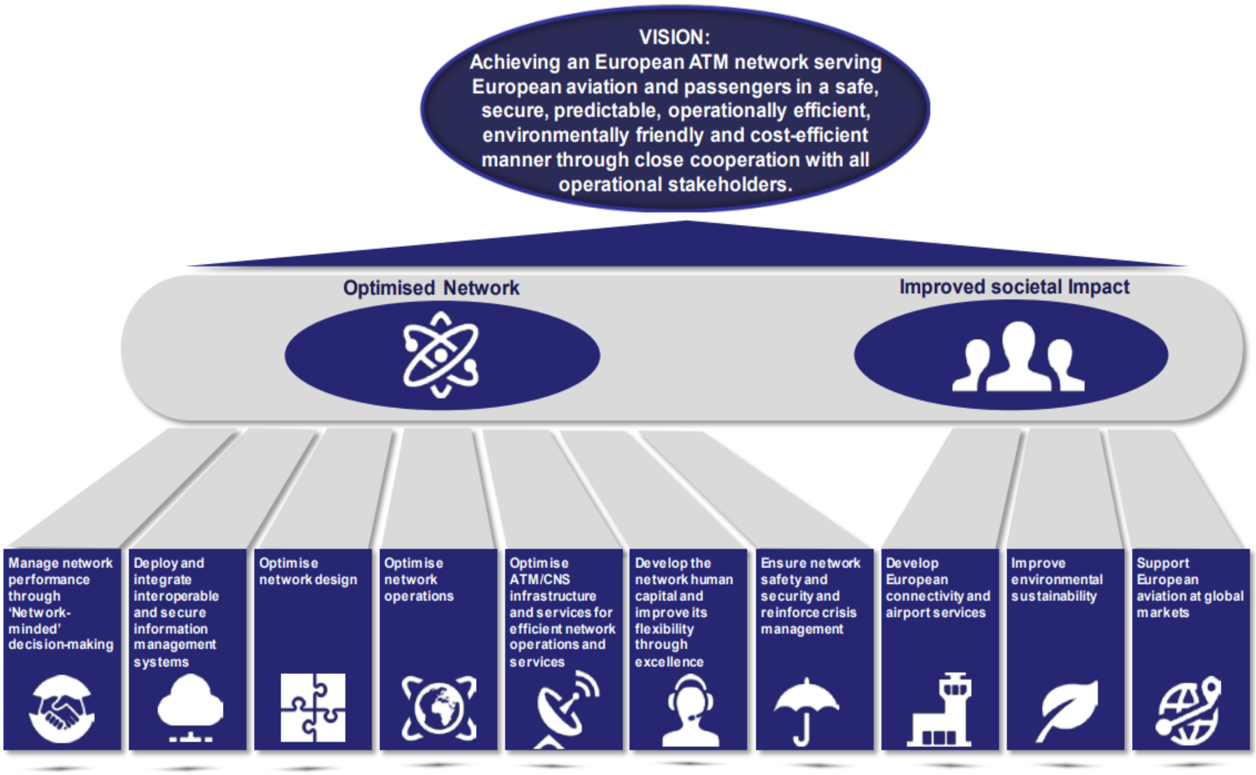


Figure 1. CONOPS Scope

Assumed ATM capabilities

The operational elements of this CONOPS are fully dependent on the other NSP Strategic Objectives addressing enablers (system/resources). A list of enablers as described and used in the SESAR activities to validate and demonstrate the concept elements of the future ATM system in Europe is shown in Annex C.

Further, the CONOPS takes advantage of ATM capabilities that are specified by the **CP1 IR No 2021/116**, to the extent that the associated target deployment dates (mostly by 2022/2023 are expected to provide increased capabilities already by 2025 through the deployment projects included in the CP1 IR.

The CONOPS also builds upon the operational and technical improvements to be delivered by the Operational Excellence Programme (OEP). This programme aims at the implementation of best-in-class operational and technical evolutions to deliver harmonised common operational capabilities among all operational stakeholders.

The CONOPS also builds **on the network strategic projects** as well as new systems and business models supporting network digitalisation, notably **the iNM and the evolution of the current ATM/CNS infrastructure**. Furthermore, it relies on the expected SESAR 3 validation developments, covering the period from 2023 to 2029.

Through alignment with the NSP and CP1 IR, this CONOPS is in line with the SESAR ATM Master Plan Essential Operational Changes and ICAO ASBUs.

CHAPTER 2 –Network Operational Context

Despite the COVID-19 crisis, the traffic is going to grow again and by 2029 it is reasonable to consider an increase of up to 50.000 flights per day. This grow will not be linear, therefore the ATM system should be resilient and scalable to adapt to the continuous changes of traffic demand, whilst ensuring the lowest costs for stakeholders and passengers. Moreover, this growth will further increase the aviation environmental footprint, hence, under a shared responsibility of all Network Actors, new operational measures and technological solutions will need to be deployed.

To succeed in delivering a performant network by 2029, a number of operational, system and infrastructure evolutions will be required. A clear description of the European ATM network operations will play a major role in bringing together all these necessary evolutions in a comprehensive way and facilitating their performance assessment.

The European ATM network supports and will continue to support all Network Operational Stakeholders to help them reaching their business needs, by ensuring an appropriate balance between flight efficiency, the optimisation of airspace and airport capacity and its utilisation and the overall cost of the network, thus minimising the total costs, whilst improving network operations scalability and resilience. To succeed, effective operational performance management of the network in partnership with stakeholders is required.

The composition of the traffic will be different from the current one, with new actors emerging (e.g. new entrants) as well as with boosting of some typology of traffic becoming more relevant (e.g. Cargo and business aviation including supersonic flights).

The airport business model likely will change, with a constant grow of minor airports, with de-location of traffic facilitated by the connectivity provided by new comers governed by UTM operations.

Military ATM demand will also evolve, with a different requirement of airspace utilisation, to cope with new generation(s) of manned and unmanned, more frequent and complex combined operations. All of them will need larger airspace structures, to be managed with advanced flexible solutions.

Despite the financial crisis of 2008-2009 and despite today's COVID-19 pandemic over a decade later, environmental concerns have not evaporated; indeed their importance has remorselessly grown. Aviation stakeholders committed to achieving a "net zero carbon" industry by 2050, in advance of the UNFCCC's COP26 meeting in Glasgow in November 2021. The European Green Deal piles further pressure on aviation to clean up its act.

Moreover, a number of these evolutions will bring new business models for a number of the future Network Operational Stakeholders. Since these changes could sometimes lead to inefficiency at network level different operational solutions will be required.

In this decade, operational stakeholders will run modernisation programmes engaging in digital transformation, which involves not only system modernisation, but a profound transformation of the business processes through the use of today's digital technologies capabilities, leading to higher levels of effectiveness.

One of the sectors of the business process transformation is the introduction of intelligence and automation in real time, by the use of big data, machine learning and artificial intelligence technologies. This will augment the human capabilities to a level otherwise not possible, allowing to anticipate problems and to provide the best solutions, to timely plan and adjust in a seamless and coordinated manner with all actors.

Integration between business partners through SWIM will continue, allowing to extend the intelligent processes beyond organisational boundaries and leading to optimised operations across the network.

2.1 Current situation of network operations and identified shortcomings

Current Network Operations can be depicted as an iterative process linking network operation planning with execution and review phases, all contributing to deliver network performance according to the defined performance targets.

A description of the Network Operations and system/infrastructure changes as envisaged by 2025 and 2029 is provided in Annex A.

Currently the following shortcomings are limiting the performance of the Network Operations.

About the airspace design and utilisation

European airspace is still fragmented. While many Operational Stakeholders have introduced Free Route Airspace, the lack of ECAC-wide cross-border FRA and connectivity with TMAs continues to limit AUs' flexibility in optimizing their trajectories according to their own business models, with associated environment and flight efficiency penalties.

Additionally, there are indications of structural airspace bottlenecks with sub-optimal ECAC-wide sectorisation that does not fully comply with the airspace design principle, i.e., for European airspace to be considered as a single airspace for design and operations.

Flexible Use of Airspace concept and procedures, while applied, lacks of full dynamism and airspace structures supporting flexible solutions. Moreover, it is not applied in a harmonized way, which prevents delivering its performance potential in aligning available airspace with actual traffic demand.

Another limitation comes from the rapid uptake of drone operations and operations at high altitude (>FL600) for which no agreed operational concept exists, preventing their effective integration into the Network Operations.

Operations planning does not always consider the most demanding growth scenarios to allow anticipated resolution of network operational performance issues. Furthermore, the limited exploitation of the business intelligence techniques and tools at local and network level results in the sub-optimal capabilities for the Network Manager to support its stakeholders and researchers to detect general trends, validate hypothesis, analyse generalised past events and behaviours, or create new data driven services for the network and its stakeholders.

Aeronautical data management is still fragmented, not harmonized and only partial digital. Lack of flexibility in the management of dynamic data limits the enhanced application of procedures to manage dynamic operations.

About capacity and flight efficiency planning

Planning for measures to resolve network imbalances do not always involve all affected operational actors, potentially resulting in solutions leading to a certain degree of compromise. Further, the network plan, defined to achieve a network-wide optimal performance, is often not the basis for local planning and execution, or it is not fully implemented, resulting in network performance penalties. The possibilities for taking into account AU priorities and business needs in the network planning and their involvement in the synchronisation of local and network measures are limited. Due to the non-rolling nature of network planning, the optimisation potential is not fully explored.

About trajectories and traffic management

Trajectories are derived from the limited information provided in the current ICAO flight plan, resulting in uncertainties as regards the trajectories used for ATFCM and local ATC. The full demand picture is therefore limited, also due to the lack of OAT flight plan data, which leads to unnecessary reduction of capacity figures of the ATSUs and NM. There is limited possibility for coordinating updates to the filed trajectories, resulting in downstream unpredictability not always taking into account existing dynamic local capabilities. Predictability is further affected by limited access by ATC and pilots to network and associated ATFCM measure planning, resulting in a gap between planning and execution, with increased ATC capacity buffers to maintain safety.

About airport and TMA - network integration

The current airspace capacity and throughput planning does not sufficiently consider, and often runs in isolation from, the airport and TMA capacity planning and declaration process. Consequently, bottlenecks are not adequately identified during the strategic planning phase, which is carried on into the pre-tactical and tactical phases, resulting in reduced flight punctuality.

About new entrants / new operations

The coming decade will see the emergence into operations of a number of technologies that have been under development for several years, namely commercial drone operations, Urban Air Mobility, High Altitude Operations and Supersonic aircraft. This will lead to a composition of the traffic different from that of today, with new actors emerging (e.g. new entrants) as well as current actors changing their operations (e.g. Cargo and business aviation including supersonic flights) increasing the complexity of the network operations .

The current U-Space regulation opens all classes of airspace to airspace reconfiguration, and so, in order to minimise operational impact, the ATM – U-space interface will need to be developed.

Despite the understandable enthusiasm in the industry surrounding the new entrants, their actual scale of operations is difficult to gauge at this stage. The industrial and financial resources behind them would suggest, however, that they will all become reality, with increasing operational deployment from 2025 onwards. The greatest uncertainty is probably around the timing of the introduction of supersonic aircraft, very few of which can be expected to be operating by 2030.

A further challenge will be the impact of a small number of spaceports that are being planned in continental Europe and the UK, the operation of which may place temporary restrictions on surrounding airspace later in this decade.

Military ATM demand will also evolve, with a different requirement of airspace utilisation, to cope with new generation(s) of manned and unmanned, more frequent and complex combined operations. All of them will need larger airspace structures, to be managed with advanced flexible solutions.

About Network Components/system and CNS infrastructure

- **Cost-efficiency and cost-containment of systems and infrastructure**

To cope with the forecasted growth of traffic and to adapt to the continuous changes in traffic demand whilst ensuring the lowest costs to stakeholders and passengers, the ATM system should be made more resilient and scalable.

However, reductions in ANSP staff numbers are not anticipated, therefore technology will be key to improving cost and operational efficiency. Artificial Intelligence and Machine Learning (AI/ML) are already making small but significant inroads. The increasing digitalisation of ATM provides an opportunity for ANSPs to contain costs by switching away from in-house data storage, processing and analysis, into cloud computing platforms covering all or part of the data value chain. This opens the door to virtualisation, software as a service (SaaS) and even infrastructure as a service (IaaS), and to ANSPs concentrating their limited resources on improving ATM rather than solving IT problems.

ECAC's CNS infrastructure is made up of thousands of individual ground facilities, all of which need maintaining and replacing at the end of their operational lives. There is sufficient redundancy to remove older facilities without impacting performance. That, together with introducing new, more modern equipment, and an increased reliance on space-based infrastructure for navigation and surveillance, will improve both cost efficiency and spectrum efficiency

Moreover, the CNS infrastructure and scarce resources will need to be dimensioned to support the new entrants. They will impose new CNS airspace requirements that are still to be defined and also will depend on the number of users (i.e. legacy users and new entrants). The CNS monitoring needs to be extended and enhanced in terms of geographical coverage, technical scope, detection delay and coordination for legacy traffic.

- **Digitalisation and virtualisation current limitations and new risks**

The existing Network components are fragmented and some of them are substantially outdated. The data exchanges between the Network components are rather limited (or non-existent), using outdated technologies, with very limited capabilities, preventing to build a real-time common situation awareness and only essential data are shared via peer-to-peer exchanges.

The level of automation of the ATM tasks is implemented with different variants by the Network Actors and is mostly low level, especially for the service providers. The capabilities of transformational technologies, such as Artificial Intelligence (AI), Machine Learning (ML) and Big Data are not yet fully exploited. The rationalization of the infrastructure, benefiting from cloud technology is only in its early steps.

With increased digitalisation, including more autonomous vehicles (e.g. UAS), the aviation cyber threats landscape is evolving rapidly and will require specific attention calling for an increased collaboration between all network operational actors and the development and deployment of new cyber services ensuring that the Network will remain cyber resilient.

- **ATM/CNS infrastructure environmental footprint**

The CNS infrastructure environmental footprint could be further reduced. Hence there is an urgent need to deploy new technologies and to rationalise the legacy elements, and also to take actions ensuring the network CNS infrastructure becomes carbon neutral.

2.2 Opportunities

In response to the above shortcomings, a number of solutions have already been identified whilst others are beginning to emerge:

- **New Business Models**

Operational and technological evolutions of the network will bring new business models for a number of the future Network Operational Stakeholders. Since these changes could sometimes lead to inefficiency at network level, different operational solutions will be required. All elements are directly impacted by the (network) performance of ANSPs and airports.

The airport business model likely will change, with a constant growth of secondary and regional airports, with de-location of traffic facilitated by the connectivity provided by newcomers governed by UTM operations.

Technological developments, business efficiency needs and regulations have been gradually loosening ANSPs' grip on their IT and data systems. The losses from the pandemic have exacerbated these trends. A previous reluctance to outsource key infrastructure and associated data flows is weakening, especially as the provision of IT/data-related services over the Internet is highly reliable. Some ANSPs have even gone as far as transferring their CNS assets to third parties to implement “infrastructure as a service” in which they effectively lease performance. The question now is how fast and how far this unbundling will be allowed to go.

Unbundling should trigger new, more efficient ways of working, and stimulate development of new applications to undertake tasks that would have been previously impossible. New business models will emerge, in which control of the infrastructure, and the unbundling of the services dependent on it, will both vary depending on need, the willingness of the original owner(s) to transfer assets and the geographical scope to be covered. Outsourcing may only go as far as common procurement, or it may encompass wholesale transfer of assets. There is no one model that fits all; rather, decisions will be taken on a case-by-case basis, and apply equally to IT and CNS infrastructure.

The introduction of new business models provides opportunities to introduce innovative financing and funding mechanisms. Traditionally, CNS deployment has relied on ANSPs and airspace users covering their costs from internal cash flow, loan financing and, if linked to the SES in particular, grant funding. The impact of the COVID-19 pandemic on cash flow and capital expenditure means that ANSPs and airspace users may have to look at new funding models for the deployment of ground and airborne equipment.

- **Network collaborative approach**

The European ATM network supports and will continue to support all Network Operational Stakeholders to help them in reaching their business needs, by ensuring an appropriate balance between flight efficiency, the optimisation of airspace and airport capacity and its utilisation and the overall cost of the network, thus minimising the total costs, whilst improving network operations scalability and sustainability. To succeed, effective operational performance management of the network in partnership with stakeholders is required.

Moreover, the anticipated growth will further increase aviation’s environmental footprint; that, however, is a shared responsibility of all Network Actors, and so new operational measures and technological solutions will need to be developed in SESAR and deployed through Collaborative Decision Making to minimise the impact.

- **Global network of networks**

The continuous growth of air traffic in recent decades, while punctuated by crises, has seen greater increases in international over domestic traffic. Long-haul operations reflect the increased globalisation and integration of the world economy. Much of that traffic arrives at and departs from Europe’s busy main hub airports, and spends far more time in European airspace than an average intra-European flight. From the network management perspective it is beneficial to have the earliest possible warning of when a long-haul flight will enter European airspace so that the sectors affected can smoothly plan their operations. The sharing of data with the regions and States buffering the IFPS zone will support this, as will the use of satellite-based surveillance data, covering airspace over the oceans and wilderness areas in particular. The very large traffic flows into and out of the NM area, in particular, are expected to increase, and so cooperation with the ANSPs controlling the relevant airspaces will remain a high priority.

- **A digitalised Network**

In this decade, operational stakeholders will run modernisation programmes driven by and harnessing digitalisation. These will involve not only system modernisation, but a profound transformation of their business processes driven by the emerging capabilities of digital technologies, leading to higher levels of effectiveness.

The key sectors for business process transformation are the introduction of intelligence and automation in real time, the use of big data, machine learning and artificial intelligence technologies. These will augment the human capabilities so that the network actors can better anticipate problems and deliver optimised solutions, as well as to plan and adjust in a timely, seamless and coordinated manner with all network actors.

Data integration and sharing among network business partners will become routine through SWIM, driving negotiated solutions through intelligent processes beyond organisational boundaries and leading to optimised operations across the network.

A **co-ordinated digital transformation at network level**, addressing the processes and systems of all stakeholders and in which the INM programme will play a central role, is required.

To benefit from the above technical and operational opportunities, in the given evolving and challenging ATM context, there is a need for a clear high level description of the future operations which is presented at chapter 3.

CHAPTER 3 – Main Directions for change

3.1 Need of changes

The previous chapter highlights the current limitations in exploiting the performance of network operations and its underlying infrastructure to meet the required performance. Different are the areas where changes are deemed necessary. The expected evolutions address both processes/procedures and systems supporting enhanced network operations.

3.2 Main Directions for change

Network operations are driven by enhanced stakeholders' participation in a rolling cooperative process with several layers over time. This is achieved by continuously sharing the demand (incorporating the latest flight intentions) and the available capacity, defining measures in the Network Operations Plan (NOP), considering NOP as a target by all actors taking into account operational updates, evaluating operations against performance targets and updating the plan.

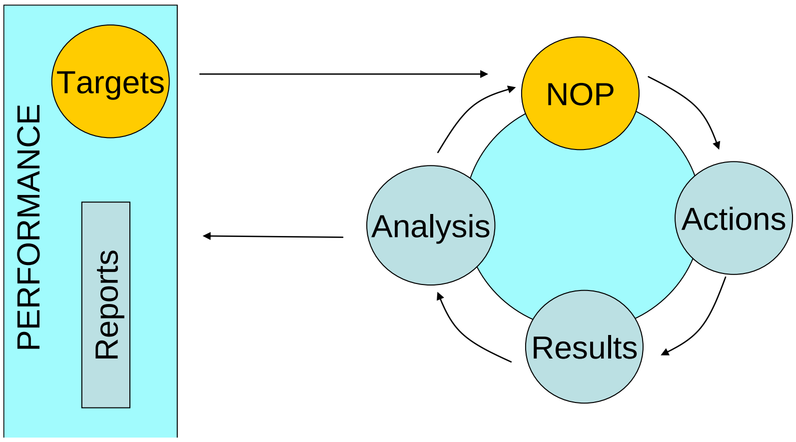


Figure 2. Rolling cooperative process

Overall network performance will be closely monitored and managed, including monitoring of the performance targets for the main actors in aviation. This enables Member States and Operational Stakeholders to enhance their local performance from a network perspective. All partners operate with a high level of transparency, through intensive information sharing via SWIM, allowing dynamic management of available resources responding to the airspace/airport user needs.

The future concept of operations relies on a paradigm shift from airspace-based operations to (business/mission) trajectory-based operations in which all flights' trajectories interact from the strategic into the tactical phases. This enables the network management to adapt the solutions to the scope of the problem and thus optimise network performance.

Critical success factor is the increased participation of all Network Actors (including human, system and procedural aspects) through systematic application of highly cooperative mechanisms by all partners at local, sub-regional and regional level, supported by automated processes via SWIM. The Operational Stakeholders interact at all planning levels, with the NM ensuring the continuous monitoring of the network performance and acting as a last resort arbitrator, based on agreed CDM processes.

Network operations require an accurate and continuously updated operations plan, aiming to reduce the ‘gap’ and create a seamless process from planning into execution. If planning reflects operational actors’ expectations better, more effective measures are expected, increasing the added value of network planning and coordination and increasing the efficient utilisation of network resources, improving network operations’ performance. Even the smallest deviations need to be communicated uninterruptedly and integrated at network level, to allow continuous accurate network impact assessment and identification of opportunities for airspace users.

These major changes will further improve the quality and reliability of network planning and boosts the effectiveness of decision making, which in return allows network management to use finer and more proportionate measures up to real time operation. The benefits effect a number of KPIs by means of increased capacity exploitation, reduced ATFCM measures, reduced negative side-effects on the network and improved flexibility and predictability.

The main directions mentioned here should never be seen in isolation. There are close interlinks among the different streams, requiring synchronised developments to exploit the expected benefits.

Furthermore, Network Operations require an underlying infrastructure which is modernised, interoperable, cost-efficient and highly performant to support any future evolution of the European Network and its required performance.

Looking at the time frame covered by the CONOPS, a stepped approach for improvements is foreseen. Two different snapshots are identified, 2025 and 2029, to group the improvements according to their level of maturity. Annex A provides a description of the foreseen operations in 2025 and 2029, while Annex C includes the main enablers supporting the enhanced operations in the two scenarios.

In addition, further network improvements will be realised through the implementation of other initiatives such as the Operational Excellence Programme (OEP) and the implementation of the iNM programme.

3.3 Main Directions for 2025

The main changes for 2025 are organised in Directions of Change and will be supported by a set of enablers, as they have been identified in the European ATM Master Plan (EATMMP). The improvements will be boosted by the OEP to spread across Europe best practises identified with the support of selected champions. The 2025 scenario will be characterised by the initial implementation of iNM programme aiming to support the digital transformation of the network operations, and by the network-wide deployment of the main CP1 ATM functionalities.

3.3.1 Optimised network design and utilisation

Combined operation of Flexible Airspace Management and Free Route Airspace is expected to enable airspace users to fly as closely as possible to their preferred trajectories without being constrained by fixed airspace structures or fixed route networks.

The current FRA application extended beyond the national boundaries by cross-border FRA implementation, aims gradually to encompass the whole of the pan-European airspace. FRA will be extended to TMA boundaries to ensure the connectivity with TMA fixed route structures established and managed flexibly to best suit the expected traffic demand.

In order to support cross-border FRA operations, further automation of ATC planning/tactical tools is envisaged (multisector planner, conflict resolution advisory, dynamic cross sector sectorisation tactical tools), as well as the initial steps of ATFCM/ATC planning integration.

The initial implementation of delegation of ATS service provision will be supported by required data exchanges and system features, as well as the required processes and procedures, and controller training and certification.

Extensive utilisation of variable profile areas (VPAs) is expected to grant flexibility in managing airspace structures required to cope with more demanding airspace requirements for new aircraft with advanced performance (5th generation).

As a step towards Dynamic Airspace Configurations, pre-defined airspace configurations are designed and dynamically managed to provide alignment of airspace availability through collaborative decision making processes at national, sub-regional and network level. Operational civil and military requirements including both flight efficiency and capacity are taken as an input.

Short notice reserved/restricted airspace request updates are continuously shared between the ATM partners in a rolling airspace update process, facilitating immediate responses from service providers and airspace users. This will enable the further integration of ASM/ATFCM processes. Real time coordination is supported with what-if functionality for selection of appropriate responses. The real time ASM coordination can offer more direct and shorter routeings and it can be used efficiently in case of airspace release. Airspace availability is shared in real time via full rolling AUP/UUP mechanism to optimise utilisation of airspace. Traffic synchronisation actions may follow as a result.

The network planning processes will be continuous, sharing the latest updated data with all users (interoperability between ASM, ATFCM and ATS). Network actors will link their own local processes to the network processes supported by SWIM compliant services.

Improved ASM process through a rolling AUP/UPP and Network impact assessment of FUA processes and data exchanges will be carried out accompanied with a continuous ASM performance monitoring.

Enhanced notification processes of updated airspace status in real time will allow AUs to improve flights efficiency, leading to an optimised airspace utilisation.

A network operations oriented development of the local airspace utilisation rules and availability (for example as reflected in the Route Availability Document) will be focused upon simplified rules that are dynamically applied. Network operations efficiency and capacity will be improved by the reduced focus on national boundaries and by the removal of redundant and obsolete limitations.

Between ATM actors real time airspace status data will be exchanged and provides the basis for ASM/ATFCM planning updating and fine-tuning.

TMA optimisation is based on connection with free route airspace above and application of PBN, enhanced arrival procedures based on GBAS and CDO/CCO techniques within TMA. Further techniques like RECAT-EU and Time Based Separation (TBS) will provide for additional efficiency increase.

The validation and early deployment of conceptual elements concerning the network integration of Higher Level Operations and drones/Unmanned Aircraft Vehicle (UAV) are envisaged in this time frame.

3.3.2 Optimum Capacity and Flight Efficiency Planning

Network Collaborative Management improves the European ATM network performance, notably by increasing the airspace capacity and flight efficiency through exchange, modification and management of trajectory information.

In the airspace and airport planning process, stakeholders aim at meeting user's business needs by providing capacity more proactively and dynamically where and when it is needed while ensuring flight efficiency, based on expected demand and operational context. In addition, Operational Stakeholders need to ensure the continuity of air traffic service provision despite disruptions by enabling a temporary delegation of the provision of air traffic services to an alternate provider with spare capacity.

Structural airspace bottlenecks are addressed with appropriate mitigation actions and with sufficient accuracy to enable efficient resource allocation and to deliver the required operational performances in respect of new sector plans.

Major ATM transition projects are coordinated across the network to ensure synchronised deployments.

AU (civil and military) requirements need to be dynamically integrated into the new airspace structure to ensure a solid civil/military utilisation of the airspace. The improved dynamicity and transparency of the airport and airspace planning processes allows AUs to optimise their fleet planning or mission planning and allows for improved flight planning for individual flights.

Local plans need to include the flexible and dynamic sectorisation by taking into account basic complexity indicators based on specific shapes of demand, network flight efficiency needs and existing ATC technology enabled capabilities. In addition, the local/regional plans should consider the cross-border sectorisation plans and consolidation/reconfiguration of upper airspace sectors in a dynamic manner.

The timely sharing of dynamic operational data by ANSPs, namely the sector configurations, will contribute to improve predictability and the effective application of measures, as well as the flight efficiency coordination processes in the network.

All Operational Stakeholders (AU inclusively) will be fully involved in the establishment of ATFCM measures via Network CDM processes and tools. To support airspace users to optimise their business in the network, AUs will have more flexibility to select the flights to which specific measures will be applied, and will have access to automated processes for optimising their departure sequences (for priority flights), with ATFM slot swapping capabilities.

EU-wide performance targets are cascaded down via Network Operations Plan to capacity performance targets (regional and local) to a workable operations level.

The Network Manager and its operational stakeholders will have to ensure:

- the timely development of operational plans and their coordination at network level;
- the identification of bottlenecks and the development of an optimised airspace structure;
- the implementation of identified measures and optimum sectorisation, with the operational resources needed to deliver the required performance.

The ATC exchanges will be supported by OLDI transfer and dialogue message exchanges to the interfaces where deemed beneficial and operationally justified. The OLDI exchanges will be used for sharing of limited trajectory data.

The phone coordination between APP/TWR and ACC will be replaced by the OLDI message exchanges that support notification, coordination and planning process or share flight data via connection on common FDPS. Some of these exchanges might be cross-border.

3.3.3 Trajectory and Cooperative Traffic Management

As a first set of measures towards 4D business trajectory management, Operational Stakeholders need to ensure timely implementation of eFPL based on ICAO FF-ICE that will include the planned 4D trajectory of the flight. The FF-ICE/R1 services (filing, trial, data request, notification and data publication services) need to be supported by the Network Actors.

Flight information (both for FPL and eFPL) exchanged during the pre-tactical and tactical phases by ATC systems and Network Manager supports the predictability of network events and their impact, and it reduces uncertainty, thereby improving operational performance.

Planned 4D-measures (e.g. Target Times) will be communicated to all relevant actors as targets, so to ensure that the flight execution is performed against the plan to permit optimised network performance.

Trajectory modifications for flight efficiency purposes will be beneficial to airspace users and without negative impact to downstream operations. In specific areas, special attention by ATC is given to flights subject to downstream constraints, to ensure that targeted measures established in the planning phase are respected.

The accuracy of the traffic demand is improved by the initial integration of OAT and VFR flight planning at network and local level. The accuracy of the trajectory information will be improved by comparing eFPL flight planning information with the flight intention information[1], evaluating the Airspace Users proposed trajectories (Shared Business Trajectories), extended AMAN data, trajectory data distributed by Network Manager and by increased exchanges of departure and arrival planning information before/during flight execution.

The iOAT flight plan will provide means to express Military mission needs in accordance with the flight planning requirements. At the same time it will represent the first concrete step towards the initial Mission Trajectory (iMT) and the transition towards the future Trajectory Based Operation environment.

Providing OAT flight plans to the pertinent civil or civil military ATS, limited to those needed to provide ATS to that military IFR flights, can create an enhanced awareness for civil ATCOs on military traffic. This aspect is also valid for the military ATCOs when it comes to ensuring conflict detection and separation between the participating and the non-participating traffic to a certain mission. Mutual awareness is considered enhancing flight safety, reducing ATCO communication workload in civil and military units, enabling enhanced flexible use of airspace and facilitating tactical civil-military co-ordination. The enhanced predictability of military air operations, other than the ones executed in time of crisis or conflict, for the other Network Actors will also be one of the main gains of introducing the iOAT flight plans into the network operations.

The extended projected profile (EPP) contains an updated FMS route prediction and it includes the predicted aircraft weight, predicted horizontal and vertical speeds and up to 128 future waypoints along the route. The Network Actors will receive Extended Project Profile (EPP) via the ADS-C ground distribution and use it, as deemed appropriate, to update some segment of ground trajectories. ANSPs need to present EPP to ATCOs and monitor of compliance of ground and airborne trajectories.

The integration of FF-ICE, EPP and airborne flight exchanges with ANSPs will enable Network to obtain much greater accuracy of planned/revised trajectories and future flight intent.

ATC will provide efficient flows of traffic by, in principle, implementing trajectories optimised during the planning phase and necessary trajectories revision in order to maintain the declared sector throughput and de-conflict the oncoming/outgoing traffic flows.

Flow Management shall move to a Cooperative Traffic Management (CTM) environment, optimising the delivery of traffic into sectors and airports and the need for Air Traffic Flow and Capacity Management (ATFCM) measures. The scenario management tools and what-if/Network Impact Assessment will support the decision making process for any DCB measures.

The monitoring process of Network Capacity also takes into account new indicators and threshold values related to complexity and workload. This requires en-route and airport capacities to be updated in real time.

In the planning phase, to efficiently use resources, an optimal plan of sectors and airspace restrictions/reservations will be timely updated to balance with the demand and achieve the most optimum airspace configuration. The automation of restrictions management will be

[1] Compliance with Article 9 of Regulation (EC) No 255/2010 on common rules on air traffic flow management

implemented as well as further evolution of flow constraints model.

ATC will optimise network operations by, in principle, implementing the coordinated targeted measures (4D: time, route, level) through adherence to the agreed business/mission trajectory, and in addition, to anticipate opportunities for airspace users when and where possible, based on cooperative traffic management procedures in coordination with civil and military ANSPs (including military views on CDM processes), Airports, FOCs/WOCs and with the Network Manager. This will allow a balanced approach on predictability and managed flexibility. In addition, ATC will be supported by the network operations for specific ATC requirements such as data sharing in support of arrival (pre-)sequencing and reconciliation of extended AMAN advisories with Target Time constraints.

In addition, adjacent control centres agree and apply cooperative over-the-horizon traffic management and coordination procedures with greater emphasis on resolving issues before they materialise, through traffic demand adaptations that reduce the dependency on downstream reactive controller workload. By coordinating hotspots (overloads/conflicts) based on complexity and occupancy values, local measures will be as much as possible cooperatively decided to prevent negative impact on downstream controller workload (e.g. Short Term ATFCM Measures - STAM). These measures could be traditional measures but also more fine-tuned and targeted measures to optimise complexity/workload. The application of a measure takes into consideration the expected network effect, including the interface with airports.

Clear organisational processes are established to deal with unplanned major events and/or significant reduced operations (applicable to local and Pan-European disruptions, but also to global disruption or out of area disruption having an impact on the Pan-European network). Depending on the nature of the situation the normal ATFCM toolbox and rules can be extended, including adapted prioritisation rules, buffers, new what-if applications, etc.

In order to support more efficient arrival traffic management, the extension of AMAN horizon is needed in order to propagate the AMAN delays further en-route. The extended AMAN advisories need to be implemented on the wider scale with the full Network involvement and awareness. Letter of Agreement (LoA) and operational procedures will be adapted with the provisions of extended AMAN delay apportionment.

The Network Actors will support the collaborative management of constraints for arrival, integration and coordination of constraints from various stakeholders (airports, ANSPs, AUs and NM). The Network daily outlook and CDM process will be enhanced by the initial implementation of the Rolling Network Plan, supported by a digital CDM platform (iDAP - integrated Digital ATFCM platform).

The network prediction and performance processes intend to provide increased efficiency through assessment of performance of network operations with stakeholders able to evaluate the impact of their intentions and decisions.

3.3.4 Airport and TMA - Network Integration

A Collaborative Network Operations Plan (NOP) consists of increased integration of NOP and Airport Operations Plan (AOP) information. The development of a Collaborative NOP shall focus on the availability of shared operational planning and real-time data.

Through the NOP, focus is maintained on planning and implementation of improvements to properly deliver the required en-route and airport capacity (the latter through integration with the AOP). This is a rolling process, through continuous assessment of performance and identification of improvements and/or mitigation actions.

Airport capacity declaration (and the subsequent airport slot allocation) process and airspace planning are closely linked and need to be consistent. Airport capacity planning process needs to be optimised taking into account the airspace capacity planning and Network optimisation. The quality of the data used for network planning purposes is significantly enhanced with the provision of more accurate data directly from airport operators (specifically P-DPI and API messages), via the SWIM interfaces for AOP/NOP integration.

In addition, data from other airports (or groups of airports), not mandated to implement AOP but that generate any significant levels of traffic will be used as input into the planning process, so a complete and accurate picture of the expected traffic situation can be established.

Smaller airports, who decided that local CDM development is not feasible and/or not required, will be linked to the network via SWIM interfaces. These airports can then become Advanced ATC Tower airports exchanging DPI, for improving traffic demand predictability, ground operations monitoring and via ATC DPI, assuring that departure planning data for the small airport is available for the Network. Alternatively, small/regional airports might opt to implement the ADS-B based system for DPI generation and then also via SWIM make this data available to the Network.

For airports, comprehensive capacity assessments are carried out to ensure that all aspects of the slot allocation process are fully aligned and accurate data is used as part of the network planning process.

The planning process from strategic through pre-tactical until tactical operations is adapted to allow for a constant quality management cycle including post operational analysis, which is consistent with the application of the Gate-to-Gate and air-to-air concept. The present reporting of airport delays has evolved from one of reporting effect to one of more accurately reporting the causes for the delay, which includes information on when the demand exceeded the agreed capacity figure and the reasons for the excessive demand.

Local partners in the Airport Operations Centre (APOC, including a local DCB function) and network capacity managers collaboratively decide on appropriate measures considering network and local airport demand and capacity constraints, to ensure the appropriate balance between efficient Airport/TMA operations in all weather conditions and efficient en-route operations.

The departure flows will be improved by the application of Departure Management (DMAN), synchronised with pre-departure sequencing (part of A-CDM). In addition, the Airport/TMA throughput will be increased by the initial integration of Arrival and Departure Management (AMAN/DMAN).

The A-SMGCS Airport Safety Nets will provide warnings concerning conflicts and incursion on aerodrome movement areas. In order to improve runway throughput, further actions need to be taken concerning the enhanced Optimised Runway Delivery (eORD), Runway Occupancy Time CATegorisation (ROCAT) and Landing in an Occupied Runway.

3.3.5 Network components/systems and CNS infrastructure evolutions

By 2025, Network Operations will need to rely on the availability of performant network systems, components and CNS infrastructure which will be more agile, resilient, sustainable and scalable, enabling the required flexibility to deal with growing complexity of technological life cycles or rapid changes in traffic demands. To this extent, the current systems and infrastructure must be modernised and for some of them rationalised and their performance be monitored and enhanced. Moreover, it should be noted that the network components/systems and CNS infrastructure evolutions will not be only driven by operational requirements, but also by the general evolution of technology: digitalisation and automation. These will impact the operational requirements and some of the network actors roles and responsibilities. This will be achieved by:

- Co-operating for a full digital transformation of the network
- Developing solutions for pan-European deployment together with the operational stakeholders;

- Co-ordinating the synchronised deployment and operations of network infrastructure systems and services from a network centric approach;
- Co-ordinating the further evolution of the ATM infrastructure in alignment with the evolution of operations;
- Monitoring the performance of the ATM infrastructure with a high network impact, in order to quickly address unsatisfactory performance and anticipate anomalies before their impact is significant;
- Modernising the NM systems (e.g. iNM).

As a result, by 2025:

The iNM initial stage of implementation will already allow new services such as the use of Big Data and Machine Learning, allowing to turn data into value for business, augmenting the human capabilities with the knowledge buried in the past events or past behaviours, supporting the detection of trends and even starting to provide real-time advice to the Network Actors.

The deployment of SWIM across the European Air Traffic Management Network (EATMN) will bring interoperability between the Network components, allowing a real common situation awareness, enabling the automation of tasks at network level, promoting effective collaboration and, additionally, being a catalyst for innovation.

Moreover, the Network business intelligence techniques and tools will provide a common framework and toolbox to the other solutions and actors, allowing them to assess the Network Performance in the pre-tactical and tactical phases of the Network Management.

The evolution of the CNS applications should be considered together with the evolution of the CNS infrastructure By 2025, only some initial elements towards this long-term vision should start to be in place:

CNS applications will be supported by the evolution of the CNS infrastructure, composed of a backbone of recent and mostly space-based technologies, in the form of secure CNS services. Security requirements need to be implemented to mitigate cyber-threats. This backbone will be complemented by a back-up layer in the form of “Minimum operating Network – MON” of the legacy or modernized technologies.

Considering the CNS applications, performance based Communication, Navigation and Surveillance applications are being developed, allowing the ATM CNS to evolve from system-based operations toward the delivery of CNS services.

Technology evolution opens also the door to the implementation of more environmentally friendly and cost-efficient infrastructures, and in some cases, it also provides opportunities for the development of new operational concepts and services. This will be the case for the CNS infrastructure which will gradually move towards being provided as a service rather than operated as physical assets, impacting the CNS infrastructure business model and CNS actors’ roles and responsibilities.

The monitoring of the CNS infrastructure and the allocation of scarce resources is supporting the optimised use of the current infrastructure. The evolution of the CNS data eco-system, increasing the data sharing amongst stakeholders and optimizing the use of the data all along the data life-cycle will allow the CNS monitoring activities at network level to evolve from an initial capability to a mature digitalised service.

In order to facilitate the implementation of operational changes listed in previous sections and accelerate the digitalisation of the network, the Network Actors will support the following evolutions of their systems and infrastructure:

1. **The wide scale enhancements of existing Network system components**

- Initial implementation of new NM system (iNM), bringing higher levels of automation with state-of-the-art tools, in support of all Network actors;
- System support to cross-border FRA by all Network actors;
- Further enhancement of existing ANSP/NM/AU data exchanges to support cross-border FRA;
- System support to extended AMAN, AMAN/DMAN integration, AOP systems and A-SMGCS;
- Initial system support of FF-ICE by Network Manager, Airspace Users and ANSPs;
- Further local integration between ASM and ATC, supported by digital processes;
- Enhancements of NM Crisis management tools (e.g. maps for managing nuclear emergency events, heat map showing 1030/1090 saturation and GPS interference)
- Wide utilisation by Network actors of the NM simulation tools, demand forecast tools and call-sign similarity detection and resolution.

2. Network digital transformation: initial steps

- Increased cyber resilience of the ATM network supported by new network cyber-security services
- Wide exchange of aeronautical, meteorological, flight and network data (regulations, re-routings, proposals, traffic monitoring values) with all actors using SWIM Yellow Profile;
- Transition to the OLDI exchanges via SWIM YP;
- Digitalisation of the AIS processes and initial integration with operational processes supported by integrated workflows and data
- Selected Digital NOTAM services, with enhanced aeronautical information management of static and dynamic data and digital data publication;
- Initial steps towards secure virtual ATC centres, by starting to do cloud deployment for some components, aiming at infrastructure cost reduction, as well as, flexibility, scalability, reliability and safety improvement.

3. CNS evolution – initial steps

- The evolution of the CNS applications should be considered together with the evolution of the CNS infrastructure. Considering the CNS applications, performance based Communication, Navigation and Surveillance applications are being developed, allowing the ATM CNS to evolve from system-based operations toward the delivery of CNS services;
- An efficient multi-datalink combining the different technologies available, modernized and multi-constellation GNSS, the composite surveillance concept and the continuation of the rationalisation of the legacy technologies.

4. CNS infrastructure monitoring

- A fully coordinated approach to the allocation of scare resources at network level during the strategic planning to ensure an optimised use of available infrastructure, identification codes and radio-frequency spectrum;
- An enhanced capability to detect localised and temporal disruption or performances reduction of the CNS infrastructure;
- A full consistency between the CNS aircraft capability as declared via their flight plans or measured via the EUROCONTROL monitoring network and the airspace requirements;
- A continuous and global monitoring of the CNS infrastructure nominal performances during the execution phase, detecting any deviation with a fair lead time;

- Enhancement of CNS of post-operational analysis, detecting any deviation from the required standardised performance and interoperability;

3.4 Main directions for 2029

The Network Operational Concept will evolve from 2025 onwards and additional elements need to be considered as buildings blocks to address the Network performance and rectify the identified deficiencies. Many of these operational/system evolutions are still in R&D pipeline, their inter-dependencies and contributions to the overall network performance need to be further assessed. The main 2029 concept elements, in addition to the foreseen 2025 situation, that are expected to contribute to the network performance are described in the following clusters. The 2029 scenarios will achieve the full deployment of the new NM system (iNM), granting a common platform for advanced network operations, with high levels of automation and connectivity of the network systems and actors.

3.4.1 Optimised network design

- Ultimate steps towards full Pan-European cross-border FRA implementation and FRA extension until TMA boundaries.
- Further automation of ATCO conflict detection tools with support for conflict resolution taking into account the environmental constraints and including separation with new entrants (i.e. UAVs/Drones).
- Improvement of airspace utilisation is obtained through flexibility in airspace organisation and design and dynamicity in airspace management.
- Larger airspace structures are needed in order to address the evolved requirements of airspace utilisation to cope with new generation(s) of military air assets. The military air operations are combined into a wider variety and require a more dynamic and flexible response of the Network. In order to minimise the effect on network operations of national borders and uncoordinated local decisions, 2029 will see the full application of Dynamic Airspace Configurations (DAC) that will be used to accommodate civil and military demand. DAC processes will include the management of dynamic ATC sectorisation, including dynamic cross-border sectorisation, dynamic mobile areas (DMAs), dynamic TMA structures that are adapted to the traffic demand and military operations in order to respond to any Airspace Users performance needs, for instance by enabling the Airspace Users to benefit from capacity opportunities as soon as they become available.
- Enhanced segregation features (e.g. Dynamic Mobile Areas (DMA)). DAC integration in ATFCM will contribute to the collaborative optimisation of traffic flows. Dynamic Mobile Area (DMA), complementary to the extended utilisation of VPAs, with exploitation of cross border opportunities, will support the dynamic configuration of airspace and management of Business and Mission Trajectory, thus contributing to the efficiency of both civil and military operations.
- Cross-border delegation of service will be supported by a full cross-border data sharing and specific capabilities that permit reallocation of airspace volumes from one unit to another, with network impact assessment of these allocations.
- Integration of Higher Level Operations (HAO) into the European ATM Network.
- Integration of Unmanned Traffic Management (UTM) and ATM both at local and network level.
- ASM process and procedures for new entrants (HAO, drones/UAV).
- TMA operations will benefit from the capability to dynamically extend the scope of terminal airspace, which is further optimised by the application of advanced continuous climb and descent operations for improving descent and climb and synchronisation of arrival/departure flows.

- iNM will be used as a vehicle to implement the majority of Network Manager's elements related to this DoC and contributes to the achievements of these evolutions by other Network Actors.

3.4.2 Optimum Capacity and Flight Efficiency Planning

- The European Airspace will be optimised by consolidation/reconfiguration of current sector configurations. ATC Sectors will be redesigned irrespective of national boundaries and dynamically allocated to support the expected traffic flows and ensure connectivity with TMAs.
- In order to increase the resilience of European ATM network, the Operational Stakeholders will ensure the management of an enhanced Demand Capacity Balancing (DCB) process to support capacity on-demand ATS service.
- In order to cover the planning gap between ATFCM and ATC processes and facilitate layered ATM planning in the execution phase, Integrated Network and ATC Planning (INAP) will be gradually implemented.
- Full implementation of iNM enabling the provision of Common Network Situation awareness and enhanced demand and capacity balancing tools.
- Network UDPP can be considered as an extension of multi-swap capabilities. UDPP will provide airspace users with a greater flexibility to prioritise their flights, maximise performance and agree to a mutually acceptable plan in a cooperative manner.
- Virtual centre operations will gradually be introduced to exploit spare capacity at network level to better balance the traffic demand.
- Civil-military ATM priorities should be understood as indicators defined at national level and integrated into AU demand. This facilitates the recognition of ATM needs of the operational stakeholders and used in CDM process to define the perimeter of acceptable flexibility to accommodate stakeholder operational requirements
- Enhanced use for CPDLC exchanges (ATN B2 improved clearances and instructions) concerning more efficient use of AGDL data link communication, the support to complex (e.g. multi element) clearances and the automatic uplink of clearances with controller validation and the auto-load to FMS of uplinked clearances.

3.4.3 Trajectory and Cooperative Traffic Management

- Advance tools supporting the reconciliation of required ATFCM measures at network level, optimising the capacity throughput and reducing delays.
- Collaborative multi constraint management process will re-conciliate the multiple constraint resolution strategies from all the Operational Stakeholders, including Airports, in order to identify the best measure given the nature, scope and time horizon making ATFCM measures close to the time of occurrence in a cooperative manner.
- Network Operations will be further enhanced by optimisation of multiple ATFCM time based measures, reducing the adverse impact of multiple regulations affecting the same flight or flows.
- The Demand Capacity Balancing (DCB) tools for specific service related to the capacity on-demand ATS service.
- The DCB process will be supported by Scenario Management and what if/ Network Impact Assessment of airborne rerouting in support to any DCB measures.
- The Network Management will gradually evolve towards flow centric operations enabling a collaborative approach in the context of flow and network management for increased dynamic capabilities and predictability.
- Full implementation of Rolling Network Plan and its supporting CDM digital platform - iDAP (integrated Digital ATFCM platform).

- FF-ICE/R1 services not mandated by CP1 IR (Planning service and Consolidated feedback) will be gradually implemented. The FF-ICE planning service includes the provision of Preliminary Flight Plans (PFPs), PFP updates and Flight Cancellations.
- Network Operations will be enhanced by full integration of OAT flight planning function across the European airspace and further steps will be performed in the direction of Mission Trajectory management.
- Full integration of VFR flight planning
- The Trajectory management will be based on the centralised coordination and FF-ICE/R2 coordination capabilities, including involvement of all Operational Stakeholders in the decision making process with emphases on both civil and military AU needs. In-flight revision of eFPL will be fully coordinated with all operational actors. Target Times (TT) will be exchanged via FF-ICE/R2 services.
- The network flight briefing service for ARO and AUs, integrating aeronautical data, weather, flight and flow management information, as part of the new NM system (iNM).
- Provision of ATC tactical updates to NM, contributing to the accuracy of NM trajectories, which are then distributed to all Network actors.
- The Network actors will use the airborne trajectory data or a portion of it (Extended Project Profile) as deemed appropriate in order to update some segment of ground trajectories.
- All elements belonging to this DoC within the 2029 time horizon will be covered by iNM.

3.4.4 Airport and TMA - network integration

- The arrival management function will be further enhanced by the integration with DMAN, application of queue management techniques for multiple airports, extended Arrival Manager with overlapping horizon.
- Additional data need to be included in the AOP and these data to be exchanged with NOP.
- The further enrichment of the APOC process through inclusion of landside elements and evolving towards Total Airport Management (TAM), will further improve the AOP quality within the Network Operations Plan and thus improve the dynamic/rolling picture of the network situation to be used by all operational stakeholders to prepare their plans and their inputs to the network CDM processes.
- Small and Regional airports will be integrated as a component of the ATM Network. Advanced data exchange combined with advanced ground operations surveillance will improve all ATM stakeholders Common Situational Awareness and it will improve traffic departure predictability.
- Majority of Network Manager’s elements belonging to this DoC will be achieved via iNM.

3.4.5 Network Components/system and CNS infrastructure

The Network components/systems and CNS infrastructure will further evolve with the cooperation of all stakeholders to deliver a balance between the network perspective and the local operational and business needs (resilient, scalable and decarbonised). The following evolutions are envisaged as:

➢ **A fully digitalised network**

- The finalisation of the iNM Programme and the modernisation programmes of the Operational Stakeholders will bring in this time horizon an ATM network operating with end-to-end fully digital processes based on safe and secure digital services provided by the different stakeholders via SWIM

- SWIM-based Air-Ground and civil-military information exchange to ensure a sound common view as basis for coordination and collaborative decision making.
- Increased ATC virtualisation will continue with the gradual implementation of Virtual ATC centres.
- Full integration of AIS process (EAD-CACD integration) with operational processes supported by integrated workflows and data flows allowing the co-existence of different but consistent views and the production of a consistent, accurate and up-to-date ATM dataset that is the reference data for all ATM actors in the European context;
- Further enhancement of aeronautical information management including fully implemented digital NOTAM .
- Some ATM Data Service Providers will be operating and providing services around Europe.
- Global interoperability will be improved through standardised interfaces for ATM information exchanges, allowing seamless ATM operations for all operational stakeholders

➢ **The wide scale enhancements of existing Network system components**

- The ATC automation will be enhanced by adapted conflict detection/resolution tools which includes airspace and LoA constraints.
- The ground distribution of EPP data is operational and the systems of all Network actors are able to process this data.
- The NM crisis management capabilities will be extended to support the operations of new entrants.

➢ **Changes of CNS infrastructural components, such as**

- The CNS infrastructure will evolve towards a performance-based service-oriented approach. CNS services will be provided by a number of recent and global technologies supported by a backbone of legacy and modernised technologies (i.e. the Minimum Operational Networks providing backup and support to the new technologies). in the form of secure CNS services complemented by Minimum Operational Networks
- Higher levels of automation and connectivity will enable an efficient and integrated CNS infrastructure and associated Radio Spectrum that will support the operational concepts described in this CONOPS (including the new entrants' operational needs).
- Enhancements to the CNS and Network Performance monitoring tools will improve detection, mitigation and prediction of failures/interferences impacting the network, increasing therefore its resilience. These monitoring tools will further be used to support the pre-tactical and tactical network operations phase.
- Improved civil-military interoperability and data sharing between ATM and military. The CNS monitoring tools will be expanded in 2029 to include the network changes that can have a high impact on the performance of the network (e.g. new entrants, new infrastructure performance).
- Lean and efficient use of ANS infrastructure, based on interoperable standards and services decoupled from system specifics will ultimately allow lower ATM system-related operational, maintenance and depreciation costs

CHAPTER 4 –Impact on Performance

4.1 Background

This chapter provides an initial quantification of the performance benefits, which are aimed at one single year, the 2029, as well as the costs implied to achieve the 2029 performance benefits.

Nominal values are used for both performance benefits and costs.

The chosen approach is as it follows:

- Based on the 2018 performance, the “do nothing value” is computed for the year 2029. Then the 2029 performance is computed considering the expected performance which will be achieved after the implementation of High Level Network Concept of Operations.
- Then the performance difference between the “do nothing” and the performance value “after the implementation of High Level Network Concept of Operations” is monetised.
- The High Level Network Concept of Operations provides direct performance benefits to Air Transport Operations on top of ATM performance benefits. The two set of benefits are presented in a distinct way and avoidance of double counting is ensured.
- Finally, the qualitative link between each improvement of High Level Network Concept of Operations and the delivered performance benefits are described in the last paragraph.

This initial assessment takes into account that the Performance scheme, the Network Strategic Plan, the SESAR Deployment (Deployment Programme) and SESAR R&D are all aligned towards the performance ambitions described in ATM Master Plan Edition 2020.

Performance objectives, including quantified targets, are aligned with the performance ambitions and they are established through the SES Performance Scheme (current Reference Periods RP3 2020-2024) and the Network Strategy Plan (2020-2029).

As indicated in the Network Strategy Plan 2020-2029, optimising network design and network operations will both significantly contribute to meeting the Capacity and Environmental Key Performance Indicators as defined in the Performance Scheme Implementing Rule, and will also contribute to Safety and Cost-efficiency.

The elements described in this High Level Network Operational Framework are designed to support meeting Network Performance objectives and Operational Stakeholder business requirements.

The impact on ATM performance of the progressive integration of UAS/HAOs operations in controlled airspace cannot be estimated mainly for the following reasons. First of all the ICAO SARPs allows remote-piloted flights (RPAS in ICAO lexicon) in controlled airspace only in the case that the RPAS has got an airworthiness certificate like an aircraft and that the RPAS operators comply with the ICAO SARPs for flight operations like an aircraft operator. Therefore, the presence of RPAS in controlled airspace will not affect the Operational performance framework. However, there is no reliable data source to estimate traffic forecast for UAS and RPAS in controlled airspace. Furthermore, there is no agreed KPIs for assessing the benefits for UAS/RPAS traffic. In summary, it is rather difficult if not impossible to assess and estimate performance needs for UAS/RPAS.

4.2 Scope of this analysis of costs and benefits

The geographical scope of this assessment is limited to ECAC, further benefit may be obtained from applying the Network concept to adjacent regions.

The High Level Network Concept of Operations scope of analyses of costs and benefits includes:

- SESAR Deployment Programme (DP) enablers;
- SESAR 3 enablers which will be mature for implementation before 2029 (i.e. all enablers which are in the industrialisation phase and some enablers in V3);
- Enablers which are outside SESAR DP and SESAR 3 scope, but they are included in NM plans as approved by NMB and/or the EUROCONTROL Agency;
- OEP improvements, including CNS rationalisation and evolution

In conclusion this analysis is based on costs and performance benefits, which are included in CP1 Cost Benefit Analyses (CBA), in ATM Master Plan and NM plans.

4.3 Overall costs of Network CONOPS

It is considered that the CONOPS costs will be some 20% more than the costs estimated in the CP1 CBA given the larger CONOPS scope as described in par. 4.2.

NM Systems need to evolve to cope with the operational concepts and to take benefit of the latest technologies, as described in this CONOPS. This implies the full replacement and/or adaptation of the NM System components as part of the iNM programme.

	Million €	
Systems	**CP1**	**NET CONOPS**
Airport	€900	€1.080
ANSPs	€1.700	€2.040
AU+CFSPs	€800	€960
Military	€800	€960
NM	€200	€400
TOTAL	**€4.400**	**€5.440**

Figure 3. ***Overall NET CONOPS costs compared to CP1***

4.4 Overall Performance benefits

The performance benefits from the High Level Network Concept of Operation are:

- Environmental benefits (CO_2 savings) due to flight time and fuel reduction
- Air Transport Operation benefits
- ATM capacity & ATM cost efficiency

4.4.1 Environmental benefits

The cumulative benefits are approximately 1000 million NMs savings, i.e. the equivalent of 6 million tons of fuel saved, or reduced emissions of 20 million tons, or 5 000 million Euros.

4.4.2 Air Transport Operation benefits

The main driver of air transport operations benefits is departure delay. It is expected to reduce departure delays of 4 minutes compared to the 2018 baseline. The contributors for these improvements are:

- 2.6 minutes per flight of reduction from ATM. This impact is not monetised in the table to avoid double counting with the monetisation expressed in NET CONOPS benefits for ATM (see KPA capacity).
- 0.7 minutes per flight from primary delays caused by non-ATM actors (airlines, airports, etc.)
- 0.7 minutes per flight from reactionary delays caused by non-ATM actors.

The air transport network will also become more robust and resilient, so sustaining connectivity and payload throughput (passengers and cargo) under adverse conditions.

Industry Sector	**Key Performance Area**	**KPI**	**2018 baseline**	**2029 expected performance enabled by NET CONOPS**	**Benefit gain**	**Monetisation of gain in million € (difference between 2029 do nothing scenario and 2029 with NET CONOPS**
Air Transport Operations	**Departure Delay .**	Minutes of dep delay per flight (reference to schedule)	14,4	10,4	4	€1.081
Air Transport Operations	**Predictability**	Traffic ahead of schedule in minutes Million minutes(AIBT-SIBT)	9	7,9	1,1	€17
Air Transport Operations	**Predictability**	Opertational Cancellations (number of events)	10.000	8.000	2.000	€35
Air Transport Operations	**User Prioritisation**	Number of ATFM slot swapping	15.000	35.000	20.000	€92
					TOTAL	**€1.225**

Figure 4. High Level Network Concept of Operation benefits for air transport operations

4.4.3 ATM capacity & ATM cost efficiency

Key Performance Area	KPI	Baseline	2029 expected performance enabled by NET CONOPS	Benefit gain	Monetisation of gain in million € (difference between 2029 do nothing scenario and 2029 with NET CONOPS
ATM En-route capacity	Minutes of ATFM En-route delays per flight	5	0,5	4,5	€2.205
ATM airport capacity	Arrival airport ATFM delay	1,13	0,5	0,63	€308
Cost-Efficiency	ATCO productivity	0,94	1,21	0,27	€155
Cost- Efficiency	Supporting costs in € million	€5.718	€5.070	€648	€648
				TOTAL	€3.316

Figure 5. ATM capacity and cost efficiency benefits

Few notes in support of Figure 5:

- Capacity is expressed in terms of ATFM delay which measures the lack of ATC capacity in accordance with the methodology explained in "Capacity assessment and planning guidance document"[2].

- Given the exponential nature of en-route ATFM delay, the baseline is not the year 2018, but the maximum amount of en-route ATFM delays, which could be reached if the High Level Network Concept of Operation is not implemented. The five minutes reported in the table is the output of the simulation model described in "Capacity assessment and planning guidance document".

- Arrival Airport ATFM delay are not of exponential nature given the airport scheduling process at coordinated airports.

- The computation of ATCO productivity benefits assumes an increase of ATCO employment cost of 5% and an increase of ATCO productivity of 30%.

  The reduction of supporting costs (€648 Million nominal value) is based on the study "CNS infrastructure evolution opportunities" issued by NM (date 23/04/2021). This does not include the costs of implementing new infrastructure.

[2] https://www.eurocontrol.int/publication/capacity-assessment-and-planning-guidance-document

ANNEX A –Network Operations by 2025 and 2029

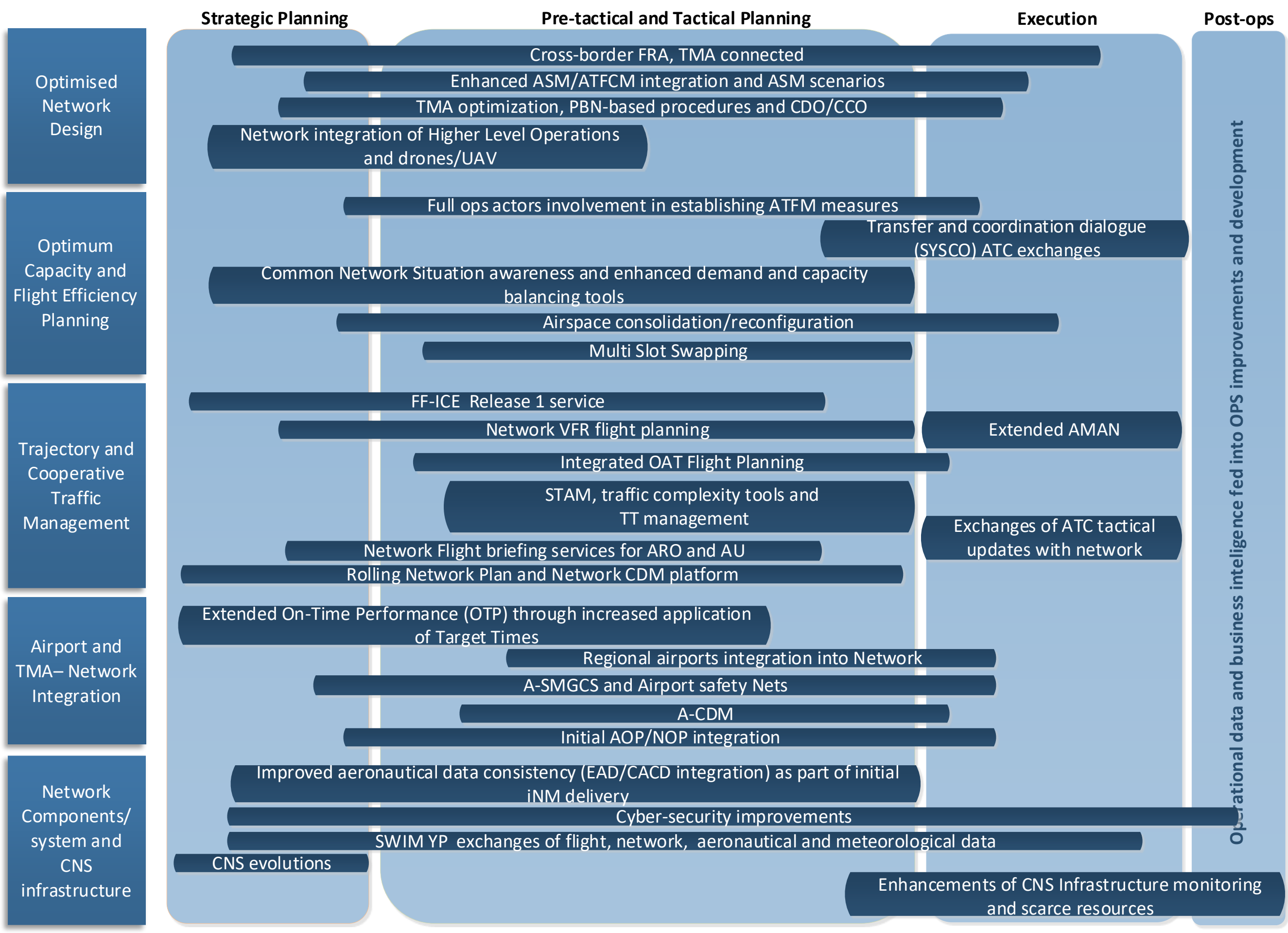
This Annex provides an overall brief description of the Network Operations elements envisaged to be deployed or in process of being deployed in 2025 and 2029. These elements are aligned with the existing plans described in the ATM Master Plan and the SESAR CONOPS. The description is organised in the operational phases, addressing for each phase the expected improvements for each snapshot (2025 and 2029). The operational improvements related to Network Components/system and CNS infrastructure are elaborated in Annex A3 has they are considered transversal contributing to almost all phases of the flight.

A.1 Network Operations by 2025

Network Operations will support the delivery of the overall performance benefits expected over RP3 and the achievement of the strategic objectives as described in the Network Strategy Plan (NSP) and the European ATM Master Plan. These operations are the result of the Network Cooperative Decision Making Process involving all the operational stakeholders and the NM.

The following picture provides an overall description of the operational improvements expected by 2025. They are organised for operational phases, grouped for main operational clusters. A group of transversal improvements, mainly enablers, are illustrated separately across different phases.

NETWORK Operations 2025



Strategic Planning

Optimised Network Design

The cross-border FRA structures and connectivity with TMAs will be agreed using NM CDM process and be shared with all Operational Stakeholders in order to adapt their ground system with published FRA volumes and interfaces.

Airspace structures will be reserved/restricted in a very dynamic and flexible way, namely extensive usage of VPA modularity, accommodating the military AUs demands and operational requirements for segregation/reservation, while still ensuring the necessary airspace throughput for the other non-participating traffic. Cross border solutions will be promoted to exploit airspace efficiency, better satisfying military requirements.

At the strategic level, the military operational requirements will be shared with the other Network Actors in accordance with the national security and defence principles and other relevant national and international commitments. The States will remain responsible for the establishment and the operation of the dissemination mechanism both at the local, sub-regional and network level. The timely input received from the military authorities regarding the planning data of operations having a significant impact on network operations will enable to integrate the military mission requirements as early as possible in the optimisation process run at all network levels.

The TMA optimization will be further enhanced by the application of PBN within its limits, as well as the accelerated advancement of the arrival procedures based on GBAS/SBAS and the CDO/CCO techniques.

The year 2025 will see an increased dynamicity of the TMA boundaries, which will be adapted in the tactical planning phase to support the proper accommodation of the foreseen demand closer to the execution phase. The TMA adaptation and modification need to be perfectly synchronized with the surrounding airspace structures, connecting its fixed route structure i.e. SIDs and STARs with the FRA elements extended to its boundaries.

Part of the advanced designed airspace structures, a very important aspect of the successful design and implementation of a seamless and flexible airspace will be a full integration of ASM and ATFCM supported by a very robust and integrated CDM. The enhanced dynamicity as well as the introduction of new elements supporting the ASM/ATFCM process will enable a better exploitation of the airspace capability to accommodate civil and military demands.

The strategic planning phase of ASM will feed a lot of data to the strategic phase of Network Operations.

The airspace needs linked to the new entrants operations will have to be shared by their respective operators as early in advance as possible in the strategic phase. These needs will encompass both the transition airspace and the airspace used to complete the mission itself (i.e. above FL 600 for Higher Airspace Operations – HAO). The sharing of information in this phase will need to address all the concerned Network actors and the proper cooperation, collaboration and coordination mechanisms need to be in place at the local, sub-regional and regional levels. The shared data have to contain details regarding the frequency of operations from a long term perspective as well additional needs stemming from the previously executed flights, without any prejudice to the confidentiality of commercial sensitive information. In the strategic phase, contingency mechanisms will be designed, agreed and implemented by all concerned Network actors.

Optimum Capacity and Flight Efficiency Planning

Civil and military demand forecasts will be established using business intelligence techniques and tools, applying growth scenarios that have been agreed commonly through the network CDM process.

Based on demand forecast and ATC capabilities, ANSPs will establish optimal (cross-border) sector configuration scenarios to optimally facilitate the demand, in coordination with airports and neighbouring ANSPs. This will include the modus operandi and procedures for dynamically adapting sector configurations to expected demand.

In the strategic planning phase, the operational stakeholders will create the prerequisites for creating the optimum airspace structures designed to fulfil the military AUs (or other AUs reserving/restricting a specific area or portion of airspace, e.g., aeronautical industry performing test flights or industry testing specific weapons/weapon systems requiring live firing) mission requirements whilst minimising the potential impact on the wider ATM network performance.

As a direct result of this early involvement of AUs in the demand strategic collection, the ATFCM measures will take into account from the start the AUs preferences and priorities and will try to accommodate them through a continuous and layered CDM process. The AUs' access to the DCB process will offer them the possibility to become fully involved in the creation and refinement of the ATFCM measures taken to ensure the optimum performance of the entire Network.

Trajectory and Cooperative Traffic Management

The initial complexity management will start already in the strategic planning phase of the Network Operations, but the real benefits of complexity assessment are in supporting the identification of the optimum Network and local ATFCM measures in the pre-tactical, tactical planning and execution phases.

The Flow Management will evolve through the Collaborative Traffic Management mechanisms to the Flow Centric Management, where the focus of the DCB activities will be placed upon certain flows instead of certain flights.

In the Trajectory Management initial processes, a very important role will be attributed to the military operational stakeholders. The iOAT FPL mechanism will be used by military operational stakeholders to share the ATM related data with pertinent ATM, without any prejudice to the national or international security and confidentiality arrangements. All the subsequent changes and updates brought to the initially shared data will be performed within the CDM framework agreed with the military authorities.

Letter of Agreement (LoA) between adjacent ATS units will address the application of extended AMAN (including multiple extended AMAN), especially the item of delay apportionment. ATC procedures should include the provisions how the extended AMAN advisory is going to be accommodated.

In case of new entrants operations, the information disseminated between the concerned Network actors at the strategic level will contain also the planned trajectory data in conjunction with the desired needs for airspace reservation. The trajectory data will represent the general intentions of conducting the respective operations together with the intended modus operandi for the launching phase.

Airport and TMA - Network Integration

Airports will apply capacity planning as a basis for available airport slots and as input to network planning, and will coordinate with the local ANSPs to ensure aligned TMA capacity values. The initial AOP input into the Collaborative NOP and the publication of relevant information into the NOP will support the strategic planning phase.

The local DCB process for the airports drive the AOP to achieve the local performance targets i.e. punctuality and an acceptable level of airport delays. In order to have efficient local DCB processes, it will be extremely important that these processes be fed with the most up-to-date information as early as possible. Therefore, the local DCB processes will have to start already in the strategic planning phase and continue in the other planning phases that are closer to the execution of the operations.

Pre-tactical and Tactical Planning

Optimised Network Design

Cross-border FRA structures will offer AUs to fly their preferred flight patterns and file the flight plans (eFPL) using the cross-border FRA opportunities. NM will validate these AUs preferences in terms of flight planning and notify them if further optimisation of flight profiles is feasible.

Getting closer to the execution moment, the available operational, technical and other support data (e.g. meteorological conditions) will allow the military stakeholders to refine their requirements, integrating their latest mission elements into the overall network conditions. The continuous exchange of information executed within the agreed CDM framework will allow the other Network actors to better anticipate the latest modifications in the network operating environment and identify the optimum solutions for their operations.

The enhanced ASM/ATFCM integration will take benefit of the VPA design principle of the airspaces used by the military air operations. The optimum airspace configuration in the pre-tactical and tactical phase will be achieved for both civil and military AUs through the continuous CDM process run at the local, sub-regional and regional level. The military authorities will be the ones setting the limits of their involvement in the CDM process, based on the latest available military operational needs.

The enhanced utilisation of ASM scenarios, integrated with ATFCM scenarios where feasible, will facilitate the identification of optimum airspace solutions to accommodate civil and military traffic demands.

The integration of the ASM/ATFCM process with additional elements, e.g. restrictions, to be managed in a more dynamic way, will limit the ATM constraints to the effective needs, with positive effects on flight efficiency.

For the new entrants, in this phase of operations, more detailed aspects linked to the medium and short term planning processes become available and the airspace needs expressed in the strategic phase are further fine-tuned in order to meet the business requirements of the new entrants' operators. As many new entrants HAO will take place in the airspace over the high seas, the ICAO provisions will be followed and a special focus will be placed on the publication and dissemination of information concerning the airspace reservation and utilisation to all the Network operators.

Optimum Capacity and Flight Efficiency Planning

This phase of the Network Operations aims at further refining the dynamic airspace structures and configurations designed, negotiated and agreed during the strategic phase between all the operational stakeholders. As the timeline moves closer to the Day of Operations, more information is available regarding the AUs' demand expressed in the form of shared FF-ICE trajectories, as well as an update of the ATM constraints at the local and network level.

In the pre-tactical and tactical planning phases, all the traffic demand and airspace/airport capacity elements will be taken into account. The result of this process will be to collaboratively determine what are the most limiting elements in a certain timeframe, and working in a collaborative manner to take the appropriate measures in order to find the best possible balance.

The dynamic adjustment of airspace in the pre-tactical and tactical planning phases will deliver performance gains by responding in a flexible way to AUs' expectations.

As the planning phase gets closer to the execution time, the accuracy of the data representing the forecasted demand and the available capacity will increase, thus allowing the possibility of DCB to evolve into a more dynamic process. These types of solutions will optimise and support the adaptation of capacity to meet a minimally adjusted demand expressed in the form of AUs' preferred trajectories.

The Network dynamicity will see airspace portions reserved more and more only on temporary bases, as the continuous evolution of AUs' preferred trajectories (following more and more the optimum flight related meteorological conditions i.e. wind) will require a more flexible and agile allocation of airspace.

In this specific timeframe of the planning process, the slot swapping process based on the priorities and preferences declared by the AUs will evolve and will involve multiple slots. The slot swapping will be supported by the proper procedures and tools.

Trajectory and Cooperative Traffic Management

In the pre-tactical planning phase, the integration of more accurate and up-to-date trajectory information will bring many benefits into the ATFCM processes. The decision to design, coordinate and implement the optimum measures or set of measures will be based in all cases on accurate information and will be supported by the latest updates of available ATM resources, i.e., airspace and airport capacities.

In the planning phase conducted closer to the execution time, the ATFCM measures will be thoroughly analysed, coordinated and agreed from the local perspective, as well as from the network perspective within the CDM process, considering as much as possible the AUs' preferred trajectories and business needs. The result will be a set of synchronized and reconciled measures, which will contribute significantly to the overall Network performance, whilst following the performance targets set at the local level. The agreed sets of measures will be published in the Cooperative NOP and will be transparent to all the parties involved.

Traffic Complexity Management will represent a key capability within the dynamic DCB process.

A very important operational enabler for the identification and analysis of optimum Network measures will be offered by the continuous improvements brought to the what-if processes and automated support tools. The what-if impact results based on the commonly shared AU's preferred trajectories, as well as the shared ATM constraints and available resources will support the local and network planners to react in a very agile and flexible way to the network increased dynamicity. System supported analysis performed in very short periods of time will allow these planners to adopt the optimum solutions for meeting the performance targets at the local and network level, whilst keeping the tactical interventions to an agreed minimum.

Regarding the ATS, this component will be supported by the Network Operations in the planning phases for specific ATC requirements such as data sharing of Target Times and initial ATFCM measures.

This specific planning phase will become increasingly complex, as all the operational stakeholders will need to reconcile the conflicting time or 4D profile targets involving the departure, en-route and arrival portions of the flights. The optimum measures will have to be agreed at the network level in an effort aiming to minimise their impact on the overall performance at the network.

The overall traffic demand will be enriched with the iOAT flight plan data. The military mission trajectories will have a greater accuracy when moving closer to the moment of flight execution. The sharing and update of mission trajectories will reflect the military needs and will be based on the CDM process. The decision regarding which mission trajectories will be shared with the other Network actors will remain solely within the remit of military authorities. For specific flights indicated by these authorities, the dissemination process will be subject to strict confidentiality rules.

The military authorities will be the only ones deciding for each mission trajectory if it may be or not subject to ATFM measures.

For the new entrants operations, the intended trajectories shared in the strategic phase will be further refined considering the latest operational, technical and environmental (e.g.

meteorological conditions) constraints and opportunities.

The VFR Flight planning capabilities will support AU/ARO to provide the VFR traffic demand.

FF-ICE/R1 will drive the operational stakeholders operations towards the end-to-end management of trajectories, especially when referring to the network level. The FF-ICE/R1 services (Filing, Flight Data Request, Trial, Data Publication and Notification) will enhance the exchange of data related to the trajectories and performances. NM will provide eFPL to FPL translation for ATS units which are not FF-ICE enabled.

Airport and TMA - Network Integration

Airports will apply capacity planning as basis for available airport slots and as input to network planning, and will coordinate with the local ANSPs to ensure aligned TMA capacity values. The AOP input into the Collaborative NOP and the publication of relevant information into the NOP will support the strategic planning phase.

All the traffic demand and airport capacity elements will be taken into account. The result of this process will be to collaboratively determine what are the limiting elements in a certain timeframe, and working in a collaborative manner to take the appropriate measures in order to find the best possible balance. This then should trigger an update of the AOP, in order to inform in a transparent and timely manner all the other operational stakeholders.

Execution

Optimised Network Design

AU will execute the flights within cross-border FRA in accordance with the established plan. These flights will remain under ATC for tactical flight changes. ATC tactical interventions, notifications, coordination and transfer of control procedures will be applied by ATC to the flights within cross-border FRA structures.

The key feature enabling the Dynamic Airspace Management is the continuous real time sharing of the latest updates in terms of airspace configurations, airspace reservations and their corresponding states.

The execution phase will see a continuation of the dynamic DCB processed started already in the strategic phase and developed in the pre-tactical and tactical phases.

Optimum Capacity and Flight Efficiency Planning

AUs will have basic capabilities to provide the trajectory changes meant to cope with the dynamic modifications of the ATM constraints in the execution phase.

There is a need for further integration and modification of changes requested by Operational Stakeholders to optimise their operations. Such change occurs at granular level, and may be driven by new opportunity to maximise individual trajectory efficiency, or to fine-tune traffic complexity and controller workload at local level.

The AUs will continue to monitor and provide their necessary input in this measures fine-tuning process, making available to the local and network planners their updated trajectory preferences when considering the possible evolutions of the ATM constraints in the execution phase.

Trajectory and Cooperative Traffic Management

The execution phase will also require a very consistent view of the trajectory data at any given moment. The 4D Trajectory data, contained in eFPL, will be widely shared with all the involved operational stakeholders.

The complexity tool will provide real ATFCM measure (level caps) and propose the optimum and dynamic airspace configuration following last minute traffic demand adaptations.

The extended AMAN advisories need to be executed further en-route as agreed by LoA provisions in order to optimise the traffic sequencing at the busiest airports. Traffic sequencing/metering should be conducted in the en-route before top-of-descent, to improve predictability and smooth the flow of traffic. Extending the AMAN horizon may affect the airspace design, and it is therefore essential that all stakeholders, including military authorities are consulted.

ATS units implementing extended AMAN operations shall coordinate with ATS units responsible for adjacent and up-stream en-route sectors as well as ATS units responsible for inbound traffic originating from airports impacted by the Extended AMAN horizon. Input data to Extended AMAN need to be provided by the most accurate trajectory prediction information available (including EFD or flight data available via the NM B2B publish/subscribe mechanism).

ATS units should exchange the relevant Extended AMAN data with the Network Manager for the improved ATFCM and arrival sequencing, overall network impact assessment and relevant network optimisations using Arrival Planning Information (API).

In this phase a wider application of Target Times (TTs) for regulated flights in support to Extended Arrival Management and in support of improvements to On-Time Performance is expected. An extensive combined application of CTOT/TTA techniques will improve, balance and integrate airport/en-route operations with overall benefits in terms network of performance.

Military will execute their agreed trajectories with strict adherence to the defined targets with level of precision required to accomplish mission objectives. These trajectories could also be subject to update and revision in the execution phase.

Constant monitoring of new entrants' operations in the execution phase will be performed by all the concerned Network actors, with any changes or updates of trajectory data shared as soon as possible between these actors as well as with other concerned actors from the adjacent regions.

Airport and TMA - Network Integration

It will be extremely important to continue the local DCB processes and to integrate its tactically evolving results as inputs in the NOP via the Collaborative NOP mechanisms. The continuous integration of local airport DCB with the network DCB will allow the overall network to react in an optimum way to all the possible changes and deviations from the agreed AOPs.

The availability of airport resources or the change in the meteorological conditions in the airport area will represent a significant modification of the overall ATM constraints, driving further updates or revisions of the 4D Trajectories for all the involved OPS stakeholders. The awareness issue of all these changes and their real-time status updates will alleviate their significant impact, especially when synchronizing the AMAN and extended AMAN functionalities with the airport operations.

Post Operations

General

The post-operational phase will make full use of the available business intelligence technologies (big data, machine learning, AI, etc.) as the complexity of analysing the trajectory refinement, update and revision instantiations will increase.

Optimised Network Design

The post operations analysis will support all the operational stakeholders to further refine and fine-tune the published cross-border FRA structure and airspace configurations. Horizontal and vertical flight efficiency will be calculated for the flights within cross-border FRA structures.

The post-ops analysis will identify in each case the impact created by an airspace reservation or restriction on specific traffic flows and will feed relevant data about the size and location of airspaces into all the planning phases.

The military authorities will be able to run their own post operations analysis based on the fulfilment of the mission objectives. The analysis will include both the quantitative and the qualitative aspects of airspace request and allocation processes contained in the Dynamic Airspace Management, with a special emphasis on the Network ability to respond in a flexible and scalable way to the mission requirements expressed close to the execution of the flights operated by the military Airspace Users.

Optimum Capacity and Flight Efficiency Planning

AUs' input in the post-operational analysis phase will improve the quality of the process. The difference between the planned and agreed trajectories will provide the basis for the detailed analysis of the implemented measures or sets of measures;

Trajectory and Cooperative Traffic Management

Detailed and comprehensive post-operational analysis of all the implemented capacities, capabilities, airspace configurations and the measures or sets of measures taken to ensure the DCB process will have to be performed by all the operational stakeholders. The data provided as an input for all these above-mentioned parameters have to be accurate, with the appropriate level of quality and shared between all involved parties.

All the identified results of these analyses, together with the complexity quantitative and qualitative measurements will be fed into the planning and execution phases in a continuous process of network optimisation at all levels and all the constituent elements.

Moreover, the LoAs and operational procedures will have to be adapted with the provisions of extended AMAN extended AMAN delay apportionment.

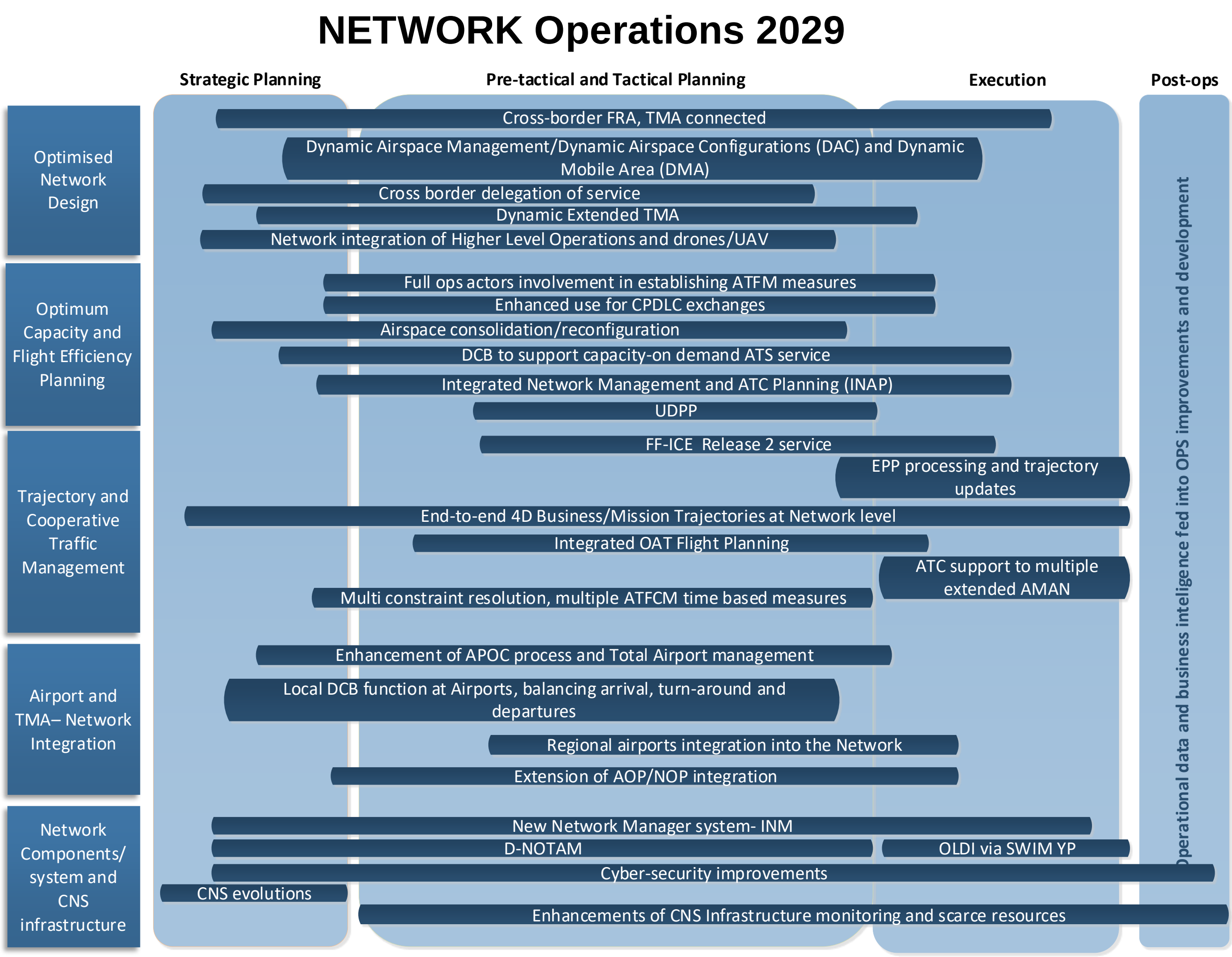
Airport and TMA - Network Integration

Detailed analysis conducted by the airports will provide high value data in the post-operational process conducted at the level of Network Operations. The analysis will focus as well on the impact of all the changes performed in the network operations on the airport planning and execution of flights.

A.2 Network Operations by 2029

Network Operations will support the delivery of the overall performance benefits expected over RP4 and the accomplishment of the strategic objectives as described in the Network Strategy Plan (NSP). These operations are the result of the Network Cooperative Decision Making Process involving all the operational stakeholders and NM.

The future Network Operations elements by 2029 are grouped in four main domains as described in the following picture. The overall description of 2029 operations is provided according to the phase of operations, clustering the elements accordingly.



Strategic Planning

Optimised Network Design

The processes concerning the cross-border FRA structures and connectivity with TMAs will be enhanced compared with the 2025 horizon, but no significant change is expected.

Based on demand forecast and ATC capabilities, ANSPs will establish optimal (cross-border) sector configuration scenarios to optimally facilitate the demand, in coordination with airports and neighbouring ANSPs. This will include the modus operandi and procedures for dynamically adapting sector configurations to expected demand. Airports will apply capacity planning as basis for available airport slots and as input to network planning, and will coordinate with the local ANSPs to ensure aligned TMA capacity values.

DAC will be achieved through an integrated ATM based CDM process consistent from local to sub-regional to regional levels, which is triggered either by local or network performance requirements, depending of a specific situation in time and place. Although covering entirely the ATM planning phases, DAC processes is not bounded by time, thus the design, configuration, optimization and execution often overlap.

The implementation of DMAs will enhance the flexible solutions supporting the dynamic process, to better accommodate military requests as well as to mitigate the impacts on traffic flows.

For military AUs, the new generations of military manned and unmanned aircraft with their innovative technologies and new tactical capabilities will require more flexibility and adaptability from the ATM network in order to accommodate military mission-specific requirements. This is consistent with the needs of all stakeholders, i.e. for trajectory management to become more dynamic and capable of handling greater complexity, with enriched data content managed in real time to provide opportunities for the optimisation of entire ATM network operations.

Part of the advanced designed airspace structures, the year 2029 will see further increase of TMA dynamicity, as the TMA boundaries adapted with surrounding airspace structures, ensuring the connectivity with FRA. The TMA optimization will continue with application of PBN, CCO/CDO and will be enhanced by the increased dynamicity of TMA by extending the application of advanced continuous climb and descent operations when and where possible, and the synchronisation of arrival/departure flows.

The design and implementation of a seamless and flexible airspace with integration of ASM and ATFCM will be further enhanced and supported by adapted CDM.

The dynamicity of Airspace structures reservation will be enhanced in order to accommodate the military AUs demands ensuring the necessary airspace is booked/release in real time and available for flight planning.

Optimum Capacity and Flight Efficiency Planning

The AUs' input provided from the early phases (strategic) of the planning process of Network Operations will support the integration and the necessary coordination of the initial demand consolidation into the overall balancing process with ATC capabilities.

Sharing the AU's preferred trajectories and the available ATM resources in the early stages of Network Operations planning phases will create the possibility to move the weight of the demand accommodating process from the tactical planning and execution phases to the strategic and pre-tactical planning phases.

In specific, the AUs will have the possibility to indicate from the strategic planning phase their priorities and preferences, not only for specific flights but also for entire flows or sub-flows elements. This information will improve the accuracy of the planning process as well as bringing an important enhancement to the predictability and punctuality targets at local and network level.

The traffic demand forecasts by traditional methods will be complemented with data-driven forecasts using Artificial Intelligence (AI) and Machine Learning (ML) as part of iNM programme.

Based on demand forecast and ATC capabilities, ANSPs will establish the optimal cross-border sector configuration, addressing the capacity on demand service and delegation of ATS provision to optimally facilitate the demand, in coordination with airports and neighbouring ANSPs.

The operational stakeholders will establish the prerequisites for creating the optimum airspace structures via the airspace consolidation/reconfiguration process.

As a direct result of AU's involvement in this phase, the ATFCM measures will be aligned with AUs preferences and priorities (UDPP).

In the strategic planning phase, the AUs will have the opportunity to share their business needs in terms of priorities and preferences using Network UDPP mechanism.

Trajectory and Cooperative Traffic Management

The Flow Management will evolve through the Collaborative Traffic Management mechanisms to the Flow Centric Management, enhanced by multi-constraint resolver.

FF-ICE/R2 will drive the operational stakeholders operations towards the end-to-end management of trajectories, especially when referring to the network level. The 4D Trajectory information will be complemented by coordinated targeted measures (containing 4D constraining elements such as time, horizontal and vertical profile points).

The OAT flight planning is intended to collect the military traffic demand, contributing to the overall network performance targets achievement via sharing not only the airspace requirements concerning major events with significant impact on the network, but also information regarding military trajectories or flows.

Military AUs will have to consider the shift towards harmonised, seamless and interoperable exchange of flight related data based on new concepts i.e. FF-ICE and SWIM compliant data format i.e. FIXM.

Letter of Agreement (LoA) between adjacent ATS units will address the application of multiple extended AMAN, especially the item of delay apportionment.

Airport and TMA - Network Integration

Airport capacity planning process in the strategic planning phase of the Network Operations will be optimised by the input provided in this stage by the airspace capacity planning and the process of Network optimisation. The enhanced AOP/NOP integration and the publication of relevant information into the NOP will support the strategic planning phase.

The enhanced airport DCB process covering the APOC actors intends to improve the local performance targets.

Pre-tactical and Tactical Planning

Optimised Network Design

No major changes are planned for cross-border FRA in this phase compared with the 2025 baseline, the process will be enhanced by wider utilisation of FF-ICE/R1 features (trajectories).

The complexity measurements will provide a key input into the DAC processes, supporting the local and network planners to calculate and implement the optimum configuration of airspace reservations, ATC sectors and TMA boundaries, which provide the required capacity across the Network.

The military planners will have at their disposal a wide variety of tools capable of identifying the optimum airspaces necessary for conducting the more complex air operations. The combination of static reserved/restricted airspaces, with modular areas following the VPA design principles and with different types of DMAs will offer a good opportunity for the military planners to accurately tailor the needed airspace in order to fulfil the latest mission requirements.

The next generation fighters in conjunction with a more robust use of unmanned technologies will determine the implementation of new concepts and new operational networks for the military Airspace Users.

The dynamicity of Airspace structures reservation will be enhanced in order to accommodate the military AUs demands ensuring the necessary airspace is booked/release in real time and available for flight planning.

The migration to flow centric operations will provide a very important input to a more dynamic

ASM process. The transformation of ASM into the Dynamic ASM will be the key operational enabler towards the implementation of a seamless and flexible airspace by 2029. Focusing the pre-tactical phase on the analysis of the forecasted air traffic flows will offer to the Airspace Planners (both civil and military) the key element to be considered when deciding the geographical location of the airspace that satisfies the AU's requirements when booking specific areas whilst trying to keep to the possible minimum the reservation impact on these flows.

Optimum Capacity and Flight Efficiency Planning

The dynamic adjustment of airspace in the pre-tactical and tactical planning phases will deliver performance gains by responding in a flexible way to AUs' expectations.

Managing the transition between planning and execution, the Integrated Network Management and (Extended) ATC Planning (INAP) function will be introduced into the Network Operations. This new function will enable the seamless management of traffic and the reduction in the number of potentially conflicting trajectories to be tactically handled by ATS by the further integration of ATFCM and ATC planning functions.

Multiple slot swapping process will be evolve in terms of automation, supported by the proper tools and procedures, which will be developed and agreed in a process driven by the AUs. Multi-swap will be further be enhanced by application of Network UDPP, enabling AU greater flexibility in a cooperative manner.

Trajectory and Cooperative Traffic Management

The ATFCM measures created and negotiated in the pre-tactical and tactical planning phase will have to be reconciled between all the involved operational stakeholders before the execution phase, eliminating as much as possible the need for the tactical interventions performed in the execution phase.

A strong and integrated analysis of all the ATM constraints, including the meteorological data, will prove to be even more important when reaching the tactical planning phase. At this specific moment the fine tuning of the already initially agreed airspace allocation elements is creating the prerequisites for reaching the level of confidence in the shared trajectories that will allow them to be transformed in the reference trajectories, published in the Collaborative NOP.

The multi-constraint resolver will enhance the reconciliation of ATFCM measures created and negotiated in the pre-tactical and tactical planning phase and attempt to eliminate as much as possible the need for the tactical interventions performed in the execution phase.

The ATFCM measures will evolve as well into complex sets of measures, which will comprise not only the flow and capacity elements within the new dynamic DCB processes, but also the ASM and ATS elements, everything augmented by accurate meteorological data.

Traffic Complexity Management tools will take in account the quantitative and qualitative assessments of complexity, the uncertainty of the trajectory prediction over time, aiming to capture the relationship with workload.

The FF-ICE Planning Service and Preliminary Flight Plans (PFPs) will facilitate the trajectory information exchanges in the planning phase. The FF-ICE Planning Service will enhance the medium term Network traffic forecast and ensure better Demand Capacity Balancing at the network level.

The accuracy and validity of the ATM constraints, as well as relevant meteorological data, will increase as the timeline moves closer to the execution phase. In the pre-tactical and tactical planning phases, the trajectories expressed by the AUs (civil and military) will be subject to further refinement and fine-tuning in order to satisfy all their operational requirements, while still contributing to the achievement of the performance targets. It will be extremely important that all the changes brought in these planning phases will be made available to all the involved operational stakeholders in a timely manner and will be subject to the continuous Network CDM processes.

Flow centric operations will continue in the pre-tactical and tactical planning as well, when the refinement of individual trajectories composing a specific flow or sub-flow. This will require the increase in the dynamicity of imbalance-solving solutions provided by the local and network operations planners regarding the ATS. This component will be supported by the Network Operations in the planning phases for specific ATC requirements such as data sharing of Target Times, initial ATFCM measures and their reconciliation with ATC constraints.

Airport and TMA - Network Integration

Airports will enhance the process of establishing their capacity plans will coordinate with the local ANSPs to ensure aligned TMA capacity values. The enhanced AOP/NOP integration will take into account additional data covered not only by the airport air side.

The process of collecting the traffic demand and airport capacity elements will be enhanced and additional data will be shared, in order to establish the best possible DCB balance. This info will be shared with NM via enhanced AOP/NOP integration using SWIM and published by NM also via SWIM (further considerations of amount of AOP/NOP shared data for publishing will be needed), in order to inform in a transparent and timely manner all the other operational stakeholders. The process will be continuous and iterative in order to have at any given moment the most up-to-date information. The NOP will make use of the new technologies (big data, machine learning, AI) to improve the quality of the planning.

The integrated DCB process will follow as well multiple iterative cycles until an optimal balance is reached between the solutions that are designed to resolve both the airport and airspace limitations and imbalances.

Execution

Optimised Network Design

The FRA cross-border will be enlarged compared with the 2025 baseline. ATC process applied to the flights within cross-border FRA structures will be supported by enhanced tools and OLDI exchanges.

The Dynamic Airspace Management will be enhanced by additional real time sharing of the latest updates in terms of airspace configurations, airspace reservations and airspace releasing.

The tactical elements of the DAC processes will continue to support the fine-tuning of the local and network measures, providing in a continuous flow of information the most up-to-date data concerning the airspace reservations, the airspace configurations as well as real time airspace updates to all involved operational stakeholders.

Optimum Capacity and Flight Efficiency Planning

The AUs will enhance the provision of trajectory preferences (FF-ICE/R1, Network UDPP) when considering the possible evolutions of the ATM constraints in the execution phase.

The INAP role will continue to evolve, making this function one of the key coordinating mechanisms when establishing the optimum balance between the local and the network performance targets and needs.

Trajectory and Cooperative Traffic Management

The complexity management will be enhanced by the identification of the optimum Network and local ATFCM measures in the pre-tactical, tactical planning and execution phases. The complexity measurements will provide a key input into the DAC processes, supporting the local and network planners to calculate and implement the optimum configuration of airspace reservations, ATC sectors and TMA boundaries, which provide the required capacity across the Network

The local complexity tools will be enhanced by the integration of what-if scenario management and Network Impact Assessment capabilities provided by NM via SWIM services.

The Trajectory Management process in the execution phase will be complex and will require a continuous synchronization and sharing of information. Trajectory Management will be based on the centralised coordination of the 4D Business/Mission Trajectory vis-à-vis the AUs and an Enhanced-CDM (ECDM) process in the execution phase will be performed to the level most practicable, including involvement of all Operational Stakeholders with emphases on their business and operational needs.

The 4D Trajectory data, contained in eFPL, will be widely shared with all the involved operational stakeholders. The increased flexibility and dynamicity of the network will also require in some instances the revision or the update of the trajectory information in a short time as a response to evolving ATM constraints.

During the execution phase, there is a need for an integration and modification of changes requested by Operational Stakeholders to optimise their operations. Such change occurs at granular level, and may be driven by new opportunity to maximise individual trajectory efficiency, or to fine-tune traffic complexity and controller workload at local level.

During the execution phase, ATS is intended to execute the agreed trajectory with minimal alterations. The extended AMAN advisories needs to be executed further en-route as agreed by LoA provisions in order to optimise the traffic sequencing at the congested airports.

Further interaction between Operational stakeholders (including NM) is needed for reconciliation of tactical ATFCM measures (target Times) with ATC advisories based extended/multiple extended AMAN application.

The military operational stakeholders will define their own CDM limits and willingness to revise the trajectories on the basis of mission objectives accomplishment in a safe and efficient way.

Airport and TMA - Network Integration

The local DCB processes will be improved via enhanced AOP/NOP integration. The improved integration of local airport DCB with the network DCB will allow the overall network to react in an optimum way to all the possible changes and deviations from the agreed AOPs.

The awareness of any substantial airport change (the availability of airport resources, MET conditions, ATM constraints) will be increased via different mechanisms (AOP/NOP process, other exchanges and data sharing) involving all Stakeholders.

Post Operations

General

Future technologies developed for the business intelligence activities (like big data, machine learning or AI) will support and enhance the analysis of all the Network components and resources, mapping them in a seamless and continuous process against the Network elements identified as being the optimum ones in the performance-driven process of managing the entire pan-European Network.

Optimised Network Design

The post operations analysis of cross-border FRA structure and airspace configurations will be supported by the techniques of business intelligence (big data, machine learning or Artificial Intelligence - AI), the optimum size and location of a reserved airspace or an ATC sector will be identified with a high degree of confidence and accuracy, satisfying in the same time as much as possible all the AUs' operational requirements and needs.

The continuous feedback and impact analysis will support the airspace planners to identify in shorter periods of time the optimum airspace solutions to be deployed in a very dynamic cross-border FRA environment.

Optimum Capacity and Flight Efficiency Planning

The difference between the fine-tuned or modified trajectories flown in the execution phase will provide the basis for the detailed analysis of the efficiency of airspace configurations and allocations.

Trajectory and Cooperative Traffic Management

The enhanced and comprehensive post-operational analysis will be conducted in respect of implemented DCB measures .The data provided needs an appropriate level of quality and shared between all involved parties. Future technologies developed for the business intelligence activities (like big data, machine learning or AI) will support and enhance the analysis of all the Network components and resources, mapping them in a seamless and continuous process against the Network elements identified as being the optimum ones in the performance-driven process of managing the entire pan-European Network.

The analysis of the measure reconciliation process, with the lessons learned in this process, will support the further improvement of the DCB.

All the identified results of this analysis, together with the complexity quantitative and qualitative measurements will be fed into the planning and execution phases in a continuous process of network optimisation at all levels and all the constituent elements.

The multiple AMAN operations for specific time periods will be analysed and the results will be fed into the planning phases in the form of extension or reconfiguration scenarios ready to be deployed in operations for recurring situations.

Based on the post-ops analysis, the LoAs and operational procedures will have to be adapted with the provisions of extended AMAN/multiple extended AMAN delay apportionment as well for the integration of AMAN/DMAN and queue management techniques.

Airport and TMA - Network Integration

The analysis of airport data at the level of Network Operations will be enhanced by the use of the new technologies (big data, machine learning, AI), multiple analysis will be conducted in order to measure (both quantitatively and qualitatively) the impact on the network operations of the airport operations and their sub-sequent changes in the tactical planning and execution phases.

ANNEX B –Roles and Responsibilities

Current roles and responsibilities are going to evolve in line with the expected improvements, namely:

- Optimised Network design;
- Optimum Capacity and flight efficiency planning;
- Trajectory and Collaborative traffic management;
- Airport and TMA - Network integration;
- Network components/systems and CNS infrastructure evolutions.

For each of them the major changes expected for the scenarios 2025 and 2029 will be defined for the following relevant stakeholders:

- ANSPs:
  - ASM
  - ATS
  - ATFCM
  - Maintenance personal, including CNS
  - AIM
- NM:
  - ATFCM
  - Flight Planning
  - Systems maintenance personnel
- Military:
  - Air Defence authority
  - ATM providers
  - Airspace Users
  - Aeronautical information providers
  - Aerodrome Operators
- AIM providers (in most cases part of ANSP)
- Airport operators
- Airspace Users:
  - AOs
  - CFSPs

    - VFR users

- New actors:
    - DATM providers
    - HAO (users and ATM providers)
    - UTM (Users and service providers)
    - Supersonic aircraft operators
    - Space vehicle launch organisations.

B.1 Scenario 2025

Despite technical evolutions improving the data management and enhanced digitalisation of ATM services, no major changes are expected in the current roles and responsibilities of different ATM stakeholders.

The only exception might be a gradual introduction of new ATM role of Multi-sector Planner, refers to an ATC planning role, involved in organising the traffic flows over a number of ATC sectors (a family of sectors) within allocated airspace. Depending on the ATS environment and operational working methods the Multi-sector Planner would serve several tactical controllers in a role somewhat extended from the ATC Sector Planning role in today's environment.

Within 2025 time horizon, the initial implementation of a new APP role of Sequence Manager will commence in the high-complex TMAs. This role is mainly related to efficient arrival sequencing within the defined time horizon before entering the APP sectors and coordination of transfer condition with the upstream ACC or extended TMA sectors. The Sequence Manager converts runway throughput in delay per feeder fixes and communicates to planner controllers in charge of feeder fixes.

Gradually increased cooperation among ANSPs to extend cross-border operations, including initial dynamic cross-border sectorisation and cross-border FRA, might require some specific training requirements, as well as the definition of clear qualification requirements for ATCOs.

A wider deployment and usage of Data Link may offload the Tactical/Planner controllers and provide significant benefits in airspace capacity. Deployment of related system/HMI improvements would be necessary to achieve this.

In the context of the new working methods, post-ops analysis will be crucial in optimising the decision making process.

Increased management of dynamic data will facilitate an enhanced integration of ASM/ATFCM tasks, with potential impact on training and staff organisation.

Although rapidly increasing drones operations and initial introduction of HAO, no specific changes in tasks of the stakeholders involved are expected. Based on the U-Space regulation applicable as of January 2023, the progressive creation of U-Space airspace by States might generate training requirements for ATS personnel, in particular for the management of dynamic airspace reconfigurations. Major focus by 2025 will be on the regulatory and procedures definition to facilitate their operations in an integrated ATM environments.

The increased data sharing and process automation in the flow management area might lead to slight adaptations of the respective ATFCM roles of NMOC and local Flow Managers (FMP), with the delegation of tasks between NMOC and local FMPs.

The gradual implementation of ATC virtualisation and the use of cloud deployment (instead of physical in premises) will lead to some adaptations of ATM engineering roles and tasks, but within the 2025 timeframe, the magnitude of these changes might be rather limited. The role of CNS engineering personnel might be adapted to new CNS equipment that will be introduced, but in general, no major changes are foreseen.

The increased automation/alerting of airport ground operation and AOP/NOP data exchanges might require some training of airport ATM personnel, but no major changes of their roles and tasks.

The full digitalisation of the aeronautical data chain, including the implementation of Digital NOTAM, will require additional training of AIS personnel, but no foreseen change in roles and responsibilities.

An increased automation and the initial deployment of FF-ICE/R1 may affect the flight planning processes of AU, CFSPs and NM. However, the roles of Flight Planning actors are not foreseen to be substantially changed, as IFPS will ensure a smooth transition from ICAO 2012 flight plan to FF-ICE and the distribution of flight plan data to the concerned actors, regardless of their transition to FF-ICE.

Pilots will benefit from CPDLC data exchanges and reduction of verbal communication for non-critical clearances. The Pilot Training curriculum needs to be adapted to CPDLC messages (in most of cases it is already completed).

B.2 Scenario 2029

ATC roles

Several changes are foreseen in the ATM layered planning. The roles of ATM layered planning includes:

- "ATC Sector Planning" refers to a planning role working on one ATC sector and for which tasks would be approximately what the corresponding controller is doing in today's environment enriched by enhanced sector team task sharing resulting, in Executive Controller's workload smoothing.
- "Multi-sector Planning" refers to an ATC planning role, involved in organising air traffic over a number of ATC sectors (a family of sectors) within the AoR airspace. Depending on the ATS environment and operational working methods, the Multi-sector Planner would serve several tactical controllers in a role somewhat extended from the ATC Sector Planning role in today's environment (group of sectors Planner responsibilities). This role might cover also the interface between the Local Traffic Manager and the Planning Controller.
- "Complexity Management" refers to an operator role responsible for the entire ATS airspace consisting of a large number of ATC sectors and a number of sector families. This role is responsible for complexity assessment and resolution, as well for dynamic DCB and INAP taking into account local and Network constraints, as well as AU preferences.
- "Extended ATC Planner" refers to ATC/ATFCM integration, mostly related to the Integrated Network and ATC Planning (INAP) tasks, in coordination with the Executive/Planner team and the local FMP. Training, design of new procedures and the right balance between automated and human tasks will be key.

The INAP function can be related to several roles from Network Operations and ATC Operations. It includes the Local Traffic Manager role and appropriate ATC operational roles. Performing this function requires actors to have local expertise and the way it will be implemented (procedures, detailed activities, actors involved) will vary dependent upon local drivers. The extended look-ahead time horizon of the ATC Tools will enable the INAP function to better assess and anticipate the complex situations for ATCOs. Depending on local procedures, the INAP-related-tasks could be performed by different actors, not only limited to local Traffic Management but also encompassing the ATC scope of action. The deployment of specific system, the involvement of human actors and the granularity of the processes are based on the ATM layered planning principles and the complexity of the operations. These actors will allow the identification of the best local solutions to cope with both Dynamic DCB and ATC requirements in the execution phase.

The roles in the ATM Layered Planning could overlap. Actors endorsing these roles would depend on local ATS or ANSP procedures, operating methods and traffic environment. A given actor could assume a given role, part of the tasks of a given role, several roles or part of the tasks of several roles.

For example, the Multi-sector Planner could perform solely the task of sector planning extended to two or more sectors (group of sectors Planners responsibilities), and could also perform elements of the complexity management role.

Similarly, the Extended ATC planner task might be emulated within the Complexity Manager role or Multi-sector Planner role.

The Tactical Controller tasks will be supported by more comprehensive data capabilities. The ATC Planners may be able to take on some of the tactical tasks, provided clear procedures and rules are in place. Part of the tactical workload may shift to the Planner issuing clearances while the aircraft is in upstream sectors, through the usage of ATN B2 messages.

The OPS Supervisor role will be responsible for the general management of all activities in the Operations Room. It decides on staffing and manning of controller working positions in accordance with expected traffic demand. Supported by simulations of traffic load and of traffic complexity, and assisted by local traffic management, it takes decisions concerning the adaptation of sector configurations to balance capacity to forecast demand. Based on the results of simulations the required flow control measures may be implemented by ATFCM through a CDM process. In addition, OPS supervisor will be responsible for the task related to the delegation of ATS provision.

The role of Sequence Manager will be extended to the remaining high and medium complex TMAs and this role will be further enhanced by automated impact assessment of manual traffic sequence (what-if task and functionality).

NMOC and Local FMP roles

The Network Manager Operating Centre (NMOC) facilitates efficient network operations by and for all ATM stakeholders

- During the medium to short term phases the NMOC works towards identifying and mitigating significant DCB issues strategically, both at network and local levels.
- NMOC will take DCB initiatives, in accordance with NM IR, for seasonal traffic variations, large scale military activity, significant events (such as Olympic games) and reductions in normal capacity, due to weather, major infrastructure implementation, industrial action, etc.
- During the execution phase, the NMOC will assure the stability of the NOP (Network Operations Plan), reacting to unexpected events, which impact the overall network performance, such as unusual meteorological conditions or loss of significant assets (e.g. runways, airports). Among other means, activation of pre-agreed scenarios will enable the NMOC to restore Network stability.

The relationship between central (NMOC) and local ATFM Units is ruled by the current EC Implementing Regulation No 2019/123. The ATFM function is a *shared* function between the central and local ATFM units, through the CDM process. Sharing the responsibility for the ATFM service provision in a CDM context entails the availability of the same information/data to all the actors/decision makers. This is a continuous process that will be improved through the iNM programme: traffic demand, simulations, Network impacts, cross-border STAM RRP, MET info, as well as local ATC decisions, will be available to all the ATFM actors/decision makers in real time. This is a crucial point in the preparation of the best possible pre-tactical plan or in taking the best possible agreed tactical decision in a coordinated manner. Additionally, iNM will bring further process automation and improved collaboration facilities in support of the ATFM function.

Having access locally to the network tools and data allows local ATFM units to assess the network impact of any possible measure, relieving NMOC from that task. Many more simulations can be done, as the task is distributed, allowing to achieve much better solutions. NMOC has then more time to dedicate to the overall coordination of measures implementation with all actors.

iNM will open the door to *post-departure ATFM*, provided that on board systems/avionics will be fully integrated with NM and ANSPs. This makes possible to perform tactical STAM reroutings in response to last minute capacity bottlenecks en-route, weather or any other unexpected event causing a capacity reduction in the Network. This entails that ATC systems shall be able to display info/data on radar screens in real time coming from the NMOC.

NMOC staff profiles, currently split in the three operational domains (Airspace Data, Flight Planning, Flow Management) will be completely reviewed, adapting their roles and responsibilities to the cross-domain integrated functionalities that will be introduced gradually with the iNM programme. New recruits and current NMOC staff will be progressively trained for the new processes and tools, as the new capabilities are made available through iNM. All the NMOC operations manuals (as well for the local ATFM Units) shall be changed accordingly. FMPs/TWR/Airports will also need to be trained on new procedures and interfaces.

The current Airport Function Trial in NMOC will become a permanent position, and the scope will be enlarged to assist all Airports in the European Network versus capacity optimisation, weather impact, curfew management and airport slot adherence.

The initial EAD/CACD integration with new digital workflow processes involving AIS, ENV Coord, RAD Coord and NMOC will require some additional training and competence acquisition of the different stakeholders involved and their roles and tasks will need to adapted to new requirements.

Local Flow Management role

- The Local Flow Management has a generic responsibility for the planning activities that take place within the medium to short term planning and execution phases. The local Flow Management related actors will not be responsible for planning activity within the long term planning phase, but are more likely to act as an expert resource in the process.
- In short term planning, local Flow Management may act to optimize the ASM/ATFCM plan, taking into consideration data coming from Local Traffic/complexity management working closely with NMOC.
- The Local Flow Management generic DCB responsibilities during the execution phase are one of initiating, organising, carrying out and co-ordinating actions between the NMOC and Local Traffic/complexity Management.

ASM/DAC roles

Major changes are expected with the implementation of DAC and DCB concepts.

With the DAC concept, the local civil/military will focus on the definition of parameters, performance driven, to allow operational actors to define and manage the dynamic airspace structures (sector configuration and DMAs) at pre-tactical and tactical levels. This dynamic structures, especially DMAs, will coexist with existing structures, as well as the utilisation of predefined airspace organisation, whenever deemed easier to manage and more appropriate to solve problems.

Local DAC actor fulfils a joint civil-military function at national level which integrates ASM, ATFCM and ATS functionalities so that their processes can be performed in a combined manner allowing for a cooperative management of Airspace Configurations. This function is expected to manage civil/military airspace allocation, flow and capacity management, including sector configuration management at local/sub-regional level with following responsibilities:

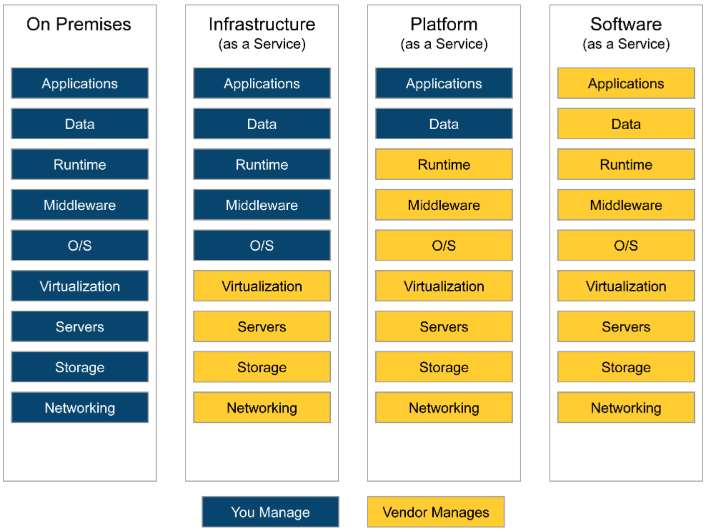
- Plan and develop Dynamic Airspace Configurations that meet defined Network and local operational performance targets for referred period;
- Monitor Airspace Configuration deployed as a result of strategic phase, taking into account Network and local performance;
- Retrieve and process MIL\Special AUs SMTs/requests;
- When and if the problem detected - using “What if” tool to find new sectorisation, matching the demand with acceptable level of performance;
- If there are no airspace sectorisation matching the demand with acceptable level of performance, - negotiate with military\special AUs other DMA/TSA/TRA activation parameters that satisfy required level of performance (preferably both: local and network ones);
- As a result of such new DMA/TSA/TRA activation parameters identify SBTs/RBTs that are not compliant anymore with new DAC and pass them to DCB actor for further coordination with AOs;
- Coordinate with other DAC actors/FAB and NM;
- Take final decision on the DAC;
- Promulgate new/latest DAC configuration on the NOP.
- When DAC process reaches its limit in terms of exploiting airspace capacity to accommodate civil and military demands, the actions pass to DCB for demand balancing:
    - either when the problems are solved, or
    - outstanding problems cannot be solved by further DAC modifications/improvement.
- DCB actor is the responsible for hotspot declaration and provision of this info to AO;
- DCB actor interact with AOs;
- DCB actor may come back to DAC process if time permits.

WOC is a generic term designating a local military airspace user function which gathers the operational processes and services directly related to the airspace users and linked to Mission Trajectories and other aerial activities and is involved in DAC as owner of ARES:

- Defines ARES (fix ARES, VPAs, and DMAs) to be processed by DAC function in accordance with AUs mission request;
- Supports integration of ASM with ATFM by sharing trajectory requests with embedded ARES (where suitable) or independent ARES requests; sharing of trajectories and ARES requests triggers the CDM process for DAC;
- Share and update trajectories (via NOP/NM) and ARES in accordance with the rules and procedures established by national authorities
- Participates to CDM for ARES location, volume and activation parameters and bears the end responsibility for their agreement.

Network components/system engineering roles

Adoption of cloud computing significantly reduces the burden of maintenance responsibilities from the operational stakeholders. The picture below shows the Cloud computing service models that determine the responsibilities of system maintenance



As cloud providers take responsibility of infrastructure availability, a share of system maintenance and **extensive monitoring become the main maintenance activities that require skilled workforce**.

Some system maintenance and monitoring activities that should be automated, will still require human oversight are as follows:

- Monitoring, logging and alert functionalities
- Security and vulnerability detection
- Backup, system failover and disaster recovery
- Virtual machine maintenance
- General maintenance and patching systems
- Data loss prevention and encryption
- Compliance audits

As per the best practices, adoption of cloud computing for critical system requires an advanced strategy. Multi-Cloud (Infrastructure/services spread over multiple cloud providers) and/or Hybrid cloud (Hybrid approach of Cloud and On Premise infrastructure) are the approaches that are most suitable for efficient cloud adoption. In such scenarios, maintenance activities over multiple cloud providers and On Premise hardware are also required. In Hybrid cloud model, Cloud provider can extend the support for general but extensive maintenance activities that's required for On Premise hardware. These activities are currently carried out manually, however activities that do not need physical access to the hardware must be automated and monitored from a single control room.

Moreover, the application of AI to user-behaviour analytics, network surveillance or incident forensics, for example, could provide a system with the capability to react autonomously to breaches, hence affecting existing roles and responsibilities of current operators.

Cybersecurity Actors:

In the context of cybersecurity, roles and responsibilities will evolve in particular in their increased reliance on technologies (e.g. AI-based applications), as well as their increased exposure to new, rapidly evolving cyber threats. In particular their role will evolve towards a joint collaboration with the artificial intelligence agent capable to better anticipate and alert on cyber threats, unexpected events etc. although the decision will remain to the human.

More over, most cyberattacks target the weakest link in a given organisation. In a fully digitalised and connected network which is expected by 2029, cyberattacks will target the weakest link of the network. Hence the cyber resilience will become a common good and responsibility that will evolve from an individual protection to a collective protection, with appropriate governance at network level.

ANSP CNS engineering personnel

CNS domain will be driven by a service-based approach that will enable the de-coupling of CNS service provision from air traffic services. CNS services will be specified through contractual relationships between customers and providers with clearly defined services and level of quality, aiming at European wide harmonised services that increase the cooperation across national boundaries. This approach will create business opportunities for affordable services with a strong incentive for service providers to compete resulting in cost-efficient services.

This new approach can result on many significant changes to the CNS engineering personnel, however, it all depends on the service provision model that will be selected for the implementation. This approach may also lead to a transfer of assets from ANSPs to CNS service providers, and may impact ANSPs' regulated cost bases

Other roles

Roles and responsibilities will further evolve over this period and new actors or services will appear in the network: new ATM Data Service Providers (ADSP) in operations, new service providers for UTM operations, HAO services, implementation of virtual centre concept in combination with DAC process will change ATCOs responsibilities, increasing the role of planner controller, etc. Work is on-going on these subjects and roles and responsibilities will be included in future updates of the High Level Network Concept of Operations.

Specific training responding to the changes in terms of roles and responsibilities will be essential. The development of the network human capital is required and needs to be achieved in a collaborative, coordinated and expeditious manner. It needs to take into account availability and flexibility of resources, network services, all operational stakeholders' interests and commitment towards achieving the common goals of the High level Network CONOPS. The ATM staff shall be well trained, competent, in order to explore the full potential of interoperability, delegations of ATS provision and flexible airspace structures. Staff competencies, including new digital skills, will remain paramount in achieving operational efficiency without compromising on safety. Flexible rostering tools will enable better management of available resources and their availability when is needed (coupling rostering tools with traffic complexity).

ANNEX C – Enablers

In order to support the main Network conceptual elements, the ATM Master enablers are grouped in a form of technology changes as:

Technological changes (Clustered enablers)	Enabler Code
ATM system improvements for cross-border FRA and connectivity with TMA	AAMS-16a, ER APP ATC 125, ER APP ATC 75, ER APP ATC 78
System Improvement for FF-ICE Release 1	NIMS-21b, SWIM-APS-18, AOC-ATM-25, AOC-ATM-23, ER APP ATC 82, NIMS-57, SWIM-APS-19, SWIM-APS-20
System Improvement for FF-ICE Release 2	ER APP ATC 170, ER APP ATC 82b, ER APP ATC 101, SWIM-APS-21, SWIM-APS-22, AOC-ATM-20
ATM system/ AU system improvements for OAT flight planning	AAMS-10a, AOC-ATM-14, ER APP ATC 143, NIMS-35, ER APP ATC 168
ATM system/ AU system improvements for mission trajectory management	AOC-ATM-15, ER APP ATC 168, NIMS-45, ER APP ATC 82b
ATM system/ AU system improvements for EPP/ADS-C data management	ER APP ATC 100, ER APP ATC 149a; ER APP ATC 167
ATM system enhancement for management of real time ASM data	AAMS-06b, AAMS-06c, AAMS-11, AIMS-04,ER APP ATC 77, FOC-002, NIMS-42
ATM system modules related to Dynamic Airspace Configurations and Dynamic Mobile Areas	AAMS-01, AAMS-02, AAMS-13, AIMS-15, AAMS-19, ER APP ATC 80, NIMS-19, NIMS-30, ER APP ATC 123,
Cooperative Management Traffic evolutions	AOC-ATM-11, AOC-ATM-22, ER APP ATC 17, NIMS-09, NIMS-13b, NIMS-23, NIMS-27, NIMS-38, APP ATC 148, ER APP ATC 119, ER APP ATC 93, NIMS-37, NIMS-38, APP ATC 92
Systems to support extended AMAN	APP ATC 111, ER ATC 163, ER ATC 158
Extended AMAN evolutions	APP ATC 158, APP ATC 162
Dynamic sectorisation/ Traffic complexity enhancements	ER APP ATC 164, APP ATC 63, ER APP ATC 93, ER APP ATC 15, NIMS-04, NIMS-36, NIMS-37
Dynamic DCB	NIMS-12, NIMS-13c, NIMS-49, NIMS-50, NIMS-52, NIMS-55
Integrated ATC/ATFCM tools	NIMS-46, NIMS-48
NM/AU System improvements related to flexibility and operational efficiency	AIRPORT-51, AIRPORT-48, AOC-ATM-17, AOC-ATM-18, NIMS-39a, NIMS-39b, NIMS-44, NIMS-56
Network awareness system evolutions	FOC-006, AOC-ATM-10; FOC-009, NIMS-14c, NIMS-29, NIMS-51, SWIM-APS-14, SWIM-APS-15, SWIM-APS-16, SWIM-APS-17, SWIM-APS-23, SWIM-APS-24, SWIM-APS-25,

AOP/A-CDM system evolutions	AERODROME-ATC-18, AERODROME-ATC-44a, AIRPORT-02b, AIRPORT-03, AIRPORT-03b, AIRPORT-03c, AIRPORT-04, AIRPORT-31, AIRPORT-35a, AIRPORT-35b
Airport/Network data exchanges enhancements	AOC-ATM-13, AERODROME-ATC-20, AIRPORT-38, AIRPORT-52, NIMS-03, NIMS-25, NIMS-41
Airport system improvements (APOC tools, constrain management, impact assessment)	AERODROME-ATC-50, AERODROME-ATC-57, AIRPORT-33, AIRPORT-07, AIRPORT-10, AIRPORT-36, AIRPORT-41, AIRPORT-42, AIRPORT-50
Systems to support Dynamic TMA Operations	APP ATC 134, ER APP ATC 120, APP ATC 117, NIMS-54
Multi Sector planner/extended planner	ER APP ATC 102, ER APP ATC 173, ER APP ATC 96, ER ATC 95
Conflict detection/resolution tool enhancements	ER APP ATC 155, ER APP ATC 104, ER APP ATC 120, ER ATC 157, ER ATC 157b, APP ATC 155, APP ATC 104b
Flight monitoring tool enhancements	APP ATC 168, ER APP ATC 104c, ER ATC 91, ER APP ATC 104d
Enhancement of traffic synchronisation and sequencing tools	AERODROME-ATC-09a, AERODROME-ATC-41, APP ATC 110, APP ATC 161, APP ATC 62, ER APP ATC 109
Safety Nets enhancements	APP ATC 136, APP ATC 148, ER APP ATC 14, ER APP ATC 171, ER APP ATC 172
Airport Safety Nets	AIRPORT-45, AIRPORT-46
ATC system enhancement for management of data link clearances	ER APP ATC 119, ER APP ATC 132, ER APP ATC 149b, ER APP ATC 149c
Flight Centric system components	ER APP ATC 174
SWIM Yellow Profile system capabilities	SWIM-APS-01a, SWIM-APS-02a, SWIM-APS-03a, SWIM-APS-04a, SWIM-APS-07a
SWIM data exchanges evolutions	AGSWIM-35, AGSWIM-36, AGSWIM-37, ER APP ATC 160, GGSWIM-51c, SWIM-APS-23, SWIM-APS-24, SWIM-APS-25
SWIM technical components	MIL-0502, SWIM-INFR-07; SWIM-INFR-01a, SWIM-INFR-05a, SWIM-INFR-06b, SWIM-INFR-06c, SWIM-NET-01a, SWIM-SUPT-01b, SWIM-SUPT-02, SWIM-SUPT-03a, SWIM-SUPT-03b, SWIM-APS-05a
SUR system Evolutions	CTE-S02c, CTE-S03b, CTE-S03c, CTE-S03d
COM system Evolutions	CTE-C02c, CTE-C02d, CTE-C02e, CTE-C02f, CTE-C03b, CTE-C03d, CTE-C04, CTE-C05b, CTE-C06b, CTE-C06d
NAV system Evolutions	CTE-N01, CTE-N02, CTE-N05, CTE-N06a
Performance monitoring of SUR systems	CTE-S07, CTE-S07a, CTE-S07b, CTE-S07d, CTE-S07e
Airport Performance monitoring evolutions	NIMS-22, AIRPORT-40, AIRPORT-40b, AIRPORT-54
MET system evolutions	METEO-03, METEO-03c, METEO-04b, METEO-04c, METEO-05b, METEO-05c, METEO-06b, METEO-06c, METEO-08c
AIM system evolutions	AIMS-06, AIMS-07a, AIMS-19a, AIMS-19b, AIMS-23
Virtual Center System capability	ER APP ATC 180, ER APP ATC 181, ER APP ATC 182, ER APP ATC 175, ER APP ATC 186, AERODROME-ATC-100, AERODROME-ATC-101

Future DATM system evolution	ER APP ATC 184, ER APP ATC 185, SVC-001, SVC-002, SVC-003, SVC-006, SVC-007, SVC-008, SVC-009, SVC-010, SVC-011, SVC-012, SVC-013, SVC-014, SVC-015, SVC-016, SVC-017, SVC-018, SVC-019, SVC-020, SVC-021, SVC-022, SVC-023, SVC-024, SVC-025, SVC-028, SVC-021, SVC-032, SVC-033, SVC-034, SVC-039

ANNEX D – NMOC improvements in the context of iNM

NMOC services to Stakeholders did not evolve significantly during the last few years. The iNM programme, aiming at implementing a digital transformation of the network management, brings opportunities to evolve the NMOC roles, based on more integrated system capabilities, but more importantly on the availability of intelligent data-driven tools and on the extensive collaboration capabilities, supporting the network actors.

The manual and repetitive tasks done today by NMOC will be automated and the staff will be available to perform more added-value tasks and to be more involved in the coordination with the network actors.

iNM will integrate the current EAD and NMOC CACD airspace data systems. All airspace data creation and maintenance processes (points, sectors, routes, RAD constraints, etc.) currently performed by NMOC manually will be done by the data owners (AIS, ENV Coord, RAD Coord), and be automatically available in iNM. NMOC will become responsible for the overall assessment of the data quality, for coordination with the data owner in case of data problems and for urgent data patching, if needed.

New models for capturing traffic for ATFCM purposes, new type of reference locations (i.e. Airport terminals, cross-border airspaces), will allow to be more precise, reducing the number of flights subject to ATFCM measures, so sensibly decreasing the overall Network ATFM delay whilst maintaining high levels of safety.

Extensive use of SWIM by all network actors will allow for seamless data sharing, enabling the integration at local level of the network tools and data.

Local ATFM units can then have access to the network situation and be able to study and assess different solutions for their local problems, looking at the overall network impact, before proposing those solutions to NMOC. NMOC will then play a role of coordination of measures implementation. The task of finding the best solution in a network context is then performed locally and validated by NMOC, which is a much more scalable working arrangement than what is possible today.

Having the extensive data sharing via SWIM, also allows NMOC to have access to the local data: active sector configurations, capacities, runway configurations, taxi times, ATC clearances, etc., from all ANSPs will be available in real time in iNM, resulting in an enhanced picture of the Network structure and the available capacity, as well as traffic predictability.

FPL collection, treatment, validation and distribution will be a fully automated process, eliminating the need for manual intervention by NMOC FP operators. These operators will then be dedicated to tasks in support of the airspace users in achieving their business objectives.

Data-driven solutions will be used to find and propose automatically to airspace users efficient alternative re-routeings taking into account fuel consumption, route charges, weather and with flight profiles that balance CO2 emissions and ATFCM delay mitigation.

Preliminary eFPL availability via the FF-ICE Planning Service will enhance the pre-tactical processes and the link with the tactical processes in a rolling pattern. 4D trajectories will be ‘negotiated‘ between AUs and NMOC systems, taking into account en-route/airport bottlenecks, the future weather situation or unexpected tactical constraints, causing a capacity reduction at local or Network level.

Integration in iNM of capabilities like the ones provided by the MIRROR tool, will contribute to a very precise tactical traffic demand (on top of the ‘traditional’ demand resulting from FPLs entry times), by considering additional info/data, such as turnaround times, reactionary delays, airport curfew and unexpected local airport constraints.

The pre-tactical/tactical planning tools will make use of data-driven approaches, using Artificial Intelligence and Machine Learning in order to predict the traffic demand, and to find out solutions in presence of capacity mismatches.

Using the powerful pre-tactical/tactical simulation tools of iNM will allow to evaluate, in real-time, the different ATFCM delay mitigation solutions (either proposed by the tools or manually proposed), by FMP/Airspace Users and NMOC, enhancing the CDM process towards the best possible agreed decision on traffic optimisation and delay mitigation actions.

The implementation of a truly integrated ASM/ATCFM process in iNM and full SWIM connectivity between the local ASM tools and iNM will allow to assess locally the impact of military activities on civil traffic during any ATFCM planning phase, and will support finding the best airspace allocations that minimise impact on civil traffic.

Airports will be fully integrated in the Network as soon as RWY configurations, gate taxi times, ATC clearances and departures/arrival sequencers (DMAN/AMAN) data will shared via SWIM and integrated in iNM, significantly enhancing predictability.

Although in a short/medium timeframe the move to full Network Target Times concept (replacing ATFM entry times and mandatory calculated take-off time) seem not feasible, the current Target Time validation trials will become eventually active procedures, initially for a number of city pairs and the relevant en-route sectors. The move to a complete ATFCM based on Target Times, which should be possible by 2029, requires aircraft on-board systems (flight management systems) to exchange real time data with CFSPs, NM and ANSPs.

Cross-border sectorisation will progress to address increased airspace complexity. ATFCM will be performed by using new measure optimisation tools, occupancy counts and target times. This will be possible only based on ATFM delay attribution.

One of the most important changes impacting ATM will be the interaction with new entrants. The recent successful suborbital flights opened a new era for space tourism, together with the creation of a number of spaceports in Europe. At this stage there are no rules for the co-existence of space activities and commercial aviation, being this an ongoing process that will take a few years to be finalised.

On top of the suborbital flights, some of the newly-declared European spaceports will deal with satellite launches programmes that will become quite common within 10 years. The European airspace, utilised by commercial aviation will be shared with such new entrants. The current procedures to segregate airspaces due to military exercises, avoiding conflicts with commercial aviation, are fit for the purpose.

Still procedures needs to be created and implemented for the numerous satellite uncontrolled re-entries (every year more than 2,000 satellites are launched), for which new software (i.e. DLR) are already available to warn ATC in due time and allow ATCO to clear the relevant airspaces affected by such re-entries. The Network Manager will play a key role for collecting info/data on re-entries (data fed by National space Agencies or private operators), closing with immediate effect areas to FPL and redistributing the plotted airspaces affected by debris, directly to ATCO radar displays, so acting as a central European Space Traffic Management Unit through the iNM system.

Integration of UTM and ATM will also be reflected in iNM. The new system will be able to provide aeronautical data to UTM service providers, in particular any dynamic airspace changes affecting their operations in controlled or uncontrolled airspace. Additionally, if crossing controlled airspace, drone information needs to be provided to NM (identification, area of operations, flight intention and real-time positioning). These processes are automated in normal conditions. Therefore, NMOC staff will mainly be involved in abnormal and crisis situations, where coordination with different actors is required to manage the issue.

ANNEX E – Correlation between operational performance benefits and Network CONOPS improvements

Code	Action Category	Network Improvement	Included in	KPA	KPI	Notes
1	Optimised Network Design	DAM/DAC configurations	CP1/NM plans	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario
1	Optimised Network Design	Dynamic border sector configuration, moving towards virtual centre OPS.	SESAR3	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario
1	Optimised Network Design	DAM/DAC configurations	CP1/NM plans	Cost Efficiency	ATCO productivity	As defined in EUROCONTROL specifications "Economic Information Disclosure"
1	Optimised Network Design	Dynamic border sector configuration, moving towards virtual centre OPS.	SESAR3	Cost Efficiency	ATCO productivity	As defined in EUROCONTROL specifications "Economic Information Disclosure"

1	Optimised Network Design	FRA extended beyond national boundaries	CP1	Environment	CO^2	It's about Extensive cross-border FRA at regional level. Horizontal Flight Efficiency
1	Optimised Network Design	FRA connectivity with TMAs	CP1/NM plans	Environment	CO^2	CP1 provides options in alternative to lower, both horizontal and vertical flight efficiency.
1	Optimised Network Design	TMA optimisation including PBN in support of CDO/CCO	CP1/NM plans	Environment	CO^2	None
1	Optimised Network Design	New entrants (HAO and UTM) evolutions	SESAR 3 / NM plans	No KPA	No KPI in ATM performance framework	Not possible to give a performance estimation at this stage. No available consolidated traffic forecast, no KPAs for UAS. At the moment, you cannot enter in controlled airspace unless you are an RPAS as defined by ICAO. Furthermore UTM is outside controlled. Finally lack of maturity of solutions.
1	Optimised Network Design	FRA extended beyond national boundaries	CP1	Operational Efficiency	Flight Time	Horizontal Flight Efficiency
1	Optimised Network Design	FRA connectivity with TMAs	CP1/NM plans	Operational Efficiency	Flight Time	CP1 provides options in alternative to lower, both horizontal and vertical flight efficiency
1	Optimised Network Design	FRA extended beyond national boundaries	CP1	Operational Efficiency	Fuel consumption	Horizontal Flight Efficiency
1	Optimised Network Design	FRA connectivity with TMAs	CP1/NM plans	Operational Efficiency	Fuel consumption	CP1 provides options in alternative to lower, both horizontal and vertical flight efficiency.
1	Optimised Network Design	TMA optimisation including PBN in support of CDO/CCO	CP1/NM plans	Operational Efficiency	Fuel consumption	Vertical Flight Efficiency

2	Optimum Capacity and Flight Efficiency Planning	Full ops actors involved in the definition of ATFM measures (i.e. Rolling NOP)	CP1	Environment	CO²	Vertical Flight Efficiency and Horizontal Flight Efficiency
2	Optimum Capacity and Flight Efficiency Planning	Full reconciliation of ATFM measures.	NM plans	Environment	CO²	Vertical Flight Efficiency and Horizontal Flight Efficiency
2	Optimum Capacity and Flight Efficiency Planning	Full ops actors involved in the definition of ATFM measures (i.e. Rolling NOP)	CP1	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario
2	Optimum Capacity and Flight Efficiency Planning	Full reconciliation of ATFM measures.	NM plans	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario.
2	Optimum Capacity and Flight Efficiency Planning	Enhanced and dynamic of a DCB process	CP1/SES AR3/NM plans	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario.
2	Optimum Capacity and Flight Efficiency Planning	Full ops actors involved in the definition of ATFM measures (i.e. Rolling NOP)	CP1	Operational Efficiency	Flight Time	
2	Optimum Capacity and Flight Efficiency Planning	Full reconciliation of ATFM measures.	NM plans	Operational Efficiency	Flight Time	

2	Optimum Capacity and Flight Efficiency Planning	Full ops actors involved in the definition of ATFM measures (i.e. Rolling NOP)	CP1	Operational Efficiency	Fuel consumption	
2	Optimum Capacity and Flight Efficiency Planning	Full reconciliation of ATFM measures.	NM plans	Operational Efficiency	Fuel consumption	
2	Optimum Capacity and Flight Efficiency Planning	ATFM measures taking into account AO flight prioritisation.	NM plans	Operational Efficiency	(Payload factor A/C2-Payload factor A/C1)	Minimise penalties for users in accordance with user preferences. This improvement allows AOs to manage their own airline network in accordance with their own internal requirements. This improvement include ATFM slot swapping provided by NM, and the benefits are experienced at transport level. ATFM delay remain equal, but its impact is reduced on airline business.
3	Trajectory and cooperative traffic management	Extensive use of target time for flight management	CP1/NM plans	Environment	CO^2	Vertical Flight Efficiency and Horizontal Flight Efficiency
3	Trajectory and cooperative traffic management	Extensive use of target time for flight management	CP1/NM plans	Capacity	Runway Throughput	Depending on the business model of the airport, target time could support either an increase of runway throughput or a reduction of Arrival Sequencing and Metering Area (ASMA) delays. Target times are initially assigned before take and then refined by Extended AMAN.
3	Trajectory and cooperative traffic management	Extensive use of target time for flight management	CP1/NM plans	Capacity	ATFM delays	Target times provide an increased traffic predictability in en-route sectors so that the ACCs will release more capacity in the planning process, ATFM regulations could become more precise reducing the amount of ATFM delays caused by inappropriate regulations

3						(when the actual demand remains below the capacity inserted in the ATFM regulations).
3	Trajectory and cooperative traffic management	Extensive use of target time for flight management	CP1/NM plans	Operational Efficiency	Fuel consumption	The avoidance of circular holdings could reduce fuel consumption (Horizontal flight efficiency). Target times and AMAN could facilitate CDOs (Vertical Flight Efficiency). Depending on the business model of the airport, target time could support either an increase of runway throughput or a reduction of ASMA delays. Target times are initially assigned before take and then refined by Extended AMAN.
3	Trajectory and cooperative traffic management	Extended AMAN	CP1	Capacity	Runway Throughput	Depending on the business model of the airport, Extended AMAN could support either an increase of runway throughput or a reduction of ASMA delays. Target times are initially assigned before take-off and then refined by Extended AMAN.
3	Trajectory and cooperative traffic management	Extended AMAN	CP1/NM plans	Operational Efficiency	Fuel consumption	The avoidance of circular holdings could reduce fuel consumption (Horizontal flight efficiency). Target times and AMAN could facilitate CDOs (Vertical Flight Efficiency). Depending on the business model of the airport, extended AMAN could support either an increase of runway throughput or a reduction of ASMA delays. Target times are initially assigned before take and then refined by Extended AMAN.
3	Trajectory and cooperative traffic management	Coordinated STAM measures	CP1/NM plans	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario.
3	Trajectory and cooperative	Coordinated STAM measures	CP1/NM plans	Cost Efficiency	ATCO productivity	The intensive use of STAM measures could reduce the need to deploy the pick sector configuration so incrementing ATCO productivity.

	traffic management					
3	Trajectory and cooperative traffic management	Reconciliation of ATFM measures	NM plans	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario. The conciliation of ATFM measures could reduce the penalties for users when the system is capacity constrained.
3	Trajectory and cooperative traffic management	Traffic complexity management	CP1	Capacity	ATFM delays	Avoidance of en-route ATFM delays compared to a given do nothing scenario.
3	Trajectory and cooperative traffic management	Traffic complexity management	CP2	Cost Efficiency	ATCO productivity	The use of traffic complexity indicators could reduce the need to deploy the pick sector configuration so incrementing ATCO productivity. There is also a benefit on safety: overloads are expected to reduce.
4	Airport TMA - Network Operations	Full AOP/NOP integration in 4D including Target Times	CP1 & SESAR 3	Capacity	Departure reactionary delays	Precise information from feeding airport will help the receiving airport to manage reactionary delays.
4	Airport TMA - Network Operations	Full AOP/NOP integration in 4D including Target Times	CP1 & SESAR 3	Capacity	Airport/TMA ATFM delays	Application of TT and UDPP preferences will allow a better management of ATFM Regulation with a positive impact on ATFM delays.
4	Airport TMA - Network Operations	On-time performance and local DCB	SESAR 3 / NM plans	Environment	Fuel burn (CO_2 emissions, etc.)	On-time performance and departure queuing managed with agreed local priority will positively reduce the taxiing time and fuel burn per aircraft. Benefits has started with CDM implementation, but they will increase with AOP/NOP.
4	Airport TMA - Network Operations	On-time performance and local DCB	SESAR 3 / NM plans	Capacity	Primary departure delays	Departure queuing managed with agreed local priority targeting the reduction of primary departure delay.

4	Airport TMA - Network Operations	Automated multi slot swapping	SESAR 3 / NM plans	Operational Efficiency	No KPI in ATM performance framework	Minimise penalties for users in accordance with user preferences. This action is about airport slot swapping at coordinated airports, This is already in use at CDG (DFLEX), however the benefits are out of scope of ATM benefits. Benefits are at air transport level.
4	Airport TMA - Network Operations	Full AOP/NOP integration in 4D including Target Times	CP1 & SESAR 3	Predictability	Strategic delay AIBT - SIBT = negative value. I.e. traffic ahead of schedule.	The main objective in air transport is "on time performance". If traffic arrives ahead of schedule <15 or <10 minutes, there is a wastage of airline resources and difficulty to manage stand allocation at airports.
4	Airport TMA - Network Operations	Full AOP/NOP integration in 4D including Target Times	CP1 & SESAR 5	Predictability	Operational cancellations	Precise information from feeding airport will improve network predictability and allow receiving airport to manage reactionary delays and reduce the number of operational cancellations
5	Systems in support of Network Operations 2029	Airport Systems evolution	CP1	Cost of investment (€)	Costs in €	The costs are incurred along the project deployment, while benefits are enjoyed at the end of the project or sometime after the project start.
5	Systems in support of Network Operations 2029	ANSPs' ATM/AIM systems evolution	CP1 & SESAR 3	CAPEX/OPEX savings € (benefit)	Cost avoidance, i.e. benefits (reduction in investments and/or OPEX) €	This is a benefit, In the CBA a cost of investment is a negative number in €, while the CAPEX/OPEX saving is a positive number accounted in the group of benefits.
5	Systems in support of Network Operations 2029	ANSPs' ATM/AIM systems evolution	CP1 & SESAR 3	Cost of investment (€)	Costs in €	The costs are incurred along the project deployment, while benefits are enjoyed at the end of the project or sometime after the project start.

5	Systems in support of Network Operations 2029	AUs FOCs and CFSPs systems evolution	CP1	Cost of investment (€)	Costs in €	The costs are incurred along the project deployment, while benefits are enjoyed at the end of the project or sometime after the project start.
5	Systems in support of Network Operations 2030	CNS evolution	SESAR 3 / NM plans	CAPEX/OPEX savings € (benefit)	Cost avoidance, i.e. benefits (reduction in investments and/or OPEX) €	This is a benefit, In the CBA a cost of investment is a negative number in €, while the CAPEX/OPEX saving is a positive number accounted in the group of benefits.
5	Systems in support of Network Operations 2029	CNS evolution	SESAR 3 / NM plans	Cost of investment (€)	Costs in €	The costs are incurred along the project deployment, while benefits are enjoyed at the end of the project or sometime after the project start.
5	Systems in support of Network Operations 2029	NM system evolution	CP1/SESAR3/NM plans	CAPEX/OPEX savings € (benefit)	Cost avoidance, i.e. benefits (reduction in investments and/or OPEX) €	This is a benefit, In the CBA a cost of investment is a negative number in €, while the CAPEX/OPEX saving is a positive number accounted in the group of benefits.
5	Systems in support of Network Operations 2029	NM system evolution	CP1/SESAR3/NM plans	Cost of investment (€)	Costs in €	The costs are incurred along the project deployment, while benefits are enjoyed at the end of the project or sometime after the project start.

Glossary of abbreviations

This Annex mainly shows the abbreviations that are specific to the Network Concept of Operations.

Other general abbreviations are can be accessed at https://www.eurocontrol.int/airial/

Term	Description
4D	4 Dimensional
4DT	4D Trajectory
A-CDM	Airport CDM
ACC	Area Control Centre
ADP	ATFCM Daily Plan
AFUA	Advanced Flexible Use of Airspace
AMAN	Arrival Management
ANSP	Air Navigation Service Provider
AO	Aircraft Operator
AOP	Airport Operations Plan
API	Arrival Planning Information
APOC	Airport Operations Centre
ASBU	Aviation System Block Upgrade
ASM	Airspace Management
ASMA	Arrival Sequencing and Metering Area
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
AU	Airspace User
AUP	Airspace Use Plan
CACD	Central Airspace and Capacity Database
CAPEX	Capital Expenditure
CBA	Cost Benefit Analyses
CDM	Collaborative Decision Making
CCO	Continuous Climb Operation
CDO	Continuous Descend Operation
CFSP	Computerised Flight plan Service Provider
CNS	Communication, Navigation, Surveillance
CTOT	Calculated Take-Off Time
DAC	Dynamic Airspace Configurations

DMA	Dynamic Mobile Area
DoC	Direction of Change
DCB	Demand Capacity Balancing
DDR	Demand Data Repository
DPI	Departure Planning Information
EAD	European AIS Database
ECAC	European Civil Aviation Conference
EC	European Commission
EPP	Extended Project Profile
eFPL	Extended Flight Plan
EATMN	European Air Traffic Management Network
FAB	Functional Airspace Block
FDPS	Flight Data Processing System
FOC	Flight Operations Centre
FPL	Flight Plan
FRA	Free Route Airspace
GAT	General Air Traffic
GBAS	Ground Based Augmentation System
HAO	Higher Altitude Operation
IFR	Instrument Flight Rules
INAP	Integrated Network-ATC Planning
KPA	Key Performance Area
KPI	Key Performance Indicator
LDACS L	Band Digital Aeronautical Communication System
NM	Network Manager
NMOC	Network Manager Operations Centre
NOP	Network Operations Plan
NSP	Network Strategy Plan
OAT	Operational Air Traffic
OPEX	Operational Expenses
OPS	Operations
OTP	On-Time Performance
PBN	Performance Based Navigation
R&D	Research and Development
RAD	Route Availability Document
REG	Regulation (European Union)
RPAS	Remotely Pilot Aircraft System
SARPs	Standards and Recommended Practises
SBAS	Satellite-Based Augmentation System
SES	Single European Sky

SESAR	SES ATM Research
SID	Standard Instrument Departure
SO	Strategic Objective
STAM	Short Term ATFCM Measures
STAR	Standard Arrival Route
SWIM	System Wide Information Management
TMA	Terminal Control Area
TP	Trajectory Prediction
TTA	Target Time of Arrival
TTO	Target Time Over
UAV	Unmanned Aircraft Vehicle
UDPP	User Driver Priority Process
UTM	Unmanned Traffic Management
UUP	Updated Airspace Use Plan
VFR	Visual Flight Rules
VPA	Variable Profile Area
WOC	Wing Operations Centre
WP	Work Package

Relevant Documentation

Network Strategy Plan 2020-2029 (NSP), approved through Commission Implementing Decision (EU) 2019/2167 of 17 December 2019

Network Performance Plan 2020-2029 (NPP), Edition mm 201x (NMB approved)

COMMISSION IMPLEMENTING REGULATION (EU) No 2021/116 of 1 February 2021 on the establishment of the Common Project one supporting the implementation of the European Air Traffic Management Master Plan

COMMISSION IMPLEMENTING REGULATION (EU) No 123/2019 of 24 January 2019 laying down detailed rules for the implementation of air traffic management (ATM) network functions and repealing Commission Regulation (EU) No 677/2011

COMMISSION IMPLEMENTING REGULATION (EU) No 317/2019 of 11 February 2019 laying down a performance and charging scheme in the single European sky and repealing Implementing Regulations (EU) No 390/2013 and (EU) No 391/2013

SESAR, *European Air Traffic Management Master Plan*, Edition x, October 201x

SESAR Concept of Operations (CONOPS 2019) edition 1, May 2019

ICAO, (draft) Performance Improvement Areas and Improvements for Block 0 (- 2013), 1 (- 2018), 2 (- 2023) and 3 (- Long Term)

ICAO, 2016-2030 Global Air Navigation Plan, Doc 9750-AN/963, Edition 5 - 2016

EUROCONTROL Airspace Architecture Study Transition Plan, 2019

EUROCONTROL Concept of Operations for NM Support to Advanced Arrival Management (as approved by NETOPS/10, 22-23 October 2014)

EUROCONTROL

SUPPORTING EUROPEAN AVIATION

www.eurocontrol.int