Opportunity for Change in Swiss Aviation

A call for prioritization and innovation

ARCS
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Disclaimer

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Winterthur, December 2020

For ARCS
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Oslo, December 2020

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Team Members

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1. Executive Summary

This report contains the ARCS/ACR strategy for an upgrade of the Swiss aviation infrastructure and all the elements needed to achieve the goals of the AVISTRAT-CH vision. This document presents a **solution for identified operational and capacitive problems.** The overall content of this strategy paper has been elaborated through desktop research and 10 executive-level interviews with subject matter experts (details in Annex 1), and then conceptualized and validated by the experienced core team.

The flow chart below shows the process levels from vision to implementation. The process steps colored in cyan are covered within this document and visualize the structure of this report.

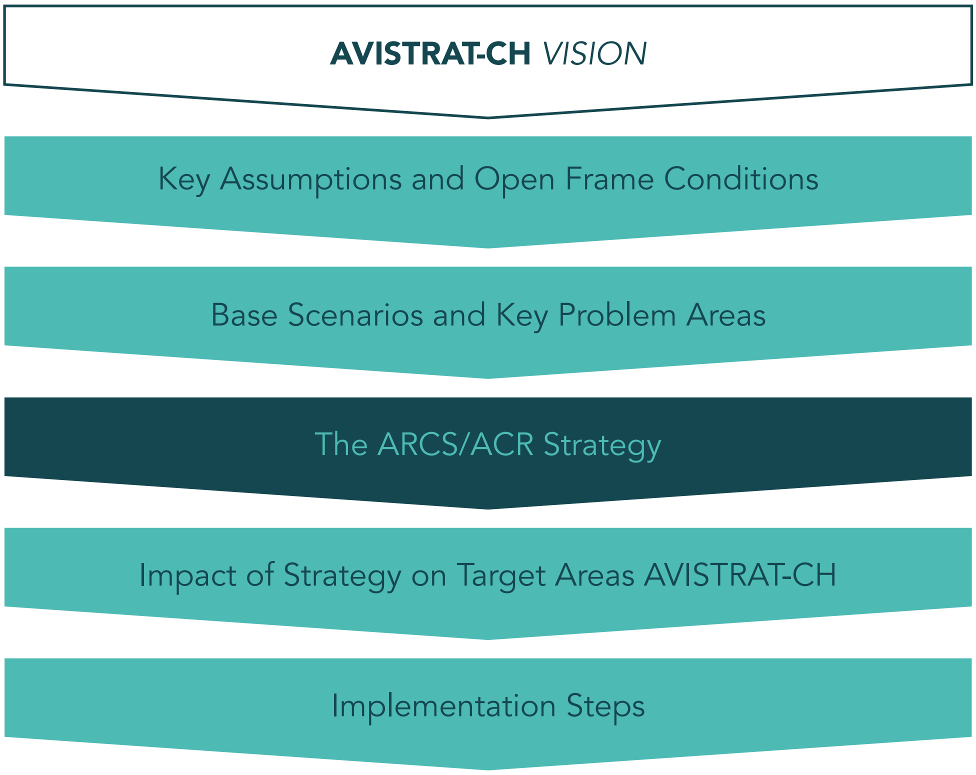


FIGURE 1: The process levels from the ACISTRAT-CH vision to implementation

The strategy is built on the assumption that while **COVID-19 will create a significant dent in the expected growth curve of the overall aviation industry, the fundamental needs and drivers for development and growth of the industry remain unchanged**. The strategy is driven by the need for **prioritization** in a saturated aviation environment and considering two observable mega-trends: **digitalization** and **environmental concerns**.These trends are attracting significant social and political attention and offer the opportunity for new and innovative solutions in the aviation fields. Some of the suggested strategic elements require R&D activities. We recommend that ARCS, together with the operators of the aviation system, be mandated to formulate a Swiss Aviation Research Plan that is administered through "Innosuisse" and **funded through the federal budget based on the intention described in LFG103**.

The key elements of the ARCS/ACR strategy for the transformation of the Swiss aviation infrastructure are condensed as follows.

Safety, Sustainability, and Security within aviation are highest-level concepts that embrace all initiatives, projects, and activities within the Swiss aviation system. These concepts are seen as brackets that form the framework within which the strategy and all the strategic elements unfold.

For the **National Airports, the prioritization of traffic and continuous optimization of existing infrastructure** are the precondition for further (but not only) qualitative growth. **Automated TMA operations**, enabled through data sharing and a **common data-pool**, integrating arrival-flows, ground operations, and departure flow, will result in a centralized TMA management as the operational silos of today are removed. **Peak-time freedoms** – temporary suspensions from limitations of the operational concept – ensure the necessary capacity, allowing for efficient hub operation in Zurich and necessary peak time capacity for Geneva.

Based on **automated data-sharing between the civil and military sides** and supported through **regulatory equality of FOCA and MAA**, airspace management processes are adjusted and the **management of the airspace becomes flexible and truly dynamic**.

The airspace is redesigned and, based on **mandatory data exchange and unique-identifier concepts** for all aerial vehicles, made easier to operate in and manage.

In the upper airspace, **digitalization and higher-level automation** are at the center of a sustainable ATM system that is fully integrated into the Single European Sky ATM architecture. **Dynamic airspace configurations** and **'capacity on demand' concepts** allow for scalability of capacity in line with the needs communicated through the network manager.

In the lower airspace, **uncontrolled airspace** is replaced by a **data-driven self-controlled airspace (DSCA)**, in which the ability to receive and transmit data is mandatory for **all users**. Over time, the airspace architecture transforms from today's airspace-buffer based philosophy towards an airspace model, where **access to any airspaces is linked to compliance with technical and operational requirements** and an adjusted licensing/certification framework.

Combined with **targeted UAS regulations**, protection of privacy, public security and critical infrastructure, as well as a reduction of noise emissions to a minimum, is assured and will positively impact societal acceptance of the new airspace users. **Dynamic geofencing** ensures that search-and-rescue and 'hot' SAF missions will always have immediate and safe access to the airspace when needed.

Dübendorf Airport, which operates a triple-use operational concept, becomes the first of several Swiss "hybrid airports" – a leading innovation hub for aviation sustainability combined with its BA concession obligation, committing to binding and measurable conditions for reducing noise and CO2 emissions (and to become CO2-neutral over time). As a hybrid airport, Dübendorf will be a testbed for R&D concepts and applied innovation in the Swiss aviation industry.

The regional airports **expand their business with the UAS customers and general aviation activities that no longer have access to the national airport infrastructure. Increased coordination and cooperation among the regional airports** can achieve scale effects in terms of procurement, marketing, yield administrative synergies and prevent duplication of efforts among the regional airports.

This is enabled by a general **empowerment of the airports** and a revised and incentive-based financing framework that distributes the user-generated fuel tax by rewarding efficiency. Transferring **CNS infrastructure/services and IP ownership of ATS Manuals to the airports** enables a selection of commercial providers.

Skyguide is transforming from an air navigation service provider into a national air navigation data and services company (ANDSC). In its changing role, skyguide's organizational and governance structure shall reflect a **distinction between regulated business and commercial business**. Regulated business contains service areas of federal interest, while commercial business includes services such as CNS, AIS, ADS, MET, and T-ANS. These services will be available and can be procured in a **commercial and competitive market**. For the regulated business, a minimum level of service shall be defined by regulation.
A fair market and correct application of procurement and tender processes requires a dedicated and independent economic regulator. For this purpose, AirCom, an independent economic regulator for aviation, will be established; this will create **a functional separation between policy and safety regulation, on one hand, and economic regulation, on the other hand.**

Even though some of the proposed strategic elements may sound visionary, it is important to state that all proposals of this target concept are **realistic on the basis of the existing European regulations for aviation**, but may be subject to supplements and/or safety assessments.

Interviews and discussions raised two specific challenges for the reformation of the current aviation landscape:

- an optimization of the regulatory and governance framework
- the needed shift from today's risk-avoidance philosophy to the application of risk-based principles across the aviation system.

Both topics require initiative and focus in order to cope with the implementation of the suggested changes.

2. Key Assumptions and Open-Frame Conditions

Prediction of future scenarios are typically composed of elements that are, at least to a certain degree, measurable and predictable and elements the development of which remains largely unknown. In order to create a basis for our proposed strategy, we have defined “key assumptions” and “open frame conditions”.

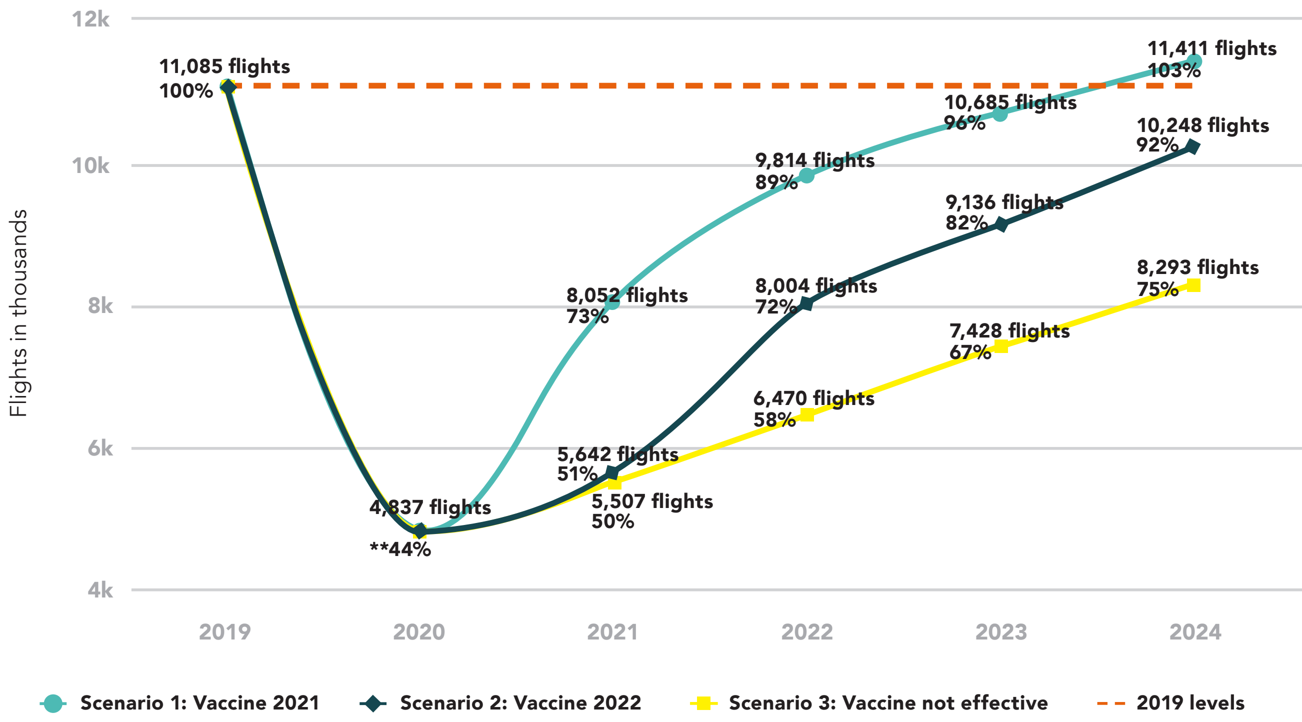
An **Assumption** is a reasonable development or a condition that is accepted as true or as reasonably certain to happen, albeit without proof that it will be.

Open Frame Conditions describe supporting structures (f. ex.: legal, societal) around which scenarios and models can be built. Open frame conditions are structures that are – at this point in time – uncertain, cannot be guessed with sufficient accuracy, but can alter the outcome of the strategic forecast.

2.1 Key Assumptions

In order to develop realistic and robust scenarios, a set of key assumptions were formulated. This section summarizes these assumptions.

- **Delayed growth development due to Covid-19:** The collapse of demand for air travel, along with the consequent decline of aviation activities-, and investments, is a reality in 2020. Avistrat, however, has a long-term perspective. In this analysis it is assumed that, although the fallout from Covid-19 will create a significant dent in the expected growth curve of the overall aviation industry, in a wider perspective, the needs and drivers for development and growth of the industry remain unchanged. To say it differently: Growth development will take place and growth targets will be reached, but later than forecasted pre-Covid 19. By when the accumulated growth will exceed the pre-Covid traffic levels depends (from today’s perspective) largely on the wide availability of a vaccine and the consequent surge in public confidence concerning air travel. As vaccines are expected to be available in 2021, Eurocontrol (2020) expects the Covid- “growth dent” to be levelled out by 2024 (see Figure 2).



*Europe = ECAC 44 Member States

**Forecast 2020 based on scenario 2

EUROCONTROL STATFOR 2020

*FIGURE 2: Traffic Forecast for *Europe 2020-2024 (Eurocontrol; 04.11.2020)*

- **No short-term adjustments to the Sachplan Infrastruktur Luftfahrt (SIL)** have been ruled out in the definition of the strategic elements. Changes to the SIL in the mid- and long run however, are considered possible. That assumption is based on the fact that the next SIL negotiation date is scheduled for 2030 and major adjustments prior to that date seem unlikely.

- **Aviation remains very important for the Swiss economy:** The overall economic contribution of the aviation sector to the Swiss economy in 2018 was approaching 35 Billion CHF (BCG, 2018). Apart from the net value creation, it is imperative to also consider the difficult-to-quantify but high value of global connectivity to the business location Switzerland (Economiesuisse, 2016). In addition, over 50% of all Swiss exports in value are transported by air freight and 38% of all the tourists coming to Switzerland enter the country by airplane (Aerosuisse, 2019).
In the context of the present study, it is assumed that growth will take place across the sector. It is assumed that an unwillingness or inability to benefit from that growth in Switzerland will not prevent industry growth itself but will rather allow neighbouring countries and regions to harvest the overall economic benefits of that growth.

- **The importance of the hub & spoke system in Zurich** is not treated in this proposal, because its importance to the general connectivity of Switzerland and its value-add to the national economy has already been proven in numerous studies (f.ex.: McKinsey, 2020).

- **Opening Hours/ Base Infrastructure of the Airports remains unchanged:** While Avistrat encourages a 'white sheet approach' and suggests not to overemphasize existing system limitations, some realism concerning possible implementation solutions must be assumed in order to make the strategy proposals realistic and implementable. We have defined following assumptions concerning the ground infrastructure and the opening hours of the airports in Switzerland:

  - Investments and improvements in the airport infrastructure are expected and encouraged, however, in the context of this study it is not assumed that new runways will be built and that significant extensions of existing runways can be done.

  - It is as well assumed that the current opening hours of – particularly the National airports ZRH/GVA – form a fixed framework within which technological, regulatory and procedural optimizations have to be done in order to meet future demand.

- **The key mission of the Air Force remains unchanged.** The mission is derived directly from Art. 58 of the Federal Constitution and Art. 1 Military Act, namely the overall responsibility for the protection of the Swiss airspace, will not change and will remain valid within the timeframe of Avistrat.

- **The shift towards a more environmental focus:** There is clearly observable societal trend towards more environmental concerns with an increasingly critical view regarding mobility needs, and this trend is attracting significant political attention. According to the Federal Office for Spatial Planning ARE, the main drivers for mobility in Switzerland typically are:

  - Population-Growth
  - Growth of Economic output (GDP)

  Within the present context, the societal focus on environmental aspects and sustainability is assumed to grow and to push for technological as well as procedural innovations. However, this trend is seen to have a strong political effect and therefore a moderating (dampening) effect on-, but not actually replace the above mobility drivers. This view is also confirmed by a recent survey by the University of St. Gallen. According to results of that study, the overwhelming majority of the participants expects long-term growth of the aviation industry and rejected regulatory restrictions of the individual mobility (CFAC-HSG, 2020).

- **International Agreements are an integral part of the strategy.** Within the context of developing the Avistrat strategic orientation, it is assumed that the key bilateral agreements with the EU will remain valid. This concerns particularly the SES legislative framework, with its 4 Basic Regulations (N° 549/2004, 550/2004, 551/2004 and 552/2004), covering the provision of air navigation services (ANS), the organisation and use of airspace and the interoperability of the European Air Traffic Management Network (EATMN). Equally, the transformation of the SES into the Digital European Sky (DES) is expected to be a development in which Switzerland will be part of.

2.2 Open-Frame Conditions

Some developments and future conditions are not possible to assume with a certain degree of probability, but can impact the way the future aviation infrastructure will be operated. This section summarizes the most relevant of these frame conditions.

- **Liability must be clarified in an automated environment:** The future aviation system will be more automated. Digitalization, data exchange and automation technology combined will play an increasingly pervasive role and the industry will evolve from a human-centric to a system-centric approach. Over time, this will result in a gradual shift from the human operator to AI driven automated systems, thereby altering the role of the human from the active, decision-making operator towards an overall process- and systems supervisor. Human intervention will only be required in extraordinary situations, comparable to the role of an aircraft pilot, that holds ultimate authority and responsibility. Such a paradigm change is crucial from a Human Factor perspective and must be supported with a major change management program.

  The pace and the degree of this evolution is, amongst others, dependent upon the legal framework and depends upon how 'liability' will be approached. In case of an incident/accident in an automated (largely verbal-communication- and interaction-free) operational environment, the question concerning the locus of liability will be central. How this liability (and related legal) questions are going to be addressed, will ultimately determine the level of automation that is going to be implemented within the timeframe relevant for this study.

- **Swiss National Transport Policies:** The development of the Swiss aviation infrastructure is driven by the needs of its users but its specific features and implementation steps are defined within a political context.
  Future Swiss Transport policies will determine how the mobility needs of society are going to be treated. Within the context of developing an aviation infrastructure, such policies can, for example, include regulations for domestic air travel and air travel on routes where high-speed rail connectivity is foreseen.
  Such higher-level transport policies will to a certain extent determine the requirements of the future aviation infrastructure but are difficult to predict today.

Unforeseen Events delay but do not stop long-term industry developments: As the Covid-19 situation demonstrates, there are unforeseen global and regional events that can impact the aviation industry and the made forecasts. In Europe, over the past 20 years, we have experienced Volcano ash, the financial crisis, 9/11 and the Swissair grounding as such unforeseen events, which delayed, but did not stop long-term industry development. Armed conflicts, a collapse of the EU or global economic downturn scenarios are just some examples of events that cannot be forecasted but would significantly impact the made predictions.

World annual traffic (trillion RPKs)

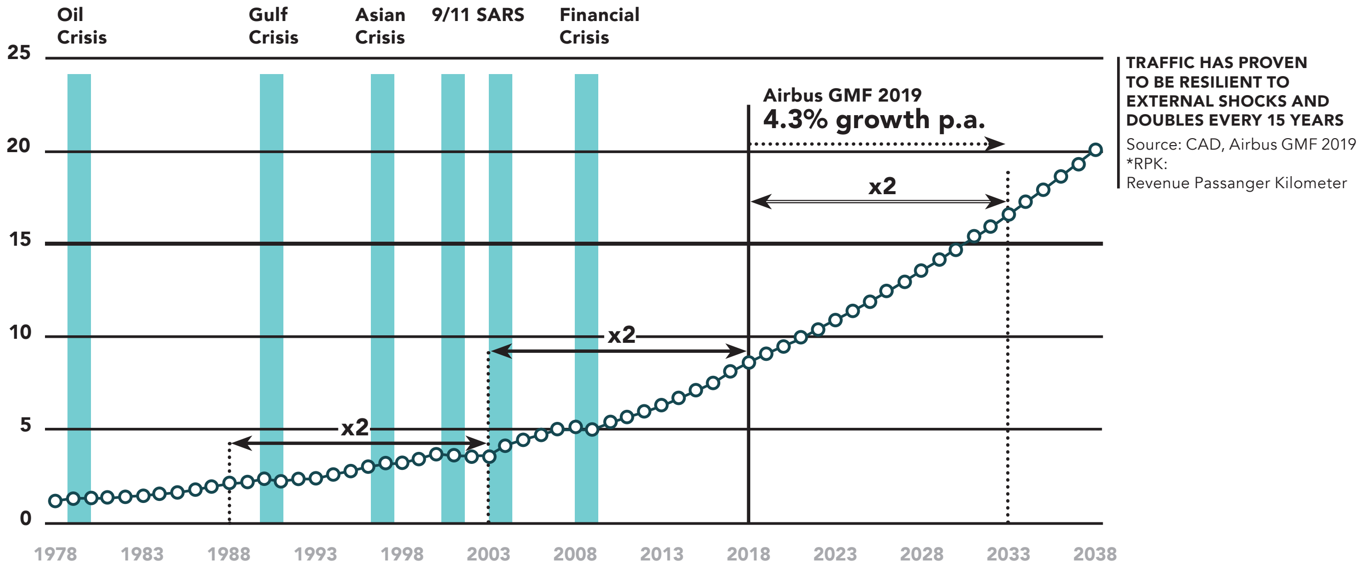


FIGURE 3: Resilience of global aviation industry to external crisis events (Airbus, 2019)


VA5624 03
NZ3436 03
MH5468 08
LX4154 03
SK8019 03
GA9450 04
VA5872 04
NZ3456 03
03
FY7322 02
SQ5604
DEPARTED
DEPARTED
GATE CLOSED
GATE CLOSED

3. Safety, Sustainability and Security

Safety, sustainability and security of the Swiss aviation system are not aspects that can be addressed with singular measures or initiatives, but must be seen as all-embracing high-level concepts that form an envelope, within which all developments and initiatives must be embedded. As such, implementation of new procedures, technologies and concepts, as described within the 21 strategic elements, must address the impact of these changes on safety, sustainability and security.

Safety

The safety of all operations in the Swiss aviation system is paramount.

All suggested changes, new technologies and operational concepts throughout this paper are assumed to be fully compliant with the EASA regulatory framework, the relevant Swiss regulatory framework and shall reflect a forthcoming just- and safety culture that exists among all stakeholders in the Swiss aviation system. Major changes shall be accompanied by dedicated change management support including Human Factors.

However: New technologies and operational concepts allow for and mandate a review of the existing safety framework. We recommend to re-assess **uniform, risk-avoidance based** target levels of safety and to adjust them to **compliant risk-based** target levels of safety. Such a review is also in line with the system requirement (no 9) as defined in the AVISTRAT-CH vision “the socially accepted level of risk in the aviation system is defined. The level of risk as well as individual risks are continually monitored”.

Furthermore, we recommend to transform towards “safety by design” - a more systemic risk management by applying risk-based principles throughout the whole life-cycle (design, implementation, operation, change and oversight) of processes, systems, data and units. Both recommendations will assure appropriate high levels of safety across the aviation system in a major changing environment, while an appropriate allocation of resources and attention is maintained.

Sustainability

Aviation has, in line with all other mass mobility industries, an environmental footprint. The reduction of all aviation related emissions and noise is not a singular goal, but represents an overarching principle for all suggested changes and improvements within the Swiss aviation infrastructure.

The high-level ambition to improve aviation sustainability and reduce its emissions in a measurable manner is a main constituent of all initiatives and projects, therefore the sustainability dimension is not portrayed as a 'problem' that can be solved but rather seen as a never-ending process.

Even so, the final section in chapter 5 contains some specifically dedicated measures and initiatives that will support in making aviation in Switzerland not only more sustainable, but aim to bringing Switzerland in the forefront of aviation innovation.

Security

The current threat and risk environment demand that aviation security remains among the highest of priorities for States and the global international community (ICAO, 2017). Aviation security usually combines human and material resources to safeguard civil aviation against unlawful interference, such as terrorism, sabotage and threats to life and property. National and European aviation security conceptions and corresponding national and European regulations have been prepared in the past years and compliance with these regulations is prerequisite for the implementation of the strategic elements discussed in chapter 5.

More digitalization and automated data exchange processes across the entire aviation landscape require a particular focus on the integrity and security of data. While this paper suggests ways to address this threat with a national solution, it is recommended that, given the international scope of the cyber security threat, measures to address data security are – where possible – addressed within an international cooperation context.

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4. Base Scenarios 2035/ 2040 and Key Problem Areas within the Swiss Aviation Infrastructure

This section contains the scenarios that shall represent the likely future evolution of the Swiss aviation system. The aim of these **Base Scenarios** is to use qualitative and quantitative data to detect and predict future system 'bottlenecks' and problem areas.

Problem areas can be described as specific operational environments, which prevent airspace users/stakeholders from obtaining the desired service level or quality. Reasons for that can, for example, be resource conflicts between stakeholders (airspace, airport capacity) or deficient infrastructure elements.

For the development of the scenarios, a number of different data sources were used[1]. In core-team workshops these data were processed, weighed and enriched with expected political, technological and/or societal events.

Finally, interviews with Subject Matter Experts (SME)[2] were used to gain both additional qualitative and quantitative information and to validate the modeled scenarios.

[1] *For a comprehensive overview on the used documentation refer to Annex 1*

[2] *For an overview on the conducted interviews with SME's, refer to Annex 1*

4.1 National Airport Scenarios

The three main airports Zurich, Basel and Geneva form a core element in the aviation infrastructure of Switzerland and their development is affecting several stakeholder groups.

4.1.1 Airport Zurich Scenario

Zurich airport (ZRH) is the largest national airport, a SWISS-operated hub connecting Switzerland with the world. The airport processed more than 31M passengers in 2018 (with approximately 280’000 movements) and is today, as part of the Lufthansa multi-hub strategy, competing with the neighbouring Star Alliance hubs MUC (Munich), VIE (Vienna) and FRA (Frankfurt) for a share of the long-haul market.
When examining growth at an airport, it is imperative to distinguish between the different performance indicators used. Growth in passenger numbers does not necessarily correlate with a growth in movements, as utilization of larger airframes and yield management strategies increasing the seat-load factor need to be considered as well.

Zurich Airport has a runway layout and an operational concept that creates numerous operational dependencies (such as: crossing runways, SID/STAR layout) and is – from a capacitive perspective – inefficiently operated. The treaty between Germany and Switzerland regulating the airspace usage around Zurich airport and noise abatement procedures cripple the theoretically available capacity throughout the day and especially during peak hours.
Furthermore, deviations from the optimal-capacity runway concept due to wind, visibility or runway unavailability introduce additional capacitive vulnerabilities to an already fragile operational framework. This leads to a situation where made delays can usually not be regained and are carried along for the rest of the day. According Eurocontrol (2018), 34% of all Swiss (LX) flights operating out of ZRH were delayed in 2018. An increase in movements at ZRH is expected to accentuate the shortage of capacity and lead to an increase in delays. In the longer perspective, such a development is threatening the role of ZRH as a national and as a Star Alliance hub.

The figure below presents the bandwidth of the expected growth of movements and passengers at Zurich airport and has factored-in the Covid-19 induced dent (and consequent delay of growth).

Passenger and movement history and forecast @ ZRH

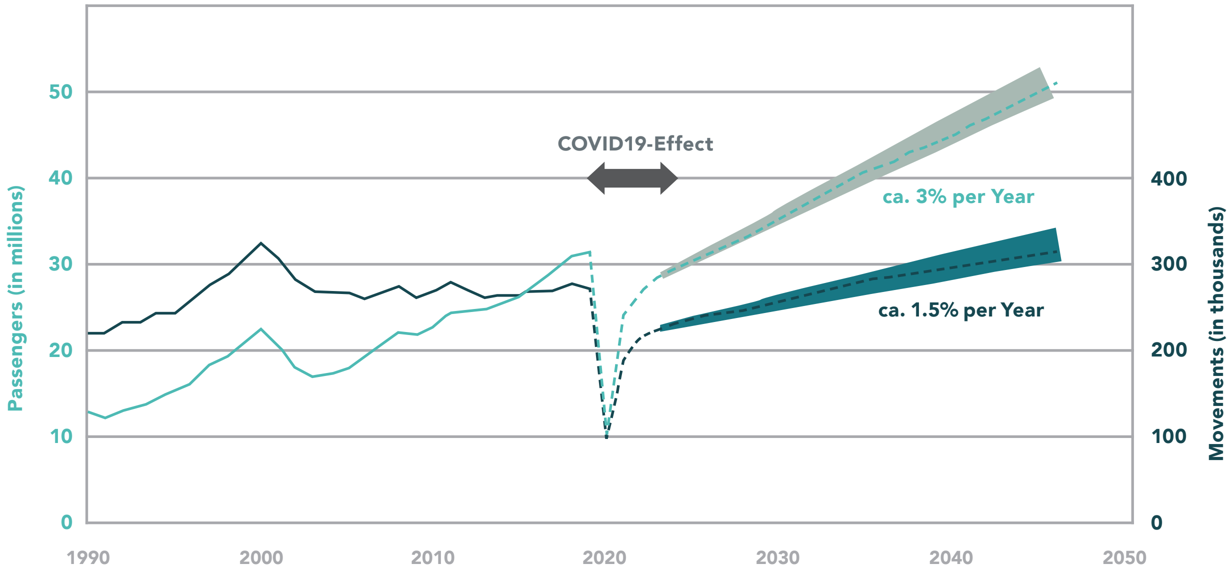

FIGURE 4: Expected growth in passengers and movement at Zurich Airport (Zurich Airport, 2020)

In this current analysis from Zurich Airport, the COVID-19 dent in growth postpones the growth as forecasted by Intraplan (2015) and EUROCONTROL (2018) by approximately 5 years[3].

While the projected movement growth at ZRH for the reference period (until around 2040) lies at around 10-15% in average compared to the 2019 numbers, the required growth in capacity for peak times lies between 20%-30% to ensure a robust operation with minimized environmental impact. This difference is based in the hub & spoke operational concept of ZRH, which requires over proportional capacity during the critical peak hours, to enable a functioning wave concept. The paradox is that even in overall low traffic situations, the capacity of the peak times remains very important in order to ensure a robust operation and improve the efficiency of the hub & spoke system.

Based on SWISS forecasts for fleet development and expansions in their route network, and because of the limitations of the existing airport infrastructure, growth will predominately, but not solely, be of qualitative nature:

- more robustness in all weather conditions and in peak times,
- optimization of ARR-DEP processes as well as ground processes during opening hours,
- predictability of overall network operations.

[3] These global and regional industry growth forecast predict an average annual growth between 1,5% and 2% for Central Europe and ZRH.

However, limited growth opportunities due to the mentioned constraints might endanger the competitiveness of Zurich and especially its hub function (limited feeder traffic for long range operations) over time. This effect can already be observed as Zurich's growth since 2000 has been lower than the benchmark 'competitor's' growth. Munich, as the closest 'competitor' serves as a good example to illustrate this growth pace difference. While MUC and ZRH both processed 23M PAX in 2000, MUC has grown 108% to 48M Pax in 2019 while ZRH grew by 36% to 31.5M Pax in the same time (Munich Airport, 2020). From a macroeconomic perspective, this inability to grow is expected to negatively impact the overall competitiveness of Switzerland. This report does **not** recommend align the growth linearly in line with the global aviation industry, but to ensure the availability of long-term capacity for the competitiveness of ZRH, the region and ultimately the Swiss economy.

A general characteristic feature of mobility systems is the management of peaks. In hub-airport operations with long-haul flights, independent of overall demand, the timely management of peaks is of key importance to the management of long-haul operations. Unlike to other mobility systems there are very limited possibilities to flatten peaks in a hub & spoke system.

In the current operational framework, general aviation, business aviation and scheduled service as charter traffic co-exist. With the projected qualitative growth of the overall traffic in ZRH the following problem areas (PA) can therefore be expected:

PA 1: Robustness of Operations at ZRH:

With the expected increase in traffic, it will become increasingly difficult to operate ZRH as a National hub. Measures are required so as to increase the robustness of the operations in all-weather conditions and peak times within the limitations of the existing opening hours.

Missing robustness and reliability of ZRH operations will threaten its role as hub and the economic growth of the sector, the region and ultimately the Swiss economy.

PA 2: Capacity of ZRH:

With the existing operational concept and a politically determined operational framework, ZRH has has exceeded its capacity limitations at peak times.

To enable a robust and sustainable operation with the predicted moderate growth and given the current framework concerning main infrastructure and opening hours, the peak capacity of ZRH must be designed for a 20-30% movement capacity increase.

4.1.2 Airport Geneva Scenario

Geneva Airport (GVA) is the second largest National airport of Switzerland that has a business model quite different from the one of Zurich Airport. In a matter of fact, Geneva Airport is a point-to-point airport, connecting mainly the west part of Switzerland and a part of France to a high number of European cities and but also to some intercontinental airports, mainly on the East coast of the United Stated and in the middle East Region and more recently Africa. The airport processed around 18M passengers in 2019 (with approximately 186'000 movements).
It is important to highlight that the growth of passenger numbers does not necessarily correlate with a growth in aircraft movements, as the use of larger airframes and yield management strategies increasing the seat-load factors need to be considered as well. For a couple of years, GVA is experiencing this trend where aircraft movements are stabilizing despite the fact that the number of passengers is increasing.

GVA's single runway is under pressure mainly during winter season weekends and at several peak hours during the day. However, Geneva Airport in corporation with Skyguide has developed infrastructures and processes in order to allow a high ratio of performance of this single runaway. The result of this diverging evolution is that bottlenecks are now shifting from airside to landside infrastructure.
The main focus will address the challenges concerning the main terminal, built in 1968, which will have to be remodelled and consider new technologies and concepts in order to gain efficiency in the different processes (such as: check-In, security) and to improve the quality of the service delivered to passengers.

In 2019, Geneva Airport produced internally its long-term passenger forecast. This forecast was based on the elasticity of socio-economic factors (Swiss GDP, population of the catchment area and ticket price) combined with the historical GVA traffic. The figure below presents the passenger volume forecast until 2030. In order to consider, the important uncertainties regarding the aviation evolution (such as flight shame or new taxes), Geneva Airport has built three scenarios using the variables mentioned above in different proportions for commercial and general aviation. Due to the maturity of the existing network, the growth will focus on optimizing the connections with European hubs and other important European destinations and increasing the number of intercontinental flights selectively.

Passenger history and forecast @ GVA

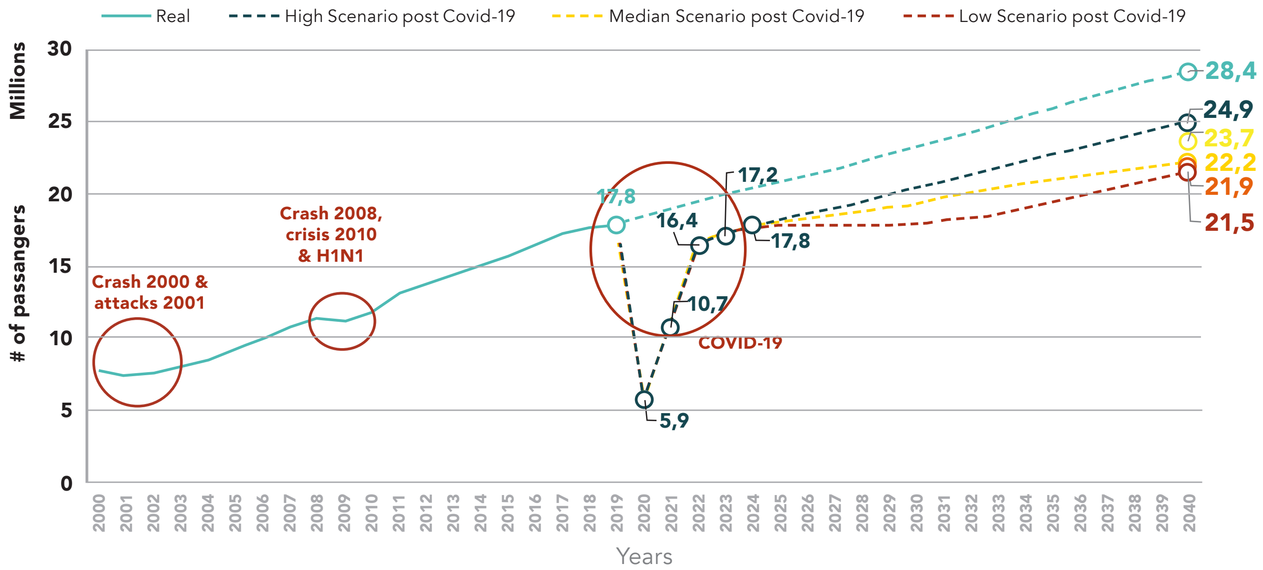

FIGURE 5: Geneva airport historical and forecasted passenger volumes [Mpax/year] (Geneva Airport, 2020)

The following figure presents the aircraft movement forecasts for 2040. As for the current situation described above, the growth of passenger numbers will not correlate with an identical growth in aircraft movements. Thus, the passenger growth rate is between 1,0% and 2,2% whereas the movement growth rate is estimated around -0,1% and 0,9%.

Movement history and forecast @ GVA

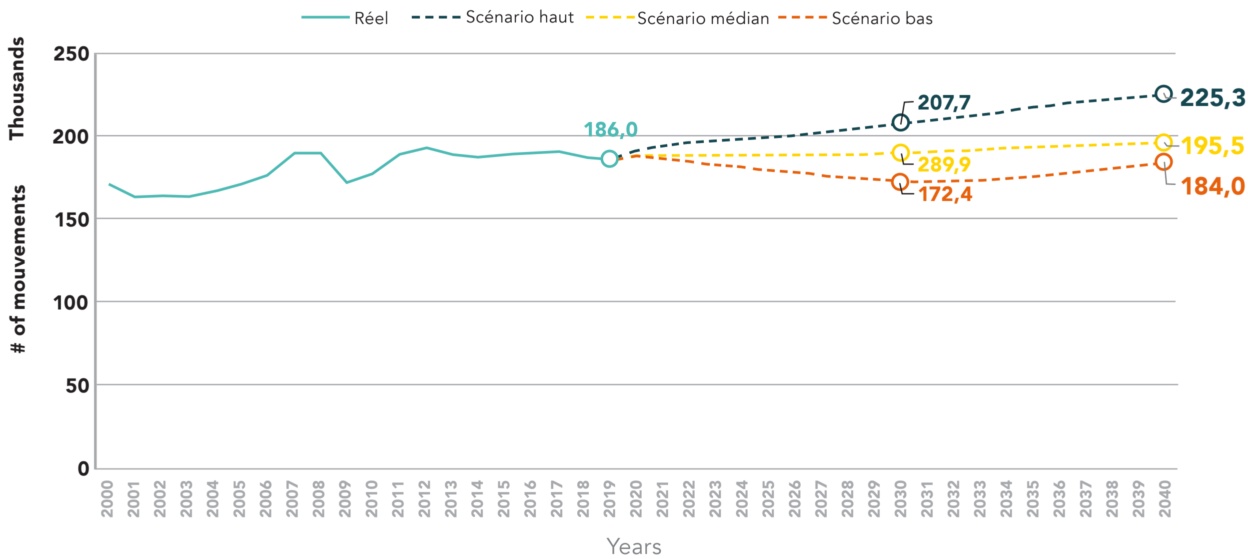

FIGURE 6: Geneva airport historical and forecasted aircraft movement volumes [Kmvt/year] (Geneva Airport, 2020)

The two challenges Geneva Airport will have to face in the future will be to maintain its aging existing facilities and to develop extra capacity for the terminal while operating the airport's most important bottlenecks.

Finally, it is of utmost importance to keep in mind that Geneva Airport development will have to be done within the framework defined in the PSIA (Plan Sectoriel de l'Infrastructure Aéronautique which is an agreement between the confederation, the Canton of Geneva and the Airport) and especially in respect of the officially agreed noise footprint.

PA 3: Capacity of GVA:

Around 2030 the passenger capacity barrier will be met and the movement barrier will be reached in the peaks assuming the existing operational concept with the current landside limitations.

The future peak capacity of GVA should be allowed to grow (in passengers and movements) in line with the expected European capacity demand (up to 20% for movements and up to 40% for passengers by 2040).*

GVA must be able to invest in the general upgrade of the landside infrastructures and the operational process improvements otherwise this growth cannot be accommodated.

** in line with the EUROCONTROL (2018) and Geneva Airport (2020) forecasts quantifying expected growth*

4.1.3 Airport Basel-Mulhouse Scenario

Compared with the ZRH and GVA, Basel Airport (BSL) has, comparatively, less capacity challenges. In 2019 BSL processed 9.5M Pax and the pre Covid forecast for 2035 was at 15M Pax. This number has, in the meantime, been readjusted to somewhere between 11.8 and 13.7M Pax (depending on the scenario).
With its long single runway and a current hourly max capacity of 34 movements, the forecasted growth will – airside – not require additional capacity.
Landside, the terminal capacity will need to be expanded to cater for the expected growth.
As BSL lies at the interface of 3 adjacent FIR's and ANSP's (DSNA, skyguide, DFS), the ATC procedures that connect BSL with the European Route network are coordination intensive and the limiting factor for the on-time performance of BSL lies predominantly in the adjacent airspaces.

PA 4: Missing harmonization of cross border operations

Basel and the other Swiss national airports are operating on or very close to the national borders. Missing harmonization of the regulatory framework and unnecessary operational complexity due to missing or unfavourable cross-border agreements or missing interface harmonization impact negatively on seamless operations and have a negative impact on capacity.

4.2 Airspace Scenario for the Air Force

The mission of the Swiss Air Force (SAF) to police and protect the Swiss airspace will not change. In line with that, the requirements of the Swiss Air Force will not fundamentally change. As regards the Swiss aviation infrastructure, Swiss Air Force is to have unrestricted and immediate access to all airspace, when needed.

However, some significant changes can be anticipated, compared to today's operational model. The number of today's 8000 flying hours of the Air Force (1000 outside Switzerland) is likely to be reduced to around 6500 flying hours (2000 outside Switzerland). However, the lower number of flying hours will be compensated by increased demands to the volume and allocation of airspace. Today's airspace allocation process is cumbersome and lacks the dynamics required for an effective mission execution. This relates to the time periods to access the airspace itself and concerns, as well, the static airspace dimensions, where no flexibility concerning vertical or horizontal extension is possible.
The airspace reservation systems of the Air Force and the Civil ATM system do not automatically exchange necessary data, a requirement for a more dynamic management of these airspaces.

In the lower airspace, Air Force needs are likely to develop towards more flexibility (cross utilization of the civil infrastructure and partial utilization of retired bases) and all-weather missions with sensor-based navigation support, allowing helicopters and unmanned aerial vehicles to fly missions along topographic silhouettes in low- and no visibility environments. In order to achieve these goals, a real-time representation of the status of the airspaces and all its users will be necessary.

PA 5: Flexibility and dynamism in the allocation and management of airspace

While there is a long-term trend of the Air Force to reduce the number of flight hours in Switzerland by a third and the mission waves from today 4 down to 3, the accessibility, the volume and the static nature of the designated airspaces have to be improved for an effective execution of the Air Force mission.

Airspace sharing with the civil user side needs to become more demand driven and dynamic in exchange of less overall utilization time.

PA 6: Priority in lower and uncontrolled airspaces during hot missions

The Air Force mission to protect and police the airspace requires unrestricted and safe access to all airspaces when needed. In lower and uncontrolled airspaces, where an increasing amount of new airspace users will be operating, safe 'see and avoid' procedures need to be in place.

4.3 Airspace (and new Users) Scenario

The airspace structure in Switzerland has been adjusted, re-adjusted and finetuned to accommodate the changing user needs. Through this evolution, the airspace structure has become very complicated to operate and manage. Airspace is a limited resource and to accommodate all user needs in the current structures has shown to be increasingly challenging and sometimes impossible.

The key principles of today's airspace organisation are a distinction between controlled and uncontrolled airspace and a philosophy of segregation of airspaces for the different user groups. Such a physical separation of airspaces is necessary as there is no data exchange between users, with the exception of safety nets like TCAS[4] or FLARM[5] . This limits the ability to identify or visualize airspace users to one another and to enable effective 'see & avoid'.

This absence of widespread digitalized data usage within the airspace requires an airspace architecture with built-in airspace buffers that serve as 'safety-cushions'. While airspace buffer architecture achieves the safety purpose, it is – from an operational perspective – an inefficient way to manage the airspace, as large areas of this limited resource are in fact not utilized.

With the entrance of new airspace user groups and air mobility concepts, a more efficient and less complex structure for the airspace is needed to enable all the airspace users to access and operate in their desired airspaces safely.

PA 7: Complexity in airspace structure

Today's airspace structure in general, and the TMA's around the national airports in particular, are very complex to operate in and manage.

Without changes in the airspace organization and operating philosophies, many user-groups will be unable to access and operate in their airspaces as desired.

Unmanned Aircraft Systems (UAS) offer new capabilities in the fields of safety and security, search and rescue, surveillance, infrastructure inspections, logistics, and mapping.

Switzerland is called the "Homes of Drones" due to the large number of 'start-up' companies originating from the Universities and encouraged by FOCA. For example: The Swiss Post in collaboration with the US company Matternet, is already transporting blood samples in Lugano and Zurich, which demonstrates the flexibility, eco-friendliness and a road-traffic independent way to deliver urgent goods and add true value for customers and patients.

[4] TCAS: (or ACAS) stands for Traffic Collision Avoidance System and belongs to a family of airborne devices that function independently of the ground-based air traffic control (ATC) system, and provide collision avoidance protection for a broad spectrum of aircraft types.

[5] FLARM (an acronym based on 'flight alarm') is the proprietary name for an electronic device which is in use as a means of alerting pilots of small aircraft, particularly gliders, to potential collisions with other aircraft which are similarly equipped.

The use of UAS will create significant benefits for society and social welfare. The EU Drone Outlook study presented in 2016 sees a big demand for the drone services in excess of EUR 10 billion annually, by 2035. While such a prediction seems optimistic today, there is general agreement that this sector will experience continuous growth. For Switzerland, the most promising applications of drones are in medicine, search and rescue, surveillance, maintenance and construction. The Swiss drone market is estimated to have an annual growth rate of (CAGR) of 17% over next 10 years.
The drone business will have its future in Operations Beyond Visual Line of Sight (BVLOS) which require autonomous technology. For this business to develop a legal framework and industrial standards are key. The new EU regulation for Unmanned Aircraft Systems (EU) 2019/947 and EU 2019/945 will provide the basis for the future of drones in Europe.

UASs operate in all airspace segments. This calls for two actions:

- Re-definition of the controlled airspace (basically everywhere in Switzerland) and
- inclusion of all UASs/manned vehicles operating in this airspace (e.g. "Modellflieger", VFR, gliders, balloons, toy drones etc.) in the new operational concept.

Driven by increasing urbanization, and road traffic congestion, new Urban Air Mobility (UAM) Concepts are being developed. The ambition is to transport and locally fine-distribute persons and goods by flying over urban areas. Several studies assume that close to 100'000 passenger drones could be in service worldwide by 2050. Although Switzerland has an excellent public transport infrastructure, the Swiss Federal Railway Company SBB has already presented visions for future transport using UAM concepts. Therefore, for Switzerland UAM concepts show most promising potential in search and rescue, surveillance, but also affluent customers and special goods transport. Such an application will provide benefits due to both: lower operating cost (electrical or hybrid propulsion) compared to the classical helicopters and more environmentally friendly operations.

The demand of UAS and Urban Air Mobility in the entire airspace highlights the critical nature of air traffic management. Switzerland has taken the lead in Europe when it comes to the introduction of a service for Unmanned Traffic Management, called Swiss U-Space Implementation initiative. A first prototype was tested in the area of the Geneva Airport and the plan is to roll out the U-Space concept in the coming years in across all airspaces in Switzerland. U-Space also provides new services in an open market for weather data, obstacles data base, no fly zones, etc. These services, apart from the technical standards, are key elements for the commercial success of these new airspace user group.

The implementation of the Swiss U-Space services requires a common and reliable reference model that is sufficiently robust to encourage investments, plan new operations and create jobs, hence the creation by FOCA and industry of the Swiss U-Space Implementation (SUSI) as public private partnership.

A critical element in the introduction of UAS is public acceptance. Concerns regarding safety, security, privacy and noise are likely to be reflected in a regulatory framework that will protect critical infrastructure and sensitive areas as well as defines licencing, certification and operations criteria.

PA 8: Safe integration of new airspace users into the aviation system

The number of new airspace users and the types of applications for UAS and manned aerial systems create concerns for the safety of operations in uncontrolled and controlled airspaces.

At the same time, public concerns regarding security, privacy and noise are increasing.

How can all these users /concepts co-exist with the legacy airspace users in a safe way without limiting each other?

4.4 Business Aviation Scenario

The global business aviation (BA) industry is likely to experience moderate growth going forward, as demand for private and secure executive travel increases. In Switzerland the growth of business aviation has averaged at 0.4%/year over the past decade and there is no indication that this moderate growth pace will increase significantly in the long term[6].

The BA segment is confronted with a reputation dilemma. In the public and political perception, BA partially associated with pollution/noise, and is sometimes seen as 'rich people's privilege'. In fact, BA enables fast and direct connectivity to business locations which are not offered in the network of the Swiss airports. The value-add for the Swiss economy has increased and will increase further (LUPO, 2016).

The density of corporations operating internationally in Switzerland is 5 times higher than the EU average (BCG, 2018) and highlights the importance of the business location Switzerland, with the main business hubs in the greater areas of Geneva and Zurich. As business aviation requires closeness to where business is taking place, the main pressure for capacity will therefore be met in the regions of Geneva and Zurich.

As the national airports (see 4.1) are expected to meet capacity limits in the future, the accumulated growth of BA, will accentuate the capacity problem in these two business regions. This concerns overall airport accessibility for BA and, especially, accessibility during peak hours.[7]

The basic infrastructure required to successfully operate the BA business and operational models includes access to the same operational framework as scheduled air traffic. This also includes airport opening hours allowing for the BA business model to work and a navigational

[6] In 2020, during the Covid-19 pandemic, BA traffic on some regional AD (for example: Engadin Airport) grew over-proportionally.

[7] A quantitative decline of this traffic segment through an increased application Urban Air Mobility and UAS concepts seems unlikely, as these concepts are predominantly addressing the local distribution of goods and people and to a lesser degree concern international connectivity needed in the BA context (for the time frame of this study).

base infrastructure that makes arrivals into airport plannable and robust (ILS/GNSS/SBAS).

PA 9: Airport capacity for Business Aviation

With the expected growth of both the scheduled air traffic and the BA traffic, there are and will be capacitive bottlenecks at the national airports first in peak times, and later over extended periods of the day.

These bottlenecks concern mainly access to ZRH and will manifest themselves in GVA only at a later stage (around 2030-2035).

The limited capacity will have a negative impact on the business location Switzerland and limit its overall global connectivity.

4.5 General aviation and Regional Airport Scenario

The General Aviation (GA) segment includes all the airspace users' others than scheduled services, charter flights and Military flights. Of the annual 1.4 million aircraft movements in Switzerland, the GA is responsible for around 800'000 (KMU Factsheet, 2018). The GA with all the schooling and sport activities forms the fundament of the aviation in Switzerland. Its main activities happen around the 54 airfields and regional airports that form a tight network covering the country and allowing access to all regions.

Airspace is a limited resource and with the expected growth of scheduled traffic at the national airports, GA activities will no longer have access to these airports. The need for additional capacity at the national airports does not only impact actual utilization of the airport for the GA segment, but will also have an effect on the general airspace usage around the airport.

PA 10: General Aviation access to airports and airspaces

With the increase of traffic in ZRH and GVA, GA will no longer be able to access these airports.

Similarly, in today's airspace structure that is built on a "buffer-philosophy", access to airspace for GA activities, particularly around the busier TMA's, will become increasingly difficult.

Switzerland has a network of airports and airfields that cover the country and allow access to all regions and provide the infrastructure for GA activities. From these 54 units, 10 have the status of regional airports (REG AD). The REG AD are a core part of today's aviation infrastructure even if their significance concerning regional connectivity is limited. They must be seen as part of the national emergency and readiness infrastructure and are home to GA- and schooling activities that are at the fundament of the Swiss aviation system. The REG AD today suffer from an absence of a robust financing framework and high ANS costs, which they are unable to influence.

PA 11: Financing of the Regional Airports

Today, there is no robust framework for the provision of ANS on regional airports. In terms of finances, all regional airports are depending on an insecure fund distribution collected through the dedicated aviation fuel charge.

Attempts to define a more sustainable framework in the past have not succeeded.

4.6 Efficient and secure Data Exchange and Digitalization Scenario

For the future of aviation, the exchange of an increasingly large amount of data between all participants is of paramount importance in several areas.
However, already today, the available frequency spectrum is a scarce resource making the implementation of new data services a difficult task. Complex frequency coordination on a continental and global scale is required and parts of the spectrum are already today used to the maximum (e.g. the over-interrogation issues in Europe for secondary surveillance radars) in airborne applications. Future applications, such as unmanned vehicles, require additional spectrum for their operations that must be available and secured. Due to its scarcity, spectrum needs to be continuously defended against new and other users with a desire to operate in frequency spectra allocated or adjacent to those allocated to aviation and protected against intentional and unintentional interference.

On the ground today, different systems between different ANSP make data exchange inefficient in many cases and sometimes even impossible. A variety of different systems (terrestrial, mobile and satellite-based) are in use, supporting a variety of different use cases with varying degrees of coverage, integrity and communication performance.

Efficient structures for data exchange are a challenge. A distinction must be made between the different groups that are sharing data with each other:

a) Between aerial vehicles:

Large commercial air traffic data exchange between aircraft is an investment that needs to be made by airlines and aircraft operators in general. Once made, tasks, such as improved collision avoidance by improved trajectory sharing and processing could be delegated to

the aircraft and flight crews, e.g. for aircraft following one another. As a general rule all manned objects in the air should be equipped with collision avoidance systems that have the ability to communicate with one another.
On the side of unmanned operations, data exchange for autonomous collision avoidance is an essential component of safe operations. While it is currently envisioned that most of the traffic will not yet operate fully autonomously, such operations should be considered for future scenarios.

b Between aerial vehicles and the ground:

In addition to conventional VHF voice communication, data between aircraft and ground are increasingly shared via data links reducing the amount of voice communications and rationalizing the use of the available VHF communication channels. Data exchange is largely based on new digital data links, that allow for substantial data capacity, as well as authentication and potentially encryption of the transmitted data. This enables the sharing of up-to-date aeronautical information in real-time (e.g. airspace status information for trajectory planning, safety and security relevant aeronautical information and meteorological information for optimized weather avoidance and potential ATFCM measures that influence mission planning).
For unmanned operations, datalink is an essential component to ensure a safe and secure command and control. Especially for low flying altitudes, sufficient coverage in the intended area of operation must be ensured. The requirements such operation must fulfil in the future airspace may largely depend upon the capability for timely control and intervention of operators to ensure a necessary level of control for safe operations.

c Between different players on the ground:

Data between different ANSPs, the airports, the Network Manager and airspace users are shared based on the principles of System Wide Information Management (SWIM)[8] in standardized exchange models and via secure communication infrastructure in support of efficient and safe operations. This is a required step towards a more flexible control of the airspace and enhanced traffic flow management on a continental scale, but also an enabler for unmanned regional operations and their integration into the ATM concept for regional operations that may or may not affect higher airspace.

Skyguide is a European first-mover in regard to digital concepts for ATM applications and has already implemented first steps in this direction. However, the European regulatory environment is currently preventing faster implementation. Federal R&D support for digitalisation in ATM is non-existent in Switzerland, even though article 103b of the LFG – a mechanism designed to fund R&D in the Swiss aviation system - has been adopted by the parliamentary vote in (2010)[9].

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[8] *The System Wide Information Management (SWIM) concept consists of standards, infrastructure and governance enabling the management of ATM related information and its exchange between qualified parties via interoperable services (ICAO Doc.10039)*

[9] *Art 103b of the LFG states: Der Bund fördert die Aus- und Weiterbildung sowie Forschung und Entwicklung neuer Technologien im Bereich der verschiedenen Sparten der Luftfahrt.*

PA 12: Missing support structures for increased digitalization

Digitalized processes will increase safety and efficiency and enable more sustainable operational concepts and must therefore be considered to be a quantum leap in the development of aviation technology.

However, the implementation of digital concepts is very slow and further hindered by lack of political interest, guidance and support. The regulatory framework reacts only very slowly to new developments.

PA 13: Digitalization and Data Exchange/Spectrum Capacity

With the increase of airspace users and increased digitalization, the capacity for data exchange between the individual stakeholders becomes a critical element in the overall aviation infrastructure. Spectrum capacity is already limited and further capacity will be required to accommodate for all airspace users.

Data integrity will be of key importance for the networked applications, such as SWIM. An authentication process for relevant data will be required to ensure harmful tampering with information is avoided so as to assure that only approved users will be able to access these data.

In addition to securing data integrity, also the technology itself needs to provide for improved security, e.g. by providing the necessary additional capacity in data links for authentication and/or encryption.

PA 14: Data Security and Integrity Monitoring Problems

Automated processes enabling digital data sharing between airspace users will require protection assurance of all data against unauthorized access or corruption and risk-based assurance validity and accuracy of the data.

The described ongoing and accelerating digitalization and increased networking and information sharing, new potential threat scenarios in terms of cyber security become apparent, affecting different areas of the envisioned ATM scenarios and hardware of airspace users.

Data integrity will be of key importance for the networked applications, such as System Wide Information Management (SWIM: consists of standards, infrastructure and governance enabling the management of ATM-related information). An authentication process for relevant data will be required to ensure harmful tampering with information is avoided so as to assure that only approved users will be able to access these data.

In addition to securing data integrity, also the technology itself needs to provide for improved security, e.g. by providing the necessary additional capacity in data links for authentication and/or encryption.

Navigation and surveillance are largely based on the use of satellite navigation. GNSS signals are, however, prone to interference due to the extremely low power of the signals. Appropriate protection of the spectrum from any other users is therefore highly important. In general, all CNS technologies should provide a primary and a secondary means of operation, that are independent from one another to provide proper redundancy and from an operational perspective and very different attack vectors from a system perspective.

From a security standpoint it should be recognized that vulnerabilities are inherent, and they may be exploited at a certain point in time. All parts of the networks must therefore assure risk-based protection measures but also contain sufficient emergency response capabilities to handle such situations with the least possible impact on operations and means for quick recovery.

PA 15: Cyber Security protection

Digitalization and increased data exchange processes within the aviation system will require cyber security and resilience built in "by design", in order to protect work flows, computers, servers, electronic systems, networks and data from intended malicious attacks.

4.7 Organizational and Governance Scenario

The transformation of the Swiss Airspace infrastructure to the target model 2035+, which can satisfy the user needs and utilize new technology most efficiently, does not only require technology and concepts but must be supported by a stakeholder landscape and a governance framework, which enables decision-making and implementation.

In recent years, many programs and initiatives have, in absence of a decision-making authority and an overall fragmented decision making, stalled. The current aviation governance is further complicated by blurred lines of 'ownership', responsibility and a monopoly provision of infrastructure and services. This can, for example, be seen in the airport landscape, where skyguide not only provides the service and determines the service level, but also owns the technical infrastructure to provide the service.

The target model for the future Swiss aviation infrastructure will need adjustments in the governance architecture and the decision authority matrix in order to be able to realize the necessary changes within the time frame of AVISTRAT-CH. Comparing the governance of other network industries in Switzerland (postal services, railway, communication and electricity), it shows that aviation today is the sole industry that is regulated in a different manner.

PA 16: Governance of the Swiss aviation

Today's organizational and regulatory set-up and its governance require adjustments to cope with the implementation of the changes required for the future aviation infrastructure target model and to align the governance model with other Swiss network industries.

4.8 Summary of the Problem Areas

The development of the main strategic orientation must achieve multiple goals. It must acknowledge the assumptions concerning the development of the industry and the open framework conditions, it must address and provide solutions for the detected Problem Areas and it must be based on the overall AVISTRAT-CH vision. A total of 16 problem areas have been identified and they are summarized in the table 1 (below). The next chapter contains the strategic elements that need to be in place in order to address these problem areas in the future.

Problem Area Title

1	Robustness of Operation at ZRH
2	Capacity of ZRH
3	Capacity of GVA
4	Missing harmonization of cross border operations
5	Flexibility and Dynamism in allocation and management of Airspace
6	Priority in lower and uncontrolled airspaces during hot missions
7	Complexity in airspace structure
8	Safe integration of new airspace users into the aviation system
9	Airport Capacity for Business Aviation
10	General Aviation access to airports and airspaces
11	Financing of the regional airports
12	Missing support structures for increased digitalization
13	Digitalization and Data Exchange/Spectrum Capacity
14	Data Security and Integrity Monitoring Problems
15	Cyber Security protection
16	Governance of the Swiss aviation

TABLE 1: Summary of detected Problem Areas[10] in the current aviation infrastructure

[10] *The sequence of the PA's does not indicate a priority or a sequence of urgency of the PAs*

5. Proposed Strategy for the Development of the Swiss Aviation Infrastructure

This section contains the strategic orientation for the development of the future Swiss Aviation infrastructure. Before describing the specific strategic dimensions and their elements in more detail, we will outline what **the target concept** for the Swiss aviation infrastructure for 2035 and beyond should be, as seen from the user's perspective.

The Swiss airspace is a central and fully integrated piece of the European Airspace architecture and the regulatory framework in Switzerland is in line with EU regulations.

The cockpit crew of a flight approaching any of the national airports today receives positive speed control outside the Swiss airspace as the arrival managers (AMANs) are extended into the cruising levels, in order to ensure a seamless arrival at the destination airport. At the top of descent, datalink (CPDLC) clearances guide the aircraft safely towards the active landing runway, while the pilots monitor the traffic situation around them in real time on their ADS-B screens, and are thus provided with full situational awareness.

Based on the weight of the specific flight today and the runway conditions, a displaced threshold landing clearance is issued to the aircraft, which is precisely guided by augmented GNSS signals, to minimize the runway occupancy time. Airport services, air navigation services, and all the services connected to the aircraft contribute to the flight "just in time" working in the same process environment with the same set of data from a common data pool. While the passengers exit the aircraft, the departure, runway, clearance, and expected departure time have already been calculated thanks to the data pool and automatically communicated to the flight deck and coordinated with the network manager. The next flight has already begun.

Meanwhile, on the day of the operation, the airspace management cell allocating the airspace assesses the actual weather and wind data. Based on the current day's weather and wind conditions, the training area for the Swiss Air Force fighters needs to be extended. The SAF request is entered in the common airspace reservation system and the airspace request with expected dimensions of the training area is entered in the central database of the network manager in Brussels. Based on the planned traffic flows across Europe that day, all flights on a route affected by the Air Force mission immediately receive a re-routing that minimizes extra miles onto their trajectory.

As the end of the successful interception mission is approaching, the SAF releases the airspace back to the civil side with the push of a button and, within minutes, civil airliners again cruise safely through the previous mission area.

The regional airports have developed towards regional mobility hubs, where UAS activities are coordinated and the GA community finds space for training and sports activities. Some of the regional airports have teamed up into a common marketing and purchasing group, benefiting from scale effects by purchasing services together and by operating a regional airline network together.

In addition to the SAF missions, Dübendorf Airport is operating business aviation flights based on a concession linked with an obligation and binding targets to reduce emissions measurably over time. This "hybrid concept," a name that stems from its dual use of traditional and alternative propulsions and fuels, is successfully transforming Dübendorf into the leading innovation hub for aviation in close cooperation with other regional airports. Together with the SAF, new concepts and technologies are researched and supported by government R&D funds.

All UAS devices – without exception – are equipped with at least a unique identifier (UI) that has the ability to exchange a limited set of data. In addition, all manned aerial vehicles have an integrated 'detect and avoid' (DAA) functionality. The UI requirement is coupled with minimum certification/license requirements for access to airspace. Corresponding data platforms receive the UI set of data via mobile- and other networks and combine them to a situational air-picture that is offered as service for all kind of monitoring and intervention activities. As there is no longer any 'uncontrolled' airspace, all devices are tracked, which provides a new safety layer in the system.

When the SAF needs to conduct an air police mission or REGA requires immediate access to an accident site, data operators at the skyguide data and service center have started to dynamically geofence the airspace for all other users and the missions can be flown safely.

In order to achieve this target concept, several strategic elements (SE) need to be in place and implemented along the different strategic dimensions. These SE can be seen as puzzle pieces that, combined, will allow for the full target concept 2035+ implementation. Different SE relate to specific operational environments, which are referred to as strategic dimensions in the following section.

5.1 The National Airport Dimension

In line with all forecasts, the national airports will, with the existing runway infrastructure, reach movement capacity limitations at some point in the future. This will happen in peak times first at ZRH and later in GVA. BSL is not expected to reach capacity limitations within the time-frame of AVISTRAT-CH.

The expected growth of scheduled services will ultimately lead to the prioritization of traffic. Such prioritization, in line with the airport concessions, must be communicated and enforced in order to allow for the required growth and efficient functioning of the hub function.

We propose enforcing the traffic prioritization at national airports in line with the prioritization defined in the airport concessions. In addition, airports shall be given more authority to allocate some peak-time airport slots flexibly and as needed. Such an empowerment of the airports should help depoliticize the overall slot allocation process and optimize utilization of residual capacity.

1. Scheduled services
2. Non-scheduled charter flights
3. Other commercial IFR flights
4. Commercial VFR flights
5. Non-commercial VFR flights

Prioritization calls for **major transformation and change management support** for the "non-prioritized fields" and therefore funds for a limited time. The financing of prioritization -driven transformation processes has to be clarified.

Furthermore, the national airports shall upgrade existing infrastructure with 'traditional' measures until more automated and digitalized technology and concepts have reached final implementation maturity. "Traditional means" of enhancing efficiency and add residual capacity include measures such as:

- Increasing landside capacity through the upgrading and adding of terminal capacity and the improvement passenger processes (check-in capacity, baggage handling, security, etc.)
- Upgrading the airside infrastructure through structural redevelopment such as runway extensions, rapid exit taxiways, and structural optimization of existing apron/gate/ground handling infrastructure
- Optimizing airspace utilization within the terminal areas by unbundling SID /STAR routes to eliminate trajectory dependencies and increase departure capacities
- Implementing satellite navigation and augmentation capabilities such as GBAS and SBAS to enhance landing capabilities and enable arrival procedures with a glide slope increase, circumnavigation of noise-sensitive areas or 'displaced runway threshold' landing concepts, with the aim of safely increasing runway throughput by reducing runway occupancy time (ROT).

Such upgrade activities are planned and have started at all national airports and include projects such as LORD or ZRH^3 [11] in Zurich, a terminal extension in Basle, and a landside terminal extension in Geneva.

[11] LORD: Leading Optimized Runway Delivery – project aiming at reducing the Runway Occupancy Times (ROT) at ZRH; ZRH^3: Initiative to make ZRH the most integrative airport system in Europe by 2030.

SE 1: Prioritization of traffic and continuous optimization of existing infrastructure

Growth in movement and passenger numbers at the national airports will require traffic prioritization. First general aviation, then business aviation will lose access to the national airports. The change to other airports shall be supported by transition programs.

The infrastructure is continuously upgrade using today's technology and state-of-the art concepts to optimize landside and airside capacity. Efficiency must be incentivised and enforced.

A recommended next step is the creation of a digital ecosystem, under the leadership of the national airports. This ecosystem enables free flow of data among trusted and cooperating airport partners, as well as between aircraft and ATM systems, and allows integrated management of traffic flows into the airport – on the ground – and out of the airport.

In line with the deployment sequence of the ATM Master Plan[12], the AMAN function extends into the en-route airspace and is fully synchronized with ground movement, arrival-, and pre-departure-sequencing as well as with the departure manager (DMAN). Enabled through data sharing and integrated artificial intelligence, such a configuration allows for a seamless and automation-supported TMA traffic-flow management from 'one hand' and ensures that capacity is always safely optimized.

Further benefits from such an integrated system architecture will be an increase of runway throughput by exploiting wake separation reductions based on weather and aircraft characteristics, as well as enhanced visualization in low-visibility scenarios due to enhanced and synthetic visual support, including displaced threshold landing clearances. Digitalized tower and approach support functionalities for ZRH and GVA are a precondition for a digital data chain. From a financial perspective, this should be especially considered in the design of new/renovated towers in Zurich and Geneva.

In a final step, **separation responsibilities are delegated into the cockpit and direct communication between the aircraft's on-board technology and the ATM system will change the role of ATC from operational and tactical decision making to overall process supervision**. Thereby, ATC interventions will significantly be reduced while the role of today's air traffic controller is transformed into the role of an air traffic manager.

SE 2: Automated TMA Operations

Digitalized data exchange between airport partners, as well as between aircraft and the ATM system, are the basis for higher-level ATM automation, which will allow for a seamless and integrated arrival-on ground departure process, resulting in optimal utilization of airport infrastructure and fully utilized capacity.

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[12] *The ATM Masterplan contains the integrated view of the European ATM System outlining the essential operational and technology changes foreseen to deliver the SESAR contributions to the Single European Sky performance objectives.*

Developments in airframe technology, resulting in reduced noise emissions and improved climb performance capabilities, allow for the implementation of peak-time freedoms. Peak-time freedom is a temporary suspension of standard operations limitations, which is defined for and applied in peak-time windows.

Such freedoms include concepts whereby **aircraft can deviate from standard instrument departure routes (SIDs) and missed approach procedures (MAPs) above minimum vectoring altitude (MVA) to enhance departure capacity and shorten the flight distances**. The benefit of these measures is a reduction of actual flight track distances (and associated emissions), while peak time departure capacity can be increased. Such a peak time freedom to optimize departure flows is a pre-condition for efficient hub operation.

SE 3: Peak-time freedoms

Temporary suspension of standard operational concept limitations to allow efficient management of peak loads at the national airports.

Implementation of the strategic elements 1–3 is expected to solve the forecasted capacitive limitations as described in 3.2 and allow the national airports to grow qualitatively and quantitatively.

5.2 The Air Force Dimension

The regulatory status of the **military aviation authority (MAA) and FOCA are formally equaled and the two bodies cooperate in an integrated way** and appear as a single regulatory authority towards the aviation community.

The issued approvals/certificates from these bodies are mutually accepted and organizational synergies (IT, HR, procurement) are assessed and harvested where economically reasonable. Such a move towards regulatory integration reduces interface frictions, shortens process, certification, and approval times, and is a key element for a dynamic and cooperative management of the Swiss airspace.

SE 4: Regulatory Equality of CIV and MIL

Closer and more integrated cooperation, mutual recognition of certifications, and the gauging of organizational synergies between MAA and FOCA form the basis for a more integrated and dynamic management of the Swiss airspace.

The enabler for a more seamless cooperation and a more dynamic management of the Swiss airspace is an **increased data exchange between CIV and MIL**, as this is a pre-requisite for efficient digitalized processes between CIV and MIL. Data exchange shall extend, but not be limited to, the management of the airspace reservation system, surveillance data for the Swiss airspace and, more generally, all data required to manage and make timely decisions concerning the status and the availability of the Swiss airspace or parts thereof. These datasets, which are required for the operation of the Swiss airspace, can partly be procured through certified ATM data services providers (ADS) in open market conditions.

However, there are so-called **"sovereign" data** that are indispensable to maintain control in a crisis or war situation. These sovereign data, under the ownership of and needed by the Air Force, are self-produced to ensure that their missions can be executed at all times. However, dual use technical solutions will enable the reutilization of available military capabilities, hence reducing integration and technical constraints. These solutions allow for better integration into civil ATM/CNS infrastructures without putting the mission at risk. That means, in peace times, that sovereign data will be made available to the civil side. **What is considered the minimum required level of 'sovereign' data is regulated and forms a critical base infrastructure needed for the discharge of the main mission.**

The integrity of all aeronautical data is ensured at all times through the newly established Data Integrity and Cyber Security Monitoring Unit (see SE14).

SE 5: CIV/MIL data exchange

Increased digital data exchange between CIV/MIL enables the management of the airspace 'from one hand', shortens the common decision-making processes, and is key for a dynamic utilization of the airspace.

Today's airspace management process (ASM) is slow, requires long up-front reservation, and is characterized by static dimensions of training areas and low levels of short-term flexibility. The suggested future increase of data exchange between the civil and military side is also in line with the EUROCONTROL's Civil-Military CNS Interoperability Roadmap (December 2020[13]). It will support an overhaul of the entire ASM process and an evolution of today's Flexible Use of Airspace (FUA) philosophy to a dynamic airspace allocation process that will yield real flexibility on the operational level.
The re-design of today's ASM process will achieve two main benefits:

- Significantly shortened 'negotiation' and decision time and increased flexibility concerning utilization duration of and access to training areas. Such a dynamic airspace allocation process is a pre-requisite to changing training/ mission needs and guarantees optimal utilization of the airspace.
- Training area dimensions are no longer static but can dynamically be adjusted in their vertical, horizontal and their duration dimensions. Such a flexible airspace definition and allocation assures that training /mission needs can be fulfilled and adapted on short term notice.

[13] www.eurocontrol.int/publication/civil-military-cns-interoperability-roadmap

Automated data exchange between ATC and the airspace management cell allows for a seamless process of displaying the correct airspaces on the controller workstations, while early inclusion of the network manager minimizes impact on pan-European traffic flows.

Prioritization of airspaces between MIL and CIV follows agreed principles and ensures that both Air Force missions and training, as well as the civil traffic flows, can operate within a plannable framework. Such principles include that "hot missions" always have priority access to airspace.

SE 6: Airspace Management Upgrade

Enabled through data exchange and agreed cooperation principles based on equality, the airspace management process is transformed into a dynamic airspace allocation mechanism that optimizes utilization of the airspace and benefits both Air Force needs and civil traffic flows.

5.3 The Airspace (with the new users) Dimension

As described in 4.3, the airspace in Switzerland today is complex and difficult to operate in, especially for non-professional users. Any changes in the airspace structure or classification involve complicated, costly, and lengthy processes.

The suggested new airspace structure is built on a fundamental shift of the operational paradigm and acknowledges the entrance of new airspace users.

As a guiding principle, **access to any airspace is linked to compliance with technical and operational requirements and an adjusted licensing/certification framework**[14].

The general rule for how technical requirements can be defined is as follows:
All unmanned aerial vehicles – without exceptions – will require a unique identifier (UI) that has the ability to exchange a limited set of data. In addition, all manned aerial vehicles are required to have an integrated 'detect and avoid' (DAA) functionality.

The next airspace architecture will no longer be based on a distinction between controlled and uncontrolled airspace; instead, while some parts of the airspace will still be positively controlled, **there will be no more uncontrolled airspace**. Airspace without positive (ATC) control is transformed into a **data-driven self-controlled airspace (DSCA)**. The required data transmission and identification of all aerial vehicles allows for a real-time air situation that is shared between users and enables self-management in such airspaces tracked and supported through a network without the power of supervisory interference.

[14] *Military Air Police and 'hot missions' have the highest priority in all airspaces at all times.*

Considering the new operational envelopes of UAS and manned low flights within the density of activities in today's airspace, these suggested changes in the current airspace configuration are inevitable in order to safely integrate the new users and ensure that military hot missions or search-and-rescue (SAR) flights by REGA can operate safely in what is today uncontrolled airspace. In the case of emergency and SAR missions by the REGA or when the Air Force is conducting 'hot missions', **dynamic geofencing of concerned airspaces ensures priority and safety** for these blue-light missions in the DSCA.

Separation in the new DSCA is achieved through sensor and data-link based detect and avoid by the users themselves. This calls for several pre-conditions:

- All unmanned aerial vehicles – without exception – are equipped with a unique identifier (UI)
- Central registration of all unmanned aerial vehicles (*)
- Regulatory (licensing/certification) requirements for central registration
- Corresponding data platforms receiving the UI set of data via mobile and other networks (network remote identification), combining them to a situational air-picture (*) that is offered as a service for all kind of monitoring and intervention activities
- A Data Integrity Monitoring and Cyber Security Unit (*)

(*) = This function is recommended to be executed by skyguide

Access criteria for the airspace needs to be coordinated with neighbouring countries and EASA in order to achieve a harmonized view on technical standards (for example: detect and avoid with 5G, FLARM, TCAS) and licensing requirements.

SE 7: Airspace access criteria

Airspace access is based on compliance with technical and regulatory (licensing/certification) requirements.

All airspace users in the "data-driven self-controlled airspace" (DSCA) are required to have a unique identifier that enables data exchange for network remote identification.

SE 8: Transformation from uncontrolled airspace to data-driven self-controlled airspace

Today's uncontrolled airspace will be transformed along the existing mobile networks coverage into a "data-driven self-controlled airspace" (DSCA). All users share position data (network remote identification) that is tracked/provided by a network service in an autonomous way. This service can further be used for all kind of monitoring and intervention activities. For example, for planned and unplanned priority usage of the airspace (REGA, Military hot missions, events), dynamic geofencing provides safe execution.

An airspace architecture that is based on a digitalized recognition of all aerial vehicles will also reduce the need and the volume of today-used 'airspace buffers', as non-compliance with routes or airspace block limitations can be detected earlier. **A reduction of airspace buffers frees significant amounts of today unused airspaces and will allow for further de-complexing of the current airspace structure** and thus reduce existing airspace access limitations and complicated airspace change processes for the different user groups.

The changes concerning the airspace restructuring along the proposed strategic elements are wide-ranging. While the desired final stage of this transformation is a long-term goal, it is even more essential to start with the transformation process today, as current technologies (such as unique identifier chips) allow the transformation process to be launched.

SE 9: Redesign of the Swiss airspace

Data exchange and process digitalization/automatization will reduce the application of today's airspace buffers in the airspace design.

Detection and tracking of all unmanned devices and detect-and-avoid functionalities in all manned aerial vehicles allow for a more effective re-design of the airspace structure in general and the overly complex TMAs in particular.

In addition to the EASA regulations addressing the operation of UASs (Today: Rules for Unmanned Aircraft Systems (Regulation (EU) 2019/947 and Regulation (EU) 2019/945), the Swiss airspace should be regulated along some guiding principles. These fundamental principles from the recognition that Switzerland has very limited airspace and an over-average complexity in terms of accommodating all user' needs. These principles include:

- Registration of all unmanned aircraft systems, regardless of size, with the dedicated regulatory authority.
- Protection of safety-critical and public infrastructure, such as airports or densely populated environments, through dynamic geofencing or similar technological solutions.[15] This is expected to increase the public acceptance of this new user group and moderate privacy-, safety- and security-concerns.

[15] *The cost for these protection measures shall be borne by the UAS user segement.*

- Regulatory distinction and distinct airspace allocation rules and principles between professional and commercial operators of UASs, which are subject to training and licensing requirements and leisure operators.
- Requirement-free 'rooms, defined areas where no access criteria are formulated, can be considered for some UAS leisure activities.

Although UAS have rarely been used by non-state actors in a terroristic context, such a **risk exists and must be addressed by regulatory measures**. The risk that public transport will be disturbed[16] or used in asymmetric war attacks against civil infrastructure and population must be considered.

SE 10: Principles of UAV regulation

On top of the EASA framework, the UAS/UAM community in Switzerland must be regulated along the principles to protect society and safety/security critical infrastructure and to have a regulatory distinction between leisure and professional/commercial users and their required competence levels.

5.4 Business Aviation Dimension

Constitutionally, aviation is federal responsibility and cannot be delegated to the cantons. BA is a comparatively small aviation segment, but the value-add of the business aviation per passenger to the Swiss economy lies at around 20K CHF per passenger and is hence far higher than the value-add of a commercial traffic passenger (LUPO, 2016).

In line with the traffic prioritization, especially at ZRH and GVA, business aviation will increasingly be unable to access their desired airport infrastructure around the business centers of Zurich, and later also in Geneva.

The value-add of global connectivity of the business locations of Zurich and Geneva is very high and provides these regions with a key locational advantage in the global competition for the harboring of international corporations.

Required conditions for business aviation are proximity to the business regions and, from an airport perspective, a robust landside infrastructure that allows for an efficient ground handling process and runways that are accessible in all weather.

In the Zurich area, **Dübendorf airport stands out as the only realistic alternative for business aviation and combines several advantages**. These include:

[16] *For example, the closure of Gatwick Airport in 2018 due to deliberate drone incursions:* https://www.bbc.com/news/business-47302902

- Existing airport infrastructure in close proximity to the Zurich region.
- Single ATC management together with ZRH.
- In combination with the 'hybrid' airport concept (see SE 19), a sustainable operation of DUB is assured and its role as a regional and national innovation hub is strengthened.

The situation in Geneva is less critical and BA will not encounter systemic capacity limitations until after 2030–2035 (to allow GVA a more flexible and independent peak-time slot allocation, as described in 5.1, will further limit restrictions for the BA at GVA).

SE 11: New platforms for Business Aviation

BA in the regions of Zurich and Geneva is highly relevant to their role as business locations and enhances their international competitiveness. Dübendorf airport, with its existing infrastructure and potentially new business areas, stands out as the ideal location to accommodate BA and connect the business location of Zurich globally.

In Geneva, capacity limitations for BA are not expected until 2030–2035, towards the end of the AVISTRAT-CH time horizon.

5.5 General Aviation and the Regional Airport Dimension

The regional airports are an essential part of the Swiss aviation infrastructure and form part of the fundament of the Swiss aviation community.

As discussed in section 4.5, there is currently no robust framework for the provision of ANS on regional airports. In terms of finances, all regional airports depend on an uncertain distribution framework for the collected (and dedicated) aviation fuel charge for the financing of ANS. As will be shown in section 5.7.1, a restructured fuel charge distribution model that provides incentives to operate cost-efficiently is suggested.

Due to the efficiency of the public transportation network in Switzerland, the importance of the Swiss regional airports, concerning regional connectivity, is limited. However, from a Swiss aviation infrastructure perspective, it is essential that regional infrastructures provide access for training and sports activities. As such, the Swiss regional airports function not only as a valid alternative for all the airspace users that will not be able to access the national airports due to necessary prioritizations, but also ensures a base infrastructure for the 'flying general public'.

While the regional airports operate in their specific niches (training airport, business aviation airport, general aviation airport, etc.), there are areas where system-wide synergies, for the benefit of all airports, can be achieved.
To maintain the critical airport infrastructure in the future and allow operations in a more plannable financial corset, two main elements shall be investigated.

The first element is a future, **more coordinated airport landscape, which is characterized by increased coordination and cooperation among the regional airports**. The aim of such an increased cooperation is not to limit development of these airports but to ensure that a 'bird's eye view' on the overall regional landscape is maintained and to achieve synergy benefits such as:

- Assurance that, from a national perspective, infrastructure elements (such as ILS, GA capacity) to satisfy training needs and the needs of the wider GA community are available.
- Common procurement efforts can yield significant scale and cost benefits and prevent duplication of efforts; this can include procurement of services including ANS services, CNS equipment and services, ADS, ground handling services, and MET services.
- Development of resource sharing models. The sharing of certain resources and services, such as IT, airport maintenance equipment, staff or marketing channels, can prevent a duplication of workload and expenses and can yield administrative synergies. Resource sharing models might even include an airline network for regional airports.

SE 12: Regional Airport Coordination

Increased coordination and cooperation among the regional airports can achieve scale effects concerning procurement and marketing, yield administrative synergies, and prevent a duplication of efforts among the regional airports.

The second strategic element connected to a more sustainable operation of the regional airports concerns an expansion of the business activities to include the management of UAM systems. The operational concepts of the unmanned, and manned, new airspace users include the fine-distribution of people and goods. An airspace landscape that allows UAS and manned drones to take off and land without restrictions is unlikely and some form of infrastructure that can structure and manage the traffic patterns will be needed to manage the seamless integration of these users into the existing aviation system.

The network of regional airports in Switzerland provides a net of regionally located and well-maintained infrastructures. This makes them predestined **to serve as mobility hubs for these new users** and to open up new business areas through the management and integration of these new airspace clients.

SE 13: New Business Areas for Regional Airports

The management of UAM clients and UAS can open up new business areas and service lines for the regional airports.

This, combined with the accommodation of the GA traffic and activities that no longer can be operated from the national airport infrastructure, allows for new and innovative business models and ensures that these key elements of the aviation infrastructure remain accessible.

5.6 Efficient and Secure Data Exchange

The entry of new airspace users – the UAS community with all the associated operational concepts for commercial and leisure activities – requires adjustments to the way the airspace is defined, structured, and safely managed. Considering the new requirements of UAS systems and manned low-altitude flights within the already densely populated current airspace, it is recommended that the classic distinction between controlled and uncontrolled airspace be changed (see above).

It is recognized that, with the increase of airspace users and increased digitalization, **the capacity for data exchange between the individual stakeholders will become a critical element** in the overall aviation infrastructure. **Spectrum capacity is already limited** and further capacity will be required to accommodate all airspace users. According to the Federal Office of Communications (BAKOM), the spectrum problem is acknowledged and is currently addressed within the European context.

In its ECC 309 report, the European Commission summarized the analyzed spectrum issues for UAS BVLOS operations in the potentially usable frequency bands of mobile/fixed communication network (MFCN). The investigation concluded that while these frequency bands may potentially be usable, relevant procedures, guidance materials and standards would be necessary, accompanied by certain specific measures to ensure no interference with existing applications arises, and safe communication with the UAS.

The provision of sufficient spectrum capacity is a central precondition to the future operational concept in the Swiss airspace. However, aviation is not the only industry that will require spectrum capacity as a fundament for increased data exchange.

A political mandate to the Swiss Federal office of Communications (BAKOM)[17] to involve itself within the international institutions and **ensure that there will be sufficient spectrum capacity for aviation needs to be made available**.

[17] *See also: https://www.bakom.admin.ch/bakom/de/home.html*

In parallel, seamless network coverage across the Swiss territory to enable the data driven self-controlled airspace must be supported at the political level.
One key element in a new ATM architecture will be the establishment of **a new national unit that is mandated to ensure operations and data integrity for all multimodal mobility solutions** in the DCSA. Key benefits provided by such a unit include:

- The use of a common digital infrastructure for all mobility domains, which is key for seamless performance and yields cost benefits (synergies).
- System monitoring and control that can be performed in a dedicated automated Multimodal Control Center, where threat detection and data monitoring for critical infrastructures can also be performed.
- The operation of such a centralized data control center, under federal oversight, is recommended to be mandated to skyguide, as this function can be seen as part of the national aviation infrastructure and operates on the basis of a federal mandate.

Cyber Security as a specific aspect of Data Integrity

The future aviation **system architecture is characterized by increasing interconnectivity of the stakeholder's various IT and communication systems**. New technologies, the extension of the connectivity to virtually all stakeholders, as well as increasing Europe-wide interoperability requirements within ATM systems, **require protection from cyber threats**. Malicious interventions can significantly impact the safety and the efficiency of the aviation system. The cyber threat pyramid in Figure 5 depicts an overview on the cyber threat landscape and displays the different threat elements along threat likelihood and success.

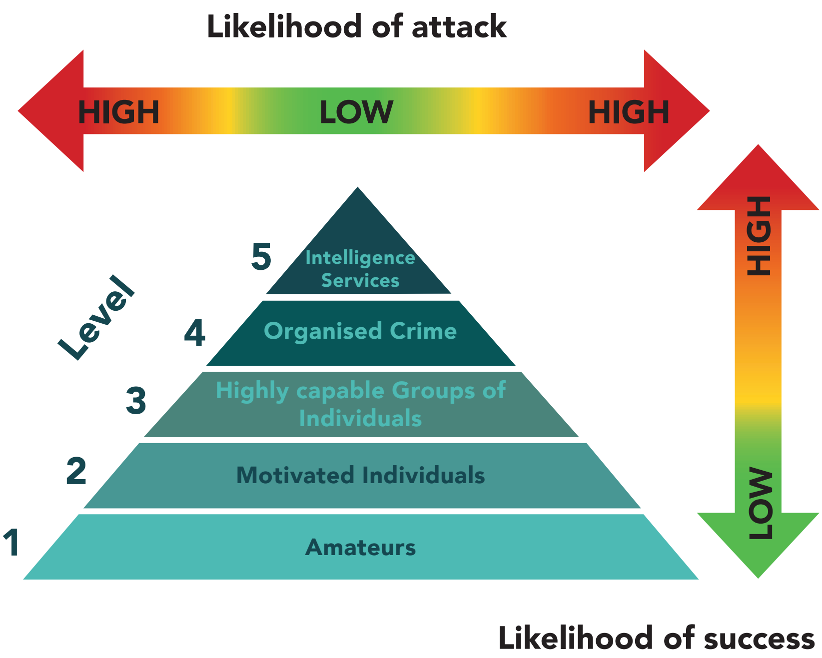

FIGURE 7: Cyberthreat Pyramid in Aviation (Thales, 2018)

As cyber security is neither an aviation specific nor a national threat alone, both national coordination and international coordination with neighboring countries and the European union is the preferred way to address this threat, and a cyber security agency protecting all infrastructure assets is of federal interest.

However, in absence of such a national (or international) protection mechanism, **the recommended Data Integrity Monitoring unit, responsible for the registration and tracking of all devices, shall have an integrated section that ensures aviation protection from the Cyber Security threat.**

SE 14: Data Integrity Monitoring and Cyber Security Unit

The establishment of a centralized unit that ensures operations and data integrity for all multimodal mobility solutions is a key element that will allow for integrated airspace management. Skyguide, within its regulated business area, is predestined to execute this critical function and ensure that all autonomous devices are registered and can be tracked.

The Cyber Security Control section within this unit is established and protects the aviation data, networks, and systems from unauthorized access or criminal use. This task extends beyond aviation and national borders and should ideally be combined with a national (or international) cyber security agency protecting all critical transport infrastructure.


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package.json
RECTANGLE
node_modules
public
src
helpers
App.css
App.js
App.test.js
index.css
index.js
PresentationPicker.css
PresentationPicker.js
PresentationPicker.test.js
registerServiceWorker.js
SlideEditor.css
SlideEditor.js
SlideEditor.test.js
Thumbnails.css
Thumbnails.js
Thumbnails.test.js
.gitignore
package-lock.json
package.json
README.md
yarn.lock
package.json

5.7 Organizational and Governance Dimension

One of the most cited problems in the current Swiss aviation infrastructure concerns **the decision making and the governance of the Swiss aviation system**. Fragmented and exhaustive decision-making and implementation durations, and the absence of an authority that ultimately decides, are seen as a key obstacle for the reformation of the current aviation landscape. Therefore, we recommend clarifying ownership of processes and/or changes of governance for the airports, skyguide and the regulatory level, as follows.

5.7.1 Airports

Airports form a central part of the national aviation, emergency, and general preparedness infrastructure, and also function as a strategic 'runway reserve' from a national defense perspective. In Switzerland, land is very scarce and the planning horizons for infrastructures are both long-term and slow. In view of future needs for existing and potential emerging users of the third dimension, we recommend that caution be exercised with regard to the conversion or elimination of aeronautical runway systems. As such, there is an overriding federal interest to maintain existing runway infrastructures. We recommend providing the airports with a **framework that allows and incentivizes their sustainable development** in line with this strategy. Furthermore, we recommend the empowerment of their decision-making capacity **to enhance their ability to operate in a more robust and self-determining way**. A distinction between regional airports and national airports is required, as their needs differ significantly.

5.7.1.1 Regional Airports

Today, the dependence of the regional airports for financial support[18] within an uncertain financing framework, as well as the dependence on costly infrastructure, maintenance, and ANS services from skyguide, limits their ability to manage their niche business in a financially sustainable way.

To empower the **regional airports in Switzerland, the administrative responsibility for the provision of ANS, including the selection of the ANS provider[19] and associated CNS and other support services, must lie with them.** However, the accountability and the obligation to comply with the respective regulatory safety frameworks remains with the

[18] The fuel tax currently covering ANS costs on the regional and channelled to skyguide is in fact an ear-marked user-tax and not to be confused with federal funding.

[19] ANS services at ZRH/GVA are today regulated as services of 'federal importance' in Article 40b Section 4 of the aviation law (LFG).

selected ANS and commercial services providers.

Such a development will allow the regional airports to determine the type and level of ANS that is best suited to support the needs of their respective customer base. Central pre-conditions for such an empowerment process include the following:

- Ownership of the CNS infrastructure must be transferred to the regional airports. Without such ownership, airports lack real opportunities to select service providers for CNS, data, and ATM services.
- Ownership of intellectual property (IP) rights of ATS manuals, including safety-data, needed for safe management of air traffic at and around the airport.
- The distribution of the user-paid fuel tax for regional airports must be defined through a financing mechanism that incentivizes and rewards innovation and cost efficiency. Planning shall be harmonized with the budgeting processes of the airports.
- While cost-efficiency within the tax fuel distribution scheme is incentivized, its scope reaches beyond the covering of ANS costs. It has a broader approach in supporting the regional airports to maintain and operate the crucial runway infrastructure.

Main benefits will result in more entrepreneurial thinking and management, a more holistic decision-making process that includes all airport relevant support processes, and increased 'ownership' of the financing problem. Additional benefits will result in a reduction of coordination- and decision-making interfaces and an increase of competence and responsibility on the airport operator side.

5.7.1.2 National Airports

On the national airports today, the provision of ANS is federally regulated (see footnote 19) and skyguide is designated to provide these services. Given the complexity of the operations and the number of system interfaces in the management of TWR/APP services at Zurich and Geneva, we recommend considering a possible change of the current service provision framework at a later stage.

However, the management of air traffic in the busy TMAs and on the ground of the national airports requires closer coordination and cooperation among all partners. To achieve efficiency optimizations and additional capacity in the busy national airports (and their TMAs), **we recommend a more data-driven process management between all the cooperation partners around the aircraft (ground handling, airlines, apron, ATC, etc.) within the overall airport system**. Automated supply chain processes, as well as warehouse processes, shall serve as a benchmark.

We recommend the establishment of so-called "**data lakes**" in Zurich and Geneva. Data lakes provide the solution to incompatibility of data and systems – centralized repositories that allow all kind of data to be stored, at any scale, without having to first structure the data.

Different types of analytics including **machine learning** will allow much more **integrated steering** of the overall airport system (including approach, ground, and departure data), supported by **big data processing, real-time analytics,** and **visualizations**.

The airport is the central node in the process network that connects with all other stakeholders and partners. Therefore, the **airport must be the owner of the data lake and the incorporated processes** in order to ensure the ability to manage operational concepts and supporting services 'from one hand' sharing operational data with the airport must become mandatory.

SE 15: Empowering the Airports

Regional airports are empowered to determine the type, level, and provider of data, CNS, MET, and ATM services and become responsible for achieving efficiency gains, incentivized through a funding scheme that rewards innovation and cost efficiency.

CNS infrastructure and IP rights for ATS manuals and safety data are transferred to the airports to allow for free market procurement of services and an independent evaluation of cost-efficient and innovative service provision in line with their niche business models.

The national airports own and manage the 'data-lake' that is fed by all partners and stakeholders and are responsible for the seamless ground operations, including incoming and outgoing traffic flows.

5.7.2 Skyguide

In its "vision 2035"[20] document, Skyguide developed the central elements that will form the future ATM architecture in Switzerland. Whereas "vision 2035" points towards increased digitalization, virtualization, and automation in the future management of the Swiss airspace, it is fully supported in this strategy. There is a shared view that without an increased application of these technologies, robust inclusion of new airspace users and a dynamic management of the airspace will not be possible. In a future European ATM architecture driven by technology and innovative processes, skyguide seems well positioned.

However, we recommend **increasing the speed of implementation for "vision2035"**. The realization should be more ambitious with regard to the anticipated shift towards an **increased service orientation**. In absence of competitive pressure, the challenge will be to yield benefits comparable to those of a competitive market landscape.

In order to prepare for its future within Europe and in view of the challenge described above, **skyguide shall transform from being the monopoly national air navigation service provider towards a national air navigation data and services company (ANDSC)**. In that re-defined role, skyguide shall distinguish two types of business areas: regulated and commercial. In the regulated business, skyguide is responsible for maintaining the key national infrastructure and providing services of national sovereign interest. These services include (but are not limited to):

- Upper Airspace ANS
- Airspace management
- Air Defense
- Publication services
- Aeronautical network services
- Data integrity monitoring and cyber security unit
- Pilot briefing
- Unmanned devices registration and tracking
- Minimum air navigation service level in crisis situations

The financing of these services is covered through airspace user charges in the overall Swiss airspace. Through federal regulation, skyguide is responsible for security aspects and a guaranteed minimum service level in crisis situations. The minimum required level of ANS (ATM and data requirements) in a crisis situation needs to be defined together with the MIL and CIV regulator as the base needs of national interest. The **minimum required level**

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[20] *Skyguide Vision 2035 summarizes the strategic goals of skyguide and can be found here: www.skyguide.ch/wp-content/uploads/2020/04/our-vision-2035.pdf*

of data services by the military shall be provided by or on behalf of the military and must be purchased by the CIV providers.

All of the services that are not considered 'regulated' are considered commercial services. For the provision of these, skyguide shall no longer be covered through a statutory monopoly and these services can be procured in open and competitive market conditions and within a level playing field for all competitors to foster innovation, increase efficiency, and reduce overall costs. Parts of them are covered through airspace user charges in the overall Swiss airspace. Commercial services include:

- Communication, navigation and surveillance (CNS)
- Aeronautical information services (AIS)
- ATM Data (ADS – according European Regulation)
- Meteorological services (MET)
- Terminal ANS (T-ANS)
- Consultancy services
- ANS abroad

Skyguide can offer these commercial services on the markets themselves; however, **entry barriers for competition or distortion of fair competition (such as non-transparent cost allocation) must be avoided**. An organizational and financial separation between Skyguide's regulated and commercial business shall support transparent financing and governance policies and ensure a level playing field in the commercial services market. This shall be assured and monitored through AirCom (see SE 18), which functions as the guardian to make sure that commercial services are not subsidized through the monopoly business.

Figure 8 illustrates the two main business areas of skyguide: the regulated business and the commercial business. To guarantee a clean distinction, financial, organizational, and governance separation of these business areas is needed and supervised by AirCom.

Skyguide’s regulated and commercial Business areas

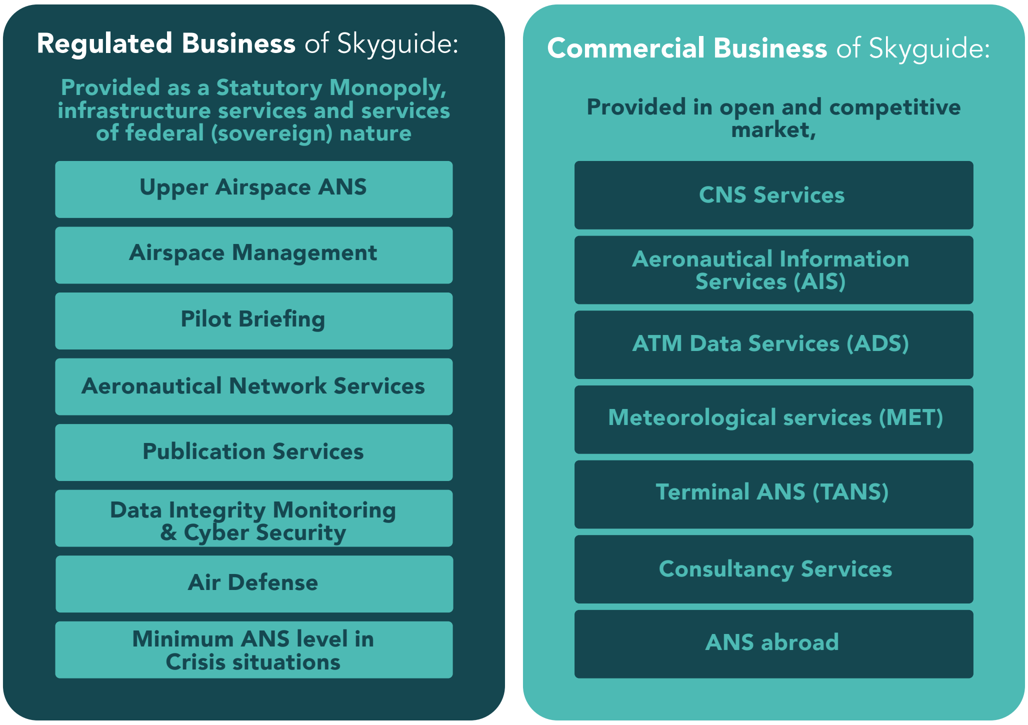

FIGURE 8: Overview over regulated and commercial business areas of skyguide (not complete)

SE 16: Transformation of skyguide

Skyguide has transformed from a monopoly ANSP to an ANDSC that operates two business areas with separated organizational set up, financial-accounting and governance:

1) *The regulated business as part of the national aviation infrastructure and services of national sovereign interest*
2) *The commercial business as provider in an open and competitive market*

For the commercial services, the statutory monopoly is lifted and replaced by a competitive market. Market forces are expected to increase the efficiency of services and incentivize innovation.

SE 17: ATM architecture Switzerland

In line with skyguide’s “vision 2035”, increased digitalization, virtualization, and automation for the Swiss ATM architecture are supported as far as they overlap with the strategic proposals in the ARCS/ACR strategy.

However, the timelines for the planned implementation shall be more ambitious.

The transformation of skyguide (SE 16) and the upgrade of the ATM architecture shall be conducted in parallel.

5.7.3 Regulatory Authorities

The **future Swiss aviation system will be more competitive and service-oriented than today.** Competition that yields the desired benefits for the users depends on a fair market with low entry barriers and equal frame-conditions for the competitors. To ensure a 'level playing field' for all market participants and prevent misuse of monopoly advantages, **a functional separation between policy related activities and regulation on one hand, and between safety regulation and economic regulation on the other hand**, shall be implemented in line with the governance models of other network industries in Switzerland (postal services, railways, communication, electricity).

The new economic regulatory body, herein called "**AirCom**" will, amongst other things, focus on:

- Activities necessary for the issuance of economic certificates,
- Oversee the correct application of procurement requirements and tender processes
- Assure the functioning of the performance and charging schemes (ATM)
- Regulate airports (airport charges and airport slots)
- Function as a refereeing body in disputes between market participants

Such an economic regulator will be necessary in a market environment where certified CNS, ADS, TANS, and MET providers compete.

AirCom will be independent and function as the highest refereeing body in economic regulatory matters. Such a role is expected to unlock blocked and lengthy solution processes in disputes and enable faster and more targeted implementation processes.

Such an organizational adjustment has also been recommended by NLR (2006), which observed that the fact "that the tasks of FOCA related to safety regulation and the tasks related to policy advice and the promotion of aviation were fully integrated throughout the organization had also important implications for the conduct of FOCA as a safety regulator."
Furthermore, such a functional separation of policy advice and regulation is in line with the regulatory set-up common in other network industries and **represents the current state-of-the-art regulatory model**.

The federal Electricity Commission ElCom[21] is seen as a good blueprint of how such a regulatory institution can be set up in a lean and functional way. In the electricity sector, ElCom is responsible for monitoring compliance with the Swiss Federal Electricity Act and part of the Swiss Federal Energy Act, making all necessary related decisions and pronouncing rulings where required. ElCom regulates grid prices at all levels, monitors electricity tariffs,

[21] *See also: https://www.elcom.admin.ch/elcom/en/home.html*

and rules on disputes relating to network access. It also monitors electricity supply security and regulates issues relating to international electricity transmission and trading. ElCom is responsible for ruling on disputes concerning feed-in tariffs and between network operators and independent producers.

AirCom shall be set up in a comparably lean and effective way.

SE 18: AirCom – the Swiss economic regulator for aviation

With the establishment of AirCom, a functional separation of safety regulation and economic regulation significantly improves the governance of the Swiss aviation system.

A more commercial and competitive market for the different ANS-related services will require assurance of fair market conditions and correct application of procurement and tender processes.

As a refereeing authority in disputes, AirCom contributes to a more efficient governance of the Swiss aviation system.

5.8 Sustainability and Environment Dimension

The transformation of today's aviation system into a more sustainable industry that **minimizes the environmental footprint** is one of the overarching goals, and the future aviation infrastructure must not only support such a transformation, but **actually drive it**. As defined in Chapter 3, sustainability (together with safety and security) is a high-level concept that embraces all activities, projects, and activities in the Swiss aviation system. As such, it must be understood as brackets that form the framework within which the strategy unfolds.

However, driving sustainability calls for **focused innovation initiatives**. Innovation in the aviation system should be done **by the market and R&D should be supported by the federal government, as defined in Article 103b of the aviation law**. Below we suggest three innovative initiatives that meet the spirit of LFG Article 103b.

Furthermore, the significance of the recurring federal aviation report – commonly referred to as **LUPO[22] – shall be increased**. LUPO (Luftfahrtpolitischer Bericht) contains aviation policies and describes how the competitiveness of the Swiss aviation can be maintained in times of changing technologies and new airspace users. In particular, the **recommendations concerning R&D activities and safety of the Swiss aviation system** shall have a binding character, and a more frequent update of the LUPO within a four-year cycle is recommended.

5.8.1 Hybrid Airports

The regional airports, with spare capacity and home to the UAS customers, general aviation and business aviation, form an ideal platform for R&D activities and innovation. R&D initiatives shall be supported by the national Aviation Research Plan (SE21). **Dübendorf has the potential to become a "hybrid airport"; that is, a leading innovation hub for aviation sustainability combined with its BA concession obligation to reduce emissions in a measurable manner over time.** However, we recommend studying the potential of **at least one other regional airport** to become the second hybrid airport in Switzerland.

Hybrid airports are the basis for pilot common projects in aviation. R&D activities are federally funded. The hybrid nature stems from its **dual use of traditional and alternative propulsions and fuels. They are steered by legally binding, measurable conditions** to gradually reduce CO_2 emissions, as well as noise at the airport and to become CO_2-neutral over time. The new function of a hybrid airport will aim to achieve three main goals:

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[22] *The last released LUPO report from 2016can be found here:*
https://www.bazl.admin.ch/bazl/de/home/politik/luftfahrtpolitik/luftfahrtpolitischer-bericht.html

- Combine academic and operational aviation competence for environment driven R&D programs with access to test airspace and infrastructure.
- Cooperate on site with SAF on new operational and digital procedures/technologies, as well as with the innovation park network for environment-driven aviation/mobility R&D.
- Become a large-scale demonstrator for sustainable development in the aviation sector by providing tangible results driven by measurable environment targets.

As such, the hybrid airport is the Swiss testbed for application-oriented research and development for sustainable fuels, alternative propulsion technology, and environmentally sustainable aviation concepts including noise reduction.

Supported by the Swiss Aviation law (LFG Article 103b) and operated with a revenue-based business model that generates income from BA, UAS, and GA users, the hybrid airport represents not only a visionary airport concept, but also highlights the leading role of Switzerland in aviation R&D.

The latest developments in Dübendorf have proven that an innovative strategy integrated in the overall aviation strategy of Switzerland is missing.

Additionally, Dübendorf – with its triple usage concept – can cooperate with the SAF in a wide range of R&D activities, given that the regulatory framework of the SAF is a more suited testbed for R&D procedures and technologies than the more stringent civil regulatory framework.

SE 19: Hybrid Airports

One (or more) airport commits to binding and measurable conditions for reducing CO2 emissions and noise. This hybrid airport will be a testbed for R&D concepts and applied innovation in the aviation industry and funded accordingly.

The hybrid nature stems from its dual use of traditional and alternative propulsions and fuels. Steered by legally binding and measurable conditions to gradually reduce CO2 emissions at the airport and to become CO2-neutral over time.

Dübendorf will be the first Swiss Hybrid Airport.

5.8.2 Sustainable ATM Infrastructure

The aviation sector has been able to decouple market growth from the growth of CO2 emissions; however, in absolute terms, the CO2 emissions have grown due to constant growth over the last decades. There is a general perception that the **impact of aviation on climate change is increasing and that the aviation sector must do more to reduce CO2 emissions.**

CORSIA[23] and the European Emissions Trading Scheme have already demonstrated a commitment of the industry to reduce its environmental footprint, but a **more system-wide approach must be taken to achieve further reductions in emissions**.
The reduction in gate-to-gate CO2 emissions is directly proportional to the average reduction in fuel burn per flight. To minimize the aviation related noise- and greenhouse gas (GHG) emissions environment becomes an integrational part of new ANS concepts and developments within the entire aviation landscape of the Single European Sky (SES) regulation of the European Commission. Unnecessary noise and GHG emissions are emissions that are produced in 'unproductive' operational phases such as unnecessary taxiing, time spent in holding patterns, or other delaying trajectories. Therefore, a goal of SES is to provide sufficient capacity on the ground and in the air to minimize 'unnecessary' emissions [24].

Engineering breakthroughs in the design of new airframes and engines, an increased use of alternative fuels, CO2 neutrality of infrastructures, as well as alternative propulsion are expected to be deployed as part of the global and technological development.

In order to minimize emissions, **the ATM architecture needs to adjust with high priority in order to enable digitalized processes** that enable safe optimization for both environment and operations – integrated data services with standardized system interfaces and interconnected system interfaces enable flow-centric operations in the en-route airspaces and ensure an optimal demand balance throughout the network. Free route airspaces, direct routing concepts, and continuous climb and descent operations are just some of the measures that will help to minimize emissions.

SE 20: Sustainable ATM infrastructure

The aviation sector must be seen as a system. Environmental targets can only be achieved if all stakeholders contribute.

The most direct and favourable trajectories, with no delays on the ground and in the air, minimize avoidable noise and GHG emissions and can only be achieved with cooperation among airlines, airports, and service providers.

Upgrading the ATM infrastructure in line with SESAR and the ATM Master Plan deployments provides management of the airspace that utilizes capacity and minimizes avoidable emissions.

[23] *Carbon Offset and Reductions Scheme for International Aviation, supported by ICAO.*

[24] *For details on the environmental effect of the SES regulation, see also:* *https://ec.europa.eu/transport/modes/air/ses_en*

5.8.3 Research & Development

The final strategic element concerns the **support of this strategy by focused R&D activities for aviation based on Swiss Aviation Law Article 103b**[25].
The highest level aviation policy in Switzerland is communicated through the Aviation Policy Report LUPO. In the last version of this report section 5.8.2 "Aviation Research in Switzerland" states:

"Switzerland is to become a more important location for aviation research and development. In the future, the 'Aviation Research Center Switzerland' (ARCS) will coordinate aviation projects and represent the relevant university departments to the outside world."

In line with the federal view on the role of aviation innovation and based on the AVISTRAT-CH strategy, **ARCS shall be mandated to develop an interdisciplinary Swiss Aviation Research Plan (SARP)** that contains the consolidated views from the academic institutions and contrasts these with the industry needs.
The SARP can include elements of the skyguide "vision 2035" as well as elements from other organizations that apply R&D to develop the Swiss aviation system.

The Aviation Research Plan shall be integrated in the Aviation Policy Report, which – within a mandate to Innosuisse – formulates a research assignment that defines the project portfolio and coordinates between industry and the universities ("Forschungsauftrag").

Innosuisse is an entity under public law that has the role of promoting science-based innovation in the interests of industry and society in Switzerland and, as such, is seen as the ideal vehicle to administrate the aviation research project portfolio. **Funding for all the projects in the research project portfolio stems from federal resources unlocked through the earmarked mechanism described in LFG Article 103b.**

SE 21: Support of R&D through LFG 103b

In order to support the SEs described above and listed below, the LFG Article 103b – stating the federal support for aviation R&D activities – shall be invoked and stocked up with funds.

ARCS is mandated to develop a national aviation research plan, based on which a national research assignment shall be formulated. This is translated into an aviation research portfolio and administered through Innosuisse (in close coordination with ARCS).

[25] *Der Bund fördert die Aus- und Weiterbildung sowie Forschung und Entwicklung neuer Technologien im Bereich der verschiedenen Sparten der Luftfahrt.*

Table 2 below summarizes the defined strategic elements and points towards the problem areas that are covered through these elements.

Safety
Sustainability
Security

Group	SE No.	Title	Covers PA
National Airports	1	Prioritization of traffic and continuous optimization of existing infrastructure	1,2,3
	2	Automated TMA operations	1,2,3,4
	3	Peak-time freedoms	1,2,3
Swiss Air Force	4	Regulatory equality of CIV/MIL	5,6
	5	CIV/MIL data exchange	5,6
	6	Airspace management upgrade	5,7
Airspace & New Users	7	Airspace access criteria	7,8
	8	Transformation from uncontrolled airspace to data-driven self-controlled airspace	7,8
	9	Redesign of the Swiss airspace	7,8
	10	Principles of UAV regulation	7,8
Business Aviation	11	New platforms for business aviation	9
General Aviation & Regional Airports	12	Regional airport coordination	10,11
	13	New business areas for regional airports	10,11
Efficient & secure data exchange	14	Data integrity monitoring and cyber security unit	12,13,14
Governance & Organization of the Swiss Aviation System	15	Empowering the airports	16,11
	16	Transformation of skyguide	16,11
	17	ATM architecture Switzerland	16
	18	AirCom - the Swiss economic regulator for aviation	16
	19	Hybrid Airport	All
	20	Sustainable ATM infrastructure	All
	21	Support of R&D through LFG 103b	All

TABLE 2: Summary of the strategic elements and which PA they impact


HDR
SLO-MO
VIDEO
PHOTO
PORTRAIT

6. Impact of Strategy on Target Areas

The higher-ranking goals and ambitions of the Avistrat-CH program have been **defined and formulated within the AVISTRAT-CH Vision** (BAZL, 2019). This vision is understood as the desirable and 'to-strive-for' condition of the future Swiss aviation infrastructure that shall be able to react to user needs in a dynamic way, be efficient, and be compatible within the European context.

In a nutshell, the AVISTRAT-CH vision is structured into eight fields of activity which cover three vision levels: The environment, target areas, and action areas [26]. Within that framework, system requirements have been defined and these requirements summarize what is expected from the future Swiss aviation infrastructure. **The strategy team has taken the AVISTRAT-CH Vision as the starting point for the work and has analyzed the content accordingly in order to have a basis for the work.** After concluding the work, the strategy team has made **consistency checks in order to ensure the full alignment of the strategy with the AVISTRAT-CH Vision**. The goal of this chapter is to demonstrate and visualize the relationship of the strategic elements to the system requirements. The last column in Table 5 points towards those SE that satisfy the defined system requirements.

[26] For a detailed overview on the AVISTRAT-CH vision, please go to:
https://www.bazl.admin.ch/bazl/de/home/sicherheit/infrastruktur/avistrat.html

6.1 OVERVIEW: All Covered Areas Through Strategic Elements

FIGURE 9: Overview over all covered areas through strategic elements in this paper.

6.2 AVISTRAT-CH – Vision: How the system requirements are met

Table 3 contains the system requirements connected to the 'Environment' vision level and points towards the strategic elements that cover these requirements.

Environment

Area	No.	System Requirement	Covered through the following SE:
Society & Politics	1	As part of the overall transport system, the aviation system covers its share of society's mobility needs.	All
	2	The aviation system is anchored securely in the political landscape and is therefore able to adapt pro-actively to socio-political needs.	18,21
Technology & Innovation	3	New technologies are applied if they address specific user requirements and offer added value after weighing up the costs and benefits.	2,5,7,8 17,20
	4	With its open, flexible architecture, the aviation system is designed to enable new technologies to be integrated easily.	2,5,7,8 9,17,20

TABLE 3: System requirements 'Environment' and the respective SE that cover them

Table 4 contains the system requirements connected to the 'Target Area' vision level and points towards the strategic elements that cover these requirements:

Target Areas

Target Area	Requirement	Covered through the following SE:
Environmental Impacts	5 Emission of pollutants, including emissions of electro-magnetic radiation: the exposure of the population/ environment due to the aviation system is reduced for each transportation unit, compared with today.	All
	6 Noise emissions: the The exposure of the population/ environment due to the aviation system is reduced for each transportation unit, compared with today.	19,20,21
	7 A reduction in the future impact on the environment is to be aimed for, for each transport unit, compared to today.	19,20,21
Safety & Security	8 The authorities involved can perform the state safety tasks at all times.	4,18
	9 Risk management: the socially accepted level of risk in the aviation system is defined. The level of risk as well as individual risks are continually monitored.	4,18
Efficiency	10 The airspace and the aviation infrastructure are serviceable and accessible for all users in accordance with socio-political needs.	All
	11 The order of priority is regulated in the system in accordance with the socio-political requirements. It is applied when the strategic situation so requires or if conflicts of use exist.	1,4 7,10
	12 The conditions in the aviation system make international competitiveness possible for users in Switzerland.	7,9,16
	13 Essential aviation services are provided cost-efficiently and transparently.	15,16
	14 The aviation system provides long-term planning security for users in terms of the use and further development of airspace and aviation infrastructure.	15,16 20,21
	15 The aviation system offers favorable basic conditions for the training of highly qualified workers in the aviation sector.	11,12 13,16
	16 The aviation system provides space for creativity and innovation, in order to enable the industry to continue the development of technologies and working processes.	13,16,21

TABLE 4: 'Target Area' system requirements and the respective SE that cover them

Action Areas

Area	Requirement	Covered through the following SE:
Structure Ground & Air	17 Dynamics: The aviation system is structured in such a way that airspace and aviation infrastructure can continue to develop dynamically; for example, in terms of new types of use or new technologies.	2,5,9 14,17,19 20,21
	18 Design: the The aviation system (airspace, take-off and landing facilities, infrastructure, etc.) enables all users of the aviation system to make use of it in close accordance with their needs and ensures that the requirements of integrated mobility are taken into consideration globally.	1,2,3 10,11 13,15
Regulation	19 RBO/PBO supervision: Supervision in the airspace system is based on principles dependent on risk and performance.	4,8,9 18,21
	20 Agility: The regulatory processes are designed in such a way that it is possible to react quickly to new requirements (such as new user requirements, innovation).	18
	21 International obligations relating to the application of standards must be met.	10,17,20
	22 The regulatory process makes it possible to define special national regulations if added value is created for the Swiss aviation system (reduction of risks or increase in efficiency with risks remaining the same). The principle is: as little as possible, as much as necessary.	10,18
	23 The aviation system enables users to make long-term plans regarding the regulation of airspace and aviation infrastructure. Stakeholders must be involved at an early stage in the regulation process.	8,18
	24 The administrative time and effort in relation to regulatory requirements will be kept to a minimum for aviation operators. Local derogations are possible if there is evidence that safety is guaranteed.	4,10,18
Management	25 Management of the airspace and aviation infrastructure is targeted and flexible, among other things as a result of the use of available technologies.	2,5,7,8 9,17,20
	26 With a view to minimizing effort that does not result in added value, simple and efficient processes are applied to the management of the airspace and aviation infrastructure.	2,6,7,8 9,17,19

TABLE 5: 'Action Areas' system requirements and the respective SE that cover them


F-HCPB
F-HCPB

7. How the strategy can be implemented

A strategy not only defines the elements required to achieve the desired outcome and illuminate the path towards the target scenario 2035+, **but must also be affordable and implementable.** Throughout the development of this strategic orientation, **the feasibility of the suggested strategic elements was among the guiding principles**.

This final chapter addresses the implementation steps required to achieve the goals defined in the target strategy.

However, this chapter is **not to be understood as an implementation roadmap**, as this would go beyond the scope of the mandate. Rather, this chapter proposes ideas of a possible implementation path. **It is strongly suggested that a comprehensive implementation and finance plan be developed as an immediate next step and a follow-up from the strategy development.**
When the strategic elements are considered, the following considerations must be kept in mind.

Strategic elements: It is not recommended that individual strategic elements be singled out from the overall strategic approach as there is a relationship between these elements that will yield most value-add to the Swiss aviation infrastructure if all elements are considered.

Time horizon: While some strategic elements have a longer time perspective due to technological availability or alignment with supra-national processes, implementation work on others can (in fact, must) start at once in order to avoid delaying necessary developments.

A future implementation roadmap should distinguish between the different time horizons, and we propose the following gradation (with an example).

Short-Term
Example SE1:

Prioritization of Traffic and continued optimization of infrastructure at the national airports describes a strategic measure that can be implemented today.

Medium-Term
Example SE5:

CIV/MIL data exchange requires prior definition of specifications and agreed technical platforms.

Long-Term
Example SE6:

Airspace Management Upgrade and dynamic management of airspace requires SE1 CIV/MIL data exchange as an enabler.

Dependencies: Some of the strategic elements have dependencies to each other. These dependencies can be sequential; for example, data exchange between the SAF and the civil ATM provider is a prerequisite to a dynamic management of the airspace.

Political landmark decisions: The implementation of an aviation strategy does not occur outside a political framework. For some strategic elements (such as "AirCom - the Swiss economic regulator for aviation"), a political fundament or landmark decision is required to actually choose such a governance structure. These SEs, where such political decisions are required, are indicated.

Single European Sky and EU regulations: While this paper presents a strategy for the development of the Swiss aviation infrastructure, the European context must be acknowledged. Switzerland is part of the SES and must comply with the EU/EASA regulatory framework. As a principle, Switzerland can always add additional regulations to the SES regulatory framework, while deviations that weaken the SES regulations must be supported with strong evidence so that safety target levels are not jeopardized.
Technological developments under the SESAR umbrella and in accordance with pan-European processes will, to a certain degree, impact which direction the ATM infrastructure development in Switzerland is taking (for example, data formats, data exchange protocols, etc.).

Urgency: Outside the time horizon framework described above, certain elements need to be addressed urgently as later implementation will be more difficult or have stronger negative effects on the desired outcome.

Within this strategy, urgency is especially recommended with the strategic elements connected to:

- Assuring sufficient capacity and robustness at Zurich Airport, enforce prioritization of traffic according to 5.1.
- Developing Dübendorf Airport to become a 'Hybrid Airport' and serve GA, BA and SAF needs.

7.1 Suggested implementation steps

Below follows an initial overview on the suggested first steps towards implementation of the strategic elements. The elements that require some fundamental political decisions are highlighted.

The **National Airport** dimension consists of the following strategic elements:

SE1: Prioritization of traffic and continuous optimization of existing infrastructure
SE2: Automated TMA operations
SE3: Peak-time freedom

In order to implement the above SE, the following next steps are suggested. Note that this overview is not comprehensive, but rather functions as an initial pointer.

Short-Term Actions

1. Implementation of LORD and ZRH[3] at Zurich airport enforces the prioritization of traffic according to 5.1 and develops/ implements a support concept for users changing to other airports.
2. Implementation of the projects enhancing landside capacity at Geneva Airport.
3. Draft regulation that transfers data responsibility and ownership to the airports (see also SE 15: Empowering of the Airports).
4. Launch feasibility study 'data-lake' for ZRH and GVA, enabling more integrated/automated TMA and ground processes at the airports (possibly in cooperation with SESAR).
5. Launch feasibility study for automated TMA operations and peak-time freedoms.

Medium-Term Actions

1. **Preparation of the required changes that need to be included in the next SIL version.**

The **Air Force** dimension is built on the following strategic elements:

SE4: Regulatory equality of CIV/MIL
SE5: CIV/MIL data exchange
SE6: Airspace management upgrade

In order to implement the above SE, the following next steps are suggested.
Note that this overview is not comprehensive, but rather functions as an initial pointer.

Short-Term Actions

1. **Assess legal foundation for a consolidation and a regulatory equality of FOCA/MAA.**

2. Under leadership of the Air Force: Establish common CIV/MIL working groups that define framework and conditions for:

   1) increased Increased CIV/MIL data exchange
   2) the The transformation of ASM into a dynamic process, the development of decision criteria

3. Clarification of what, from a national sovereign perspective, is considered:

   1) the minimum required ANS Service level
   2) the minimum required data

   in crisis/contingency scenarios and how these services/data can be obtained by SAF.

Medium-Term Actions

1. Dübendorf, as the first hybrid airport, shall establish CIV/MIL 'test-cells': The military regulatory framework is better suited to 'test' new technologies and procedures within an operational context (to be used for technologies/processes that can be used in future dynamic management of the airspace).

The **Airspace (and the new User)** dimension contains the following elements:

SE 7: Airspace access criteria
SE 8: Transformation from uncontrolled airspace to data-driven self-controlled airspace
SE 9: Redesign of the Swiss airspace
SE 10: Principles of UAS regulation

In order to implement the above SE, the following next steps are suggested.
Note that this overview is not comprehensive, but rather functions as an initial pointer.

Short-Term Actions

1. Check with mobile network providers concerning the roll-out and implementation plans for Switzerland-wide coverage of network allowing identification, tracking, and data exchange of all aerial vehicles.

   Definition of transition periods to the new identification and data exchange requirements in coordination with mobile network providers. Rollout along mobile network coverage.

Short-Term Actions

2 Develop operational concept for the new target airspace model ("Data-driven self-controlled airspace").

3 Assess potential for adjustment of uniform target levels of safety and a reduction of airspace buffers by applying risk-based principles in safety assessments and airspace design.

4 Assessment of the legal framework: Are adjustments in the aviation law pre-requisite for the implementation of SE 7–10? Based on the findings, define implementation plan.

Medium-Term Actions

1 Swiss Airspace re-design plan considering reduced needs of 'airspace buffers' and network ability to identify and track aerial vehicles.

The **Business Aviation** dimension consists of only one suggested strategic element.

SE 11: New Platforms for Business Aviation

In order to implement the above SE, the following next steps are suggested.
Note that this overview is not comprehensive, but rather functions as an initial pointer.

Short-Term Actions

1 **An operational concept for the triple usage of the air-field Dübendorf (Air Force, innovation-hub, business aviation) – including the key features of the hybrid airport shall be developed.**

The **General Aviation and Regional Airport** dimension contains the following strategic elements:

SE 12: Regional airport coordination
SE 13: New business areas for regional airports

In order to implement the above SE, the following next steps are suggested.
Note that this overview is not comprehensive, and instead functions as an initial pointer.

Short-Term Actions

1 Based on the strategy process: Definition of a financing concept that ensures planning security for regional airports and defines an incentive model for

Short-Term Actions

the distribution of BV86 earmarked fuel tax revenue funds to the airports.

Cost savings and innovation shall be rewarded by the new fund distribution model.

2. Based on this strategy: Strategy process for regional airports, defining business models and roles of airports, as well as next steps.

The **efficient and secure data exchange and digitalization** contains the following strategic elements:

SE 14: Data Integrity Monitoring and Cyber Security Unit

In order to implement the above SE, the following next steps are suggested.
Note that this overview is not comprehensive and instead functions as an initial pointer.

Short-Term Actions

1. Prepare draft regulation as a fundament for defining/enabling the two new business areas for skyguide (Data Integrity Monitoring Unit, Cyber Control Unit).

2. Clarification with neighbouring countries and the European Union on how the cyber security control can be internationally coordinated. Clarification of cooperation within Switzerland.

3. Mandate skyguide to draft a concept and a transition plan that describes how the new business areas can be integrated into their service portfolio.

4. **Political mandate to BAKOM to ensure sufficient spectrum capacity for aviation needs.**

The **Organizational and Governance** dimension contains the following strategic elements:

SE 15: Empowering the airports
SE 16: Transformation of skyguide
SE 17: ATM architecture Switzerland
SE 18: AirCom – the Swiss economic regulator for aviation

In order to implement the above SE, the following next steps are suggested.
Note that this overview is not comprehensive and instead functions as an initial pointer.

Short-Term Actions

1. **Prepare the new regulations enabling the transfer of the data authority and responsibility to the airports.**

2. **Mandate skyguide to draft a concept that describes how the organizational and governance separation between regulated business areas and commercial business areas can be done.**

3. **FOCA to draft an implementation concept for the new regulatory framework and governance.**

4. **FOCA initiates and supports the establishment of an "aviation platform", a forum where FOCA and the industry develop new business and operational concepts and assesses how the regulatory framework can be adjusted to support these.**

The **Sustainability** dimension contains the following strategic elements:

SE 19: Hybrid airport
SE 20: Sustainable ATM infrastructure
SE 21: Support of R&D through LFG 103b

In order to implement the above SE, the following next steps are suggested.
Note that this overview is not comprehensive and instead functions as an initial pointer.

Short-Term Actions

1. Development of a hybrid concept (by ARCS, for example) for airports and a describing process of how airports can apply.

   Using Dübendorf airport as a 'case study' to demonstrate the benefits of the Hybrid model.

2. Mandate ARCS for the development of a national aviation R&D plan ("Forschungsplan").

   Coordination with Innosuisse regarding the administration of the LFG103b funds.

3. Based on this strategy and supplemented by Skyguide's Vision 2035: align with SESAR for the development of a Swiss ATM concept in the frame of SES regulations.

4. **Development of a financing model that describes the financing mechanisms for the industry through LFG103b and BV86.**


SWISS
SWISS

8. Annex

8.1 References

Aerosuisse: The added valued of Switzerland's civil aviation. Swiss Aerospace facts 2019

Airbus (2019): Global Market Forecast: Cities, Airports and Aircraft 2019-2038

Boston Consulting Group (BCG): The Swiss Aviation Ecosystem – Flying Blind after 2030, October, 2018.

Bundesamt für Kommunikation BAKOM (11.11.20): Frequenznutzung im Rahmen von Drohnenanwendungen

Bundesamt für Raumplanung ARE (17.6.2020): Einfluss von COVID-19 auf die Mobilität (KKV 2/20)

Bundesamt für Zivilluftfahrt (BAZL): AVISTRAT-CH -Vision. Ittigen, August 2019

COST (European Cooperation in Science and Technology): TU 1408: Air Transport and Regional Development (ATARD). Final Achievement Report

Economiesuisse (2016): Starke Luftfahrt – Fundament der Schweizer Wirtschaft. Medienmitteilung 04.11.2016

Eurocontrol: Forecast for Europe 2020-2024: Actual and % change compared to 2019 (https://www.eurocontrol.int/publication/eurocontrol-five-year-forecast-2020-2024)

Eurocontrol (2018): European aviation in 2040 – Challenges of growth. Annex 1, Flight Forecast to 2040

Flughafen München (2020): Verkehrsstatistik, (https://www.munich-airport.de/verkehrszahlen-88506)

HSG Center for Aviation Competence (CFAC- HSG) 2020: Civil Aviation 2040 – A perspective by Swiss Society

Intraplan (2015): Entwicklung des Luftverkehr in der Schweiz bis 2030: Nachfrageprognose.

KMU Factsheet der Schweizer Luftfahrt 1/2018

McKinsey & Co.: Will airline hubs recover from Covid-19?, November 2020,

(https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/will-airline-hubs-recover-from-covid-19)

Roland Berger (November, 2018): Urban Air Mobility: The rise of a new mode of transportation

Schweizer Armee: Luftverteidigung als Gesamtsystem (Präsentation)

SESAR JU: European Drones Outlook Study – Unlocking the value for Europe, 2016.

University of St. Gallen: Ecosystem Analysis, FS19-8, 003,1.00 RPV: Aviation Industry

8.2 List of Acronyms

As some of the notions used throughout the report can easily be confused, the definitions below can be used to distinguish the meaning of these notions:

"Air Navigation Services": means air traffic services; communication, navigation and surveillance services; meteorological services for air navigation; and aeronautical information services.

Source: (Article 2(4) of Regulation (EC) No 549/2004 of the European Parliament and of the Council of 10 March 2004 laying down the framework for the creation of the single European sky.

"Air Traffic Management": The aggregation of the airborne and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations.

Source: Regulation 549/2004 - SES Framework

"Air Traffic Services": A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Source: ICAO Doc 4444 PANS-ATM

ACRONYMS

ADS:	ATM Data Services
ADS-B:	Automatic Dependent Surveillance-Broadcast
ANDSC:	Air Navigation Data and Service Company
AIS:	Aeronautical Information Services
AMAN:	Arrival Manager
ANS:	Air Navigation Services

ANSP: Air Navigation Service Provider
ARR: Arrival
ASM: Airspace Management
ATC: Air Traffic Control
ATFCM: Air Traffic Flow and Capacity Management
ATM: Air Traffic Management
BA: Business Aviation
BVLOS: Beyond Visual Line of Sight
CNS: Communication, Navigation, Surveillance
CORSIA: Carbon Offset and Reductions Scheme for International Aviation
CPDLC: Controller–pilot data link communications
DAA: Detect and Avoid
DEP: Departure
DMAN: Departure Manager
DSCA: Data driven self-controlled airspace
EASA: European Union Aviation Safety Agency
EATMN: European air Traffic Management Network
FIR: Flight Information Region
FOCA: Federal Office of Civil Aviation (in Switzerland)
GA: General Aviation
GBAS: Ground-Based Augmentation System
GHG: Green House Gas
GNSS: Global Navigation Satellite System
ILS: Instrument Landing System
LFG: Luftfahrtgesetz
LUPO: Luftfahrtpolitischer Bericht
MAA: Military Aviation Authority
MAP: Missed Approach
MET: Meteorological Services
MFCN: Mobile Fixed Communications Network
MVA: Minimum Vectoring Altitude
REG AD: Regional Aerodromes
ROT: Runway Occupancy Time
R&D Research & Development
SAF: Swiss Air Force
SAR: Search and Rescue
SBAS: Satellite Based Augmentation System
SES: Single European Sky
SESAR: Single European Sky ATM Research
SID: Standard Instrument Departure (Route)
SIL: Sachplan Infrastruktur Luftfahrt
STAR: Standard Arrival (Route)
SUSI: Swiss U-Space Implementation
SWIM: System Wide Information Management
TCAS: Traffic Collision Avoidance System
TMA: Terminal Area
UAM: Urban Air Mobility
UAS: Unmanned Aerial Systems
UAV: Unmanned Aerial Vehicles
VHF: Very High Frequency

8.3 Overview SME Interviews

In the context of developing the present strategy the following Subject Matter Experts (SME) have been interviewed:

21.08.2020	Dr. Ulrich Seewer	Bundesamt für Raumplanung ARE
24.08.2020	Helen Niedhart	CAT Aviation
25.08.2020	Div. Benni Müller	Schweizerische Luftwaffe
19.09.2020	Thomas Frick	Swiss International Airlines
07.10.2020	Matthias Suhr	EuroAirport Basel
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