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System-Based Air Traffic Controller Licence Concept

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SUMMARY

This paper will consider and analyse the challenges and opportunities of a system-based licensing methodology for air traffic controllers, as well as its possible consequences, including but not limited to technological, operational, legal, and professional issues.

1. INTRODUCTION

1.1. The concept of system-based licensing is understood as, once an air traffic controller manages the operating system (hereinafter referred to as system) to a certain performance standard, they will be able work any operating position utilising the system that falls in the category of their air traffic controller rating(s), regardless of the organisation, country or even region. Some Air Traffic Service Providers (ATSP) and industries are talking about system-based licences, as a possible evolution of the current licensing methodology. This is more than a significant shift from the current way of gaining competence and meeting the required performance standards needed to exercise the rights and duties of an air traffic controller. Whereas the handling of the system is currently a peripheral part of the qualification needed, that is well and thoroughly learned through the long and complex training on how to manage flows of air traffic, using that exact system.

1.1.1. The term "system" will be used throughout this paper and is understood to comprise all aspects of the equipment (hardware) and tools (software) used by an air traffic controller. This includes, but is not limited to, surveillance systems, situation displays, communication systems, electronic/paper flight strips, datalink systems, and information displays. The term "system" does not include humans or operational procedures.

1.1.2. This paper is being written based on a hypothetical situation and not by any known implementation desire. The embodiment of the concept is mainly based on the authors' understanding of it, without any official documentation or discussion existing on the topic.

1.1.3. Within this paper automation is mentioned throughout. To be clear, the paper is not providing an opinion on automation, only how automation relates to the concept.

1.2. Looking at today's licensing architecture, which is based on Air Traffic Control (ATC) sectors that have clearly defined geographical boundaries, system-based air traffic controller licensing would be different in matching the operational characteristics dependent on the systems used by the air traffic controller. Those system requirements need to be associated with the necessary qualification requirements and supported with appropriate training.

1.3. Training provided exclusively for the operational system the air traffic controller is going to work - is traditionally a small part of the sector endorsement for the unit, but at the same time a major and inescapable part, since the whole duration of the training is executed on the same exact system (sometimes even the simulator training). This means that within every moment the air traffic controller is learning new capabilities and features of the system, while they receive any part of an air traffic controller On-The-Job (OJT) training. This paper will explore the concept of a licence that would be only system based - meaning that almost all the operational knowledge including local knowledge on geography, procedures, traffic patterns, complexity, and local rationale will not have to be acquired anymore but instead will be system provided.

2. DISCUSSION

2.1. The concept of system-based air traffic controller licensing is akin to type ratings for pilots. Whereby, an air traffic controller could qualify on a system and subsequently work anywhere that system is employed. At the highest level, this concept seems comparable. However, it is not as comparable as it seems, as ATC is a service provided in an area not an action like flying an aircraft. There are tools that assist air traffic controllers in providing safe and efficient control service in an airspace, but without the tools the environment still exists. Whereas flying is an action, and the aircraft is the tool required for the action to occur. Without it, flying is not possible.

2.2. An aircraft, and how it is operated, is effectively the same no matter when or where it is flown. Quite simply this is because it is an unchanging machine, and the pilot is in control of all aspects of the aircraft-. Their role is to operate the machine. Conversely, the environment in which ATC service is provided is a constant variable. The service environment is continually impacted by unpredictability and randomness of weather, traffic density, air traffic controller and pilot decisions, just to name a few. An air traffic controller is continually assessing, deriving, and amending plans in response to influences entirely out of their control. The role of an air traffic controller is to monitor and direct the movement of aircraft and not operate a machine.

2.3. To achieve such a licensing concept the tools an air traffic controller must work with will need to be highly automated. This automation must provide information in the range from *almost all* to *all* data related to the typical required local knowledge, depending on the duration of experience the working air traffic controller has at the specific moment. The system would need to strictly follow all Aeronautical Information Regulation And Control (AIRAC) cycles and update all appropriate information on due date or before the AIRAC change date. The number of changes to procedures, airspace, waypoints, new and/or special volumes, local rules, change of Flight Level

Allocation Scheme (FLAS) and many other changes can be as high as 20-30 changes per AIRAC date. Incorporating all changes into the system would have to be done expeditiously and with extreme precision, to ensure the accuracy and safety of the airspace system. This information includes and is not limited to topography, procedures, types of traffic and their conflict hotspots among others as well as all local information, local features, etc. The time needed to incorporate each piece of new local or regional information is crucial to allow the system like this to work unerringly. With current methodology the air traffic controllers are briefed with AIRAC changes even if not integrated in the system in due time.

2.4. Moreover, the new system-based concept would mandate to also present *all* new data, not just integrate it in the system. The information would need to be presented in a simplistic way to keep the HMI user friendly while still presenting *all* needed information to an air traffic controller, bringing up the famous, well researched trade-off between simplicity and accuracy. For the industry to consider relocation and/or migration of air traffic controllers on a regular basis, the system would also have to be extremely standardised. This would again require the *perfect* presentation and integration of the data, no matter the demands of intricate, local knowledge requirements. This point alone questions the ability to even develop a system like this. Technology and its counterparts will never operate at 100% and they are prone to occasional failures. At the time of the publishing of this paper, a system that is accurate and reliable 100% of the time does not exist.

2.5. IFATCA standing policy WC 10.2.5 states, in part:

> **"Automation shall assist and support ATCOs in the execution of their duties." (IFATCA 2023)**

To realise the flexibility of staff allocation that a system-based licence conceptualises, it would require the automation to do more than simply assist. A large component of tasks, including conflict detection, would need to be done by the system as the air traffic controller would no longer have the required local knowledge of conflict hotspots. It would also require an air traffic controller to be more attentive to data entry and the entry accuracy, to ensure the system output is accurate and reliable. The concept of Garbage In, Garbage Out (GIGO) is hence also an important factor to consider. Moreover, the air traffic controller may have additional data retrieval tasks to support the system, which could lead to extensive data menus and/or an increased number of displays at workstations.

2.6. Computer systems are programmed with various parameters to fulfil the requirements presented. The program will operate very well within the defined parameters of the program. However, if presented with a unique unexpected problem, the system will fail. Even with Machine Learning (ML) and possible Artificial Intelligence (AI, if it could approach or surpass human intelligence (Zhang, 2022)), as it is a safety system, it is going to need to be challenged/tested to ensure its responses/reactions to problems are sound and safe. Automation designers/developers are unable to create programs to deal with all eventualities and situations. The uncontrollable variability in the ATC environment and aviation system as a whole is the most significant obstacle in automating all the tasks of the system (ICAO, 1994).

TECHNOLOGY

2.7. The International Organization for Standardization (ISO) describes human-centred design as,

> "**Human-centred design is an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, and usability knowledge and techniques. This approach enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and sustainability; and counteracts possible adverse effects of use on human health, safety and performance.**" (ISO 2019)

It is very well documented that ATC system automation must be a human-centred design and the concept is strongly endorsed by ICAO (ICAO, 1998a). However, the level of automation required to achieve a system capable of allowing a system-based licence would need to be a more technology-centred design. The various issues and concerns to a technology-centred approach cannot be overstated (ICAO, 1998b). The paper strip in the past assisted the air traffic controller in creating a mental model and identifying conflicts, whereas conflict identification can often be done by a system (Medium-term conflict detection) and the air traffic controller can use their time to find conflict resolutions. However, the removal of the tasks associated with the paper strip removed a tool used in creating a mental model of traffic, which in turn affects the situational awareness of the air traffic controller, ultimately eroding their overall instincts. Additionally, in some areas such as a tower, air traffic controllers are focusing on data entry and its accuracy, necessary to support the system, which creates more heads down time. Electronic strips are an example of a good technological solution to human inefficiency, which works well and as a result the air traffic controller does not want to return to paper. It is also an example of a common occurrence with technology, where it solves one problem but creates another.

2.8. Experiments have shown that employing conflict probe automation can improve conflict detection and the mental workload of an air traffic controller (Metzger & Parasuraman, 2005). It was noted however that a significant number of conflicts were still missed, which is not acceptable in the real world. It was also noted that contributing factors to missed events related to an air traffic controller being unfamiliar with the sector (Metzger & Parasuraman, 2005). In a system-based licence concept, air traffic controller sector familiarity reduces exponentially compared to today's licence methodology, simply due to the reduced time of sector utilisation of an individual air traffic controller. The air traffic controllers would need to utilise more sectors meaning that the time spent on each sector would decrease, thus the quality of their work would decrease affecting safety directly. Familiarity of a certain sector is not just frequencies and their coverage, or routes and coordinates, but is also traffic patterns, traffic flows, conflict hotspots and how aircraft/airlines typically perform when flying different routes in or throughout the sector. One could argue that knowing traffic patterns, hotspots, and how the whole traffic flow is behaving throughout the sector, including most common pilot requested levels or other requests is even more important than theoretical local knowledge of a sector. The familiarity gives an air traffic controller the much-needed experience as well as the additional unwritten “theoretical” knowledge that largely contribute to the safety level exercised on duty. Furthermore, this familiarity again helps build the mental model that assists air traffic controllers in being proactive in providing services, as opposed to just being reactive.

2.9. The financial cost and time to develop and implement a system-based licensing concept would be significant. With an air traffic controller's almost complete reliance on the system, it must have multiple layers of redundancy in both primary and contingency systems. The layers are necessary to ensure availability and reliability in all aspects of, hardware, software, adaptation, and the data the system produces/presents. Additionally, as the technology becomes ever more integrated and networked, cyber protections are required, including air-gapped network infrastructures to prevent potential issues on the primary system, such as a virus, from infecting the contingency system. Commercially obtained infrastructure will be necessary and may require investment/improvement to meet the requirements of the ATC system. The timelines and desires of the commercial components may not coincide with the requirements and timings of the system.

2.10. Maintenance, including preventative maintenance and failure recovery, requirements of the end-to-end system must also be considered. With the significant reliance on the system, ensuring that it is functioning correctly is necessary to ensure the safe and efficient movement of aircraft. Failure scenarios will have larger impacts on the aviation system as air traffic controllers will be less proficient without the system, potentially resulting in significant flight disruptions. Disruptions may not only be experienced locally but can extend well into the aviation system. A Flight Data Processing (FDP) system failure in the UK in August 2023 (Calder 2023), resulted in more than 1500 flights being cancelled or delayed on the day. air traffic controllers implemented the ‘fallback procedure’ of manually entering flight plan data and manually coordinating flights between sectors (National Air Traffic Services (NATS) 2023). As a result, air traffic controllers, to ensure safety, could only handle fifteen percent (15%) of normal traffic (Calder 2023). Although the FDP failure was brief, lasting a few hours, the knock-on effect of airline crew and aircraft being out of position, along with stranded passengers, caused total aviation system recovery to take days.

TRAINING

2.11. System-based licensing would lead to a loss of the broad aviation system knowledge of an air traffic controller, since they do not need to obtain or maintain any sector specifics anymore - systems would have all the information. If our understanding of the concept of system licences is correct, this leads us to conclude that all the operational knowledge including local knowledge on geography, procedures, coordination, traffic patterns and hotspots, and local rationale will not have to be acquired anymore. What kind of competency-based training and assessment will have to be developed to achieve these visions of the ATM designers? Is it sufficient to increase the harmonisation of the basic training and the unit training to achieve this? How will the regulators be able to assess future Unit competency training plans and competency schemes? How will the initial training be adjusted to these new ideas? Does the length of training reduce with a system-based licence? How does an air traffic controller respond to the system failure without operational knowledge? This is certainly a topic which merits a lot of research, which does not exist and leaves the professional public with more questions than answers.

2.12. Systems do fail and expose the *automation conundrum* which states that:

> "**The more automation is added to a system, and the more reliable and robust that automation is, the less likely that human operators overseeing the automation will be aware of critical information and able to take over manual control when needed. More automation refers to automation use for more functions, longer durations, higher levels of automation, and automation that encompasses longer task sequences.**" **(Endsley 2023)**

It is not a matter of 'if', but more of 'when'. Failures are not always inherent programming defects or bugs but can be procedural anomalies or entry errors that lead to failures. Examples include the NOTAM system failure in the FAA in January 2023 (Petrauskaite 2023) was caused by a file being unintentionally deleted and the FDP failure in NATS UK in August 2023 (Calder 2023) was caused by the system being unable to handle duplicate waypoints. System infrastructure, such as networks or supporting equipment, may also fail causing the overall system to operate in a degraded or failed state. The ATC environment remains unchanged with a system failure, i.e., airborne aircraft do not stop, and conflicts will still be present or new ones will develop. As such, air traffic controllers are expected to continue to provide service and derive solutions regardless of system availability (IFATCA 2023). It is expected that a contingency/emergency plan is available to support failures, however every failure scenario and the impacts cannot be fully understood in advance. It is very easy to understand that a failure will result in something unexpected that was not previously considered. For an air traffic controller to respond effectively and not contribute to the problem, they must maintain a reasonable level of expertise and local knowledge of the airspace they are working (ICAO 1998c).

PROFICIENCY

2.13. System-based licensing system would reduce the air traffic controllers frequency of exposure to all the airspace they could be responsible for, in the current system. This raises a question concerning how efficient and how proficient they would be, in terms of hourly capacity of air traffic. Controllers use several criteria to build a mental picture of the traffic situation, question their picture and reframe it, to achieve an efficient traffic pattern. In the context of ATC, a mental picture may include both spatial relationships (e.g., aircraft trajectories) and abstract data referring to weather conditions, aircraft performance, types of flights and so forth. For instance, controllers classify aircraft into standard or non-standard classes according to several traffic characteristics (e.g., ingress and egress points, coordination requirements, and crossing routes/altitude profiles). Therefore, a structure hierarchy (see Figure 1) is built which is dependent on context and which may be difficult to train through the system licence framework. The individual perception of the knowledge an air traffic controller has is personalised and tailor-made by all air traffic controllers for themselves in order to provide the highest levels of safety and proficiency as possible. On the other hand, this same knowledge being presented through the software of the operating system is only presented in one specific way - as decided by the software developers - and is thus broadly generalised and standardised which can never fit or improve the mental picture of all operational air traffic controllers. The system-based licensing concept would blur the mental pictures of most air traffic controllers resulting in a decrease of average and overall proficiency.

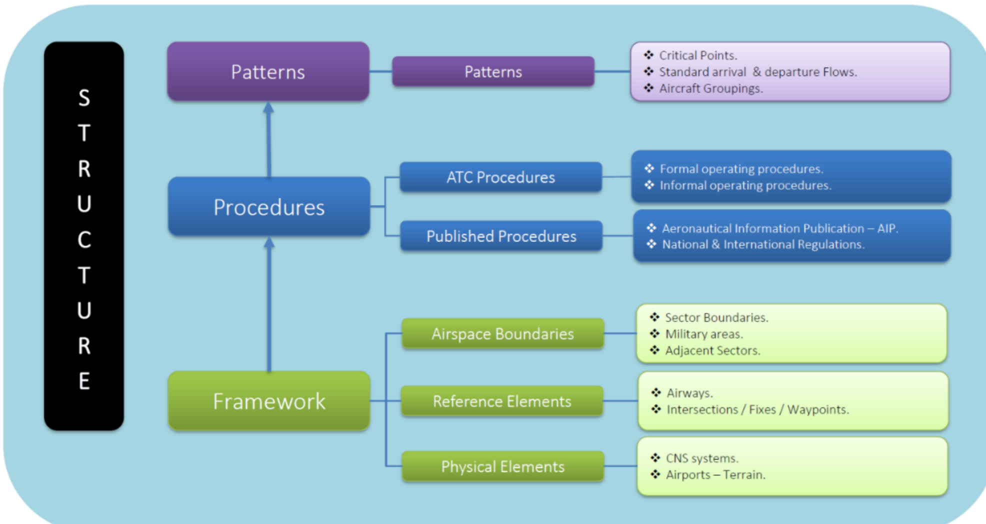

Figure 1 - Mental picture and structure (Credit: Baumgartner M. & Malakis S.)

2.14. Most ATSPs have a single system, or suite of complementary systems, employed throughout their area of responsibility (AoR). Therefore, one of the expectations of a system-based licence could also be that an air traffic controller could work in any part of the AoR, high- or low-level. The ability to work any airspace based on the tool it employs presents a significant challenge to proficiency, the ability to maintain it, and the required checks to validate that proficiency. When considering the size of some ICAO states, Canada, and the USA each have an AoR of over 10,000,000 km^2, this ability for an air traffic controller to maintain currency, in all operating positions, is difficult if not impossible. As an operating position encompasses the associated airspace and not just the system used, an air traffic controller will need to work airspace on a regular basis to maintain proficiency (ICAO 1984a). It can be a nearly impossible task for an air traffic controller to organically work all areas of a vast AoR often enough. As such, scheduling would need to occur, which ultimately defeats the conceptualised benefit of system-based licensing. For example, in Germany if you are moved to another family of sectors (covering another part of the AoR), the familiarisation training takes 3-4 months for experienced controllers just to start working a different volume of airspace in the same room, with the same equipment. It is impossible to imagine that it could be viable to move an air traffic controller to a completely different country, just to exercise a completely different part of airspace for a certain amount of time, with completely different air traffic, using the same operational system as at “home”.

2.15. To exercise the privileges of any ATC licence, ICAO stipulates an ongoing need to prove proficiency at “particular” operating positions (ICAO, 1984b). The job of an air traffic controller is not to operate a system, but to control airspace and the system is merely a tool to support safety and efficiency - as this is the case at the time of publishing this paper, it shall also remain the case in the future. As such, sectors (whether fixed or dynamic) and their associated operating positions will continue to be in place in a system-based licence concept, as they are defined not by ATC tools but the external influences on the airspace (ICAO, 1984c). Routine proficiency checks will require an air traffic controller to be evaluated in all operating positions they could possibly work. Cycling all air traffic controllers through each operating position, at an appropriate time for proficiency evaluation, will create different staffing concerns. It would further require significant amendment to the regulation, both national and international. The possibility that an air traffic controller could not work a "particular" operating position because their proficiency evaluation is not complete/current, becomes a very real possibility.

2.16. Considering the reliability of modern systems, a protracted time between failures can be expected. Ensuring adequate failure practice becomes paramount for air traffic controllers to ensure that a system failure does not create or compound a significant safety issue. ICAO stipulates that pilots shall not conduct simulated emergencies or abnormal situations with passengers or cargo on board (ICAO, 2022). Although no specific guidance from ICAO relating to ATC, it is reasonable to infer the same stipulation to the ATC environment. As such, the requirement for a high-fidelity simulation system emerges, if for no other reason, to exercise the failure practices for all areas that an air traffic controller can work.

2.17. The requirement of Evaluation Officers (EO) becomes ever more critical and timelier, as such, additional EOs are likely (ICAO, 1984d). The knowledge required for an EO to adequately assess proficiency can be unmanageable as there would be the need to understand an entire state AoR. To assist the EO, another layer of automation would need to be developed. The scope of work is also likely to require an increase in EO, which again contradicts the potential staffing benefits of a system-based licence.

PROFESSIONAL

2.18. The profession of ATC is well documented to be a challenging one, in not only the requirements and standards of the job but also the effects on the person performing the job. The skills, dedication to learning, coupled with the translation to real-world performance is paramount to that of a high-level athlete. Within the profession, these attributes create a sense of team and professional respect and above all trust. That trust and respect is also earned in the aviation community as air traffic controllers are viewed as always in control and know what to do and when to do it. There are many documented cases where an air traffic controller is the reason a catastrophic aircraft incident did not occur, when a pilot was in distress.

2.19. One of the most important questions to be asked is definitely; can an inexperienced air traffic controller managing the volume of airspace based on their system licence provide the same level of safety compared to an experienced air traffic controller? Is the system itself able to complement the level of safety and expertise of an air traffic controller to the levels achieved by air traffic controllers working in this volume of airspace every day? Connecting this question to the worldwide more popular AI question, it could be easily argued that until the Automation levels reach human intelligence, any ATC oriented system cannot compensate for the lower amount of ATC expertise and professionalism of experienced air traffic controllers. According to Zhang (2022), that actually incorporated many other studies and AI experts, there is a 50% chance this would happen in the year 2060 and hence there is no reason to believe that any ATC system could achieve the safety and professional standard of an experienced air traffic controller before that time. Since safety is and will always be number one priority in the Air Traffic Control profession, this should be a clear indication whether a solution like this is even plausible to consider.

2.20. The automation required and the reliance on that automation by the air traffic controller for a system-based licence will completely change the job and how it is done. Boredom, complacency, lack of motivation, job dissatisfaction, monotony and a breakdown of team elements are all well researched (EUROCONTROL, 2006) and are known precursors to incidents (Human Factors "Dirty Dozen", 2023). These elements would occur in an environment required to support system-based licences.

2.21. Impacts on air traffic controller health is another issue that may occur, especially in busy sector hours worked by air traffic controllers with little experience and/or currency in these sectors. Health concerns, not limited to stress, tiredness, and their consequences, on these air traffic controllers can be much worse than those who have a lot of experience working in these sectors. In a system-based licensing environment, it is challenging to visualise how an air traffic controller will gain the overall experience to overcome some of these issues. As mentioned previously, air traffic controller skills will diminish, and diminished skills and lack of overall understanding may lead to anxiety, indecision, a lack of confidence and errors.

2.22. There is a growing misconception that Air Traffic Controllers will become Air Traffic Managers in the future. In reality, they are and will always continue to be air traffic controllers regardless of the tools they use. Part of their education, knowledge and experience provides them the ability to proactively recognise issues, when to step in and "control" and when not to, as well as the ability to reason and determine solutions whether routine or not. A system-based licence effectively diminishes that ability and transforms air traffic controllers into system operators, only performing actions based on what a system tells them to do. As a result, the view of the profession in the aviation community and the public at large will change considerably and the effective respect for the profession will erode.

LEGAL and FINANCIAL

2.23. Aside from the changes to the overall licensing scheme, there are potential issues surrounding operational incidents and responsibility. With the automation having to do a majority of the work and air traffic controllers merely accepting those solutions presented, who is responsible for errors or wrong indications? IFATCA policy is clear that an air traffic controller will not be responsible for any incidents resulting from system automation. IFATCA standing policy WC 10.2.5 states, in part:

“A Controller shall not be held liable for incidents that may occur due to the use of inaccurate data if he is unable to check the integrity of the information received.

A Controller shall not be held liable for incidents in which a loss of separation occurs due to a resolution advisory issued by an automated system.” (IFATCA 2023)

Will the programmers, coders, manufacturers, testers, (the list goes on and on), be held responsible? Should they be held responsible? It is not widely standardised if they should be, however what is known is the fact that the consequence of an error in the developing process can be catastrophic. Lawyers, families, and the legal system will be looking for answers and someone to blame. Even *if* a system like this could ever be developed, will there be a legal background to support it and its operations? This could be easily compared to self-driving cars with technology well developed but being held back due to legal considerations and countries’ law systems that are unable to come up with the legal framework for the operation, use and incident analysis of self-driving cars.

2.24. Another legal aspect, already discussed through the paper, is the challenge to amend the regulation needed to facilitate the movement of air traffic controllers between countries or even continents.

2.25. Furthermore, the financial barriers could be immense. Who would start to develop a system like this, if there were a small chance it would even work as desired? With almost uncountable requirements for all the system’s levels and layers it would most probably not be profitable for an organisation, considering all the Research & Development needed just to start a project like this. It could further lead to a harmful monopoly environment if the system is developed by a (private) company that does not prioritise safety and is not mainly focused to improve the critical infrastructure of a country - what the air traffic services in reality are.

ADVANTAGES

2.26. A system-based licensing theory does have benefits, *if* it could ever be achieved in a way to provide the same or higher level of safety and quality assurance standards. ATSPs will have far more flexibility with staffing allocation, in both planning and ad hoc adjustments. Training could change to the basic air traffic controller instruction to achieve the desired rating, followed by a brief layer of system training. Upon certification, a new air traffic controller would then be available to work any operating position in the ATSP that falls in the category of the air traffic controller rating.

2.27. Domestically, a system-rated licence could be portable as the features of a system can be identical, as dictated by the ATSP. Anything less than full domestic portability with system-based licence will render the entire concept moot. The portability of such a licence may on an international scale be even harder to achieve, as adaptations and features utilised in a foreign ATSP may be different, even though the system is the same. State regulations may prohibit the ability for work functions to be similar state to state. ICAO level guidance to systems standardisations, features, and adaptations, would be necessary to allow for a system-based licence to be truly portable.

2.28. *If* ICAO level guidance is provided for systems, and the level of automation that would need to accompany a system-based licence is achieved, with the capabilities of networking technology ATC services for an airspace could occur from anywhere in the world at any time. With the lack of local knowledge requirements of the air traffic controller and no restrictions from ICAO on where ATC service is to be provided from, a competitive global market could emerge to provide ATC services to ATSPs. ATSPs, especially those that privatise, continually look for ways to reduce ongoing operating costs. With a competitive ATC service market, an ATSP could contract ATC services to the lowest bidder and no longer be responsible for some equipment costs or personnel costs.

3. CONCLUSION

3.1. The proposal for a system-based licensing methodology for air traffic controllers is a concept laden with challenges and potential pitfalls that are likely to outweigh the purported advantages. The idea of allowing air traffic controllers to work in different volumes of airspace only based on their proficiency with a particular system may seem appealing in theory. Unfortunately, a closer examination reveals significant operational, technological, legal, and professional concerns.

3.2. ATC is a complex and dynamic environment where safety and efficiency are paramount. The current methodology of licensing, which includes comprehensive training, sector-specific knowledge, and proficiency evaluations, ensures that air traffic controllers are competent to handle the unpredictable nature of air traffic. Introducing a system-based licensing approach threatens to compromise the very foundations of expertise and experience that contribute to the high safety standards, upheld by the industry.

3.3. Considering the level of system development needed to envisage deploying such system-based licensing, one needs to compensate for:

- the safety levels and standards guaranteed by experienced air traffic controllers today.
- the efficient and orderly flow controlled by experienced air traffic controllers today.
- the specific area training (licensing).
- the costs linked to such development (vs the recruitment and training costs).
- the risk of loss of human back-up/knowledge over time (operating a system rather than controlling aircraft).
- the overall restrictions imposed on traffic (e.g. If we can consider only higher layers, extra flight path restrictions will need to be imposed to standardise overall the system, probably non-optimal CO_2 flight paths and city-pairs restrictions).
- any gains seem far away and extremely costly and risky to achieve.

3.4. The solution is not to disrupt the licensing system, but for ICAO or any appropriate stakeholder to define what exactly each operational system shall have and how each system will integrate with the other. Furthermore, they will ideally produce operational performance requirements used by ANS industry worldwide in a coherent, interconnected, and a standardised way. Providing and/or specifying the best available system to all ATSPs should be the main goal of the industry. It is only through this that collusion and cooperation between countries is achieved and the flow of information is always present and tidal.

3.5. This way, the industry can continue to evolve and adapt without compromising the high standards of safety and proficiency as well as cut significant costs that are now inevitable in order to buy or develop individual systems.

3.6. System-based licence is not recommended. As we embrace the technological innovations of systems employed for ATC, we must grapple with the challenges they present. Although these technologies necessitate a shift in skills and training, they are just the tools that are used to support a service of providing the highest safety standards possible and should not be the sole criteria for obtaining an ATC licence.

4. RECOMMENDATIONS

4.1. It is recommended that this paper is accepted as information material.

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