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Air Traffic Management 2030 Strategy: Scoping Study

Prepared for Highlands and Islands Airports Limited

Final Report

an egis company

About Helios

This document is prepared by Helios, an independent consultancy specialising in aviation and air traffic management.

Helios is a world-leading aviation management consultancy, part of the Egis Group. Uniquely, we deliver high-level management consultancy skills integrated with detailed technical and operational understanding in the aviation domain. We are trusted by ANSPs, airports, governments and industry to help transform performance, innovate in strategy, and provide credible detailed advice on a range of issues. We are at the forefront of the aviation regulatory situation, where the European Commission continue to ask us to provide long term support to its strategic consultation bodies for industry, regulators and social dialogue. We have worked with Boards and senior teams from almost all European ANSPs, helping to shape the future of the industry.

In the UK, we are privileged to work with NATS, HIAL, Heathrow, Gatwick, Department for Transport, and many others, and specifically helped develop the Low Density Low Complexity Airspace strategy for the UK CAA, IAA and HIAL.

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Approval

Date	Name	Signature	Role

A limited amount of information has been redacted from this report where it considered exempt from publication. Where information has been redacted it is indicated in the text. Each redaction has a number showing the classification of redaction, and an explanation of these classifications can be found on the final page of this report.

Executive Summary

This document is prepared by Helios, an independent consultancy specialising in aviation and Air Traffic Management (ATM). It is a technical scoping study assessing the options for Air Navigation Service (ANS) provision at the 11 airports operated by Highland and Islands Airports Ltd (HIAL). The study is prepared as an input to HIAL's overall Air Traffic Management 2030 Strategy.

Context

Aviation provides essential connectivity for the Highlands and Islands region of Scotland. The airports and connecting flights directly contribute to the economy and sustainability of the communities, particularly in the more remote regions, and are critical for the future prosperity of these regions. These airports also play a crucial role in regional development across the country through the development of Scottish tourism.

Highlands and Islands Airports Limited (HIAL) is a private limited company, owned 100% by Scottish Ministers, and is responsible for the management and operation of eleven airports, as shown in the map below. In 2016-17, the airports under HIAL management served 1.66m passengers (an increase of 15.4% over the previous year) with 129,000 aircraft movements.

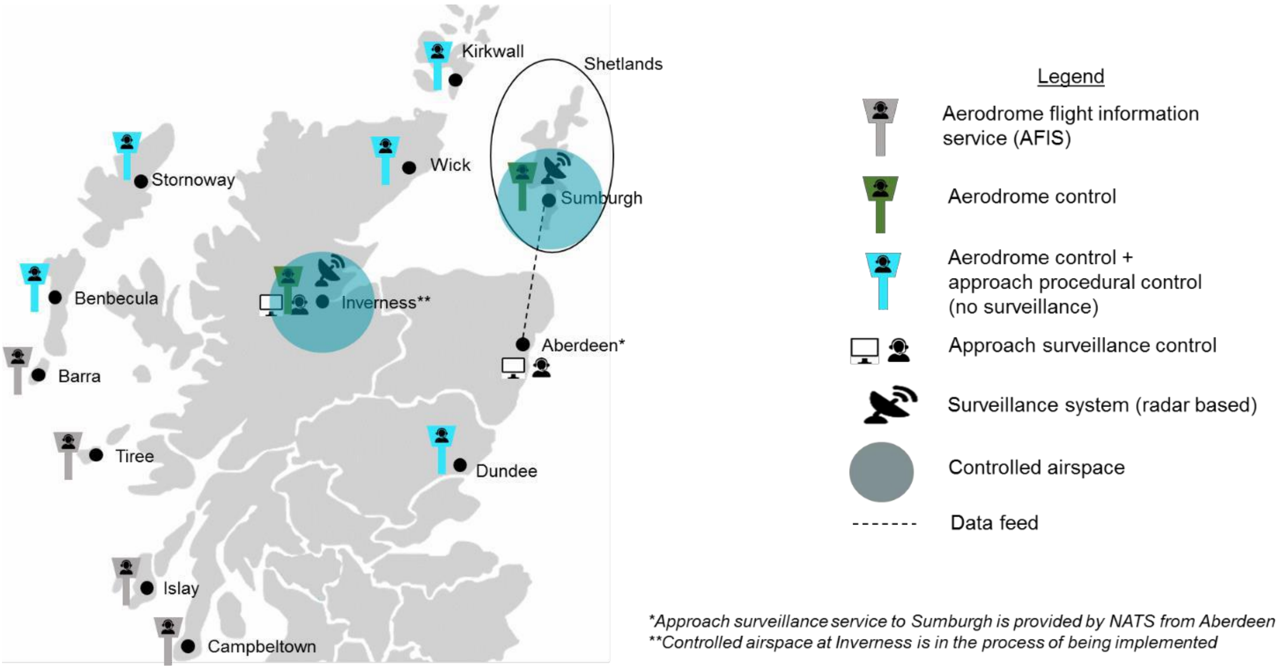

Figure 1: Current HIAL air navigation services

Under the UK Civil Aviation Act, as the airport operator, HIAL must ensure that appropriate Air Navigation Services (ANS) are provided to maintain an acceptable level of safety for aircraft flying to and from the airports. HIAL itself is the licensed provider of ANS and is regulated by the UK Civil Aviation Authority.

These services can include providing information on other traffic, alerting aircraft to each other, or proactively separating aircraft according to pre-defined minimum distances or times. An airport with very low levels of traffic may only require an Aerodrome Flight Information Service (AFIS), provided by an Aerodrome Flight Information Service Officer (AFISO). An airport with multiple concurrent movements of aircraft will likely require the more stringent Air Traffic Control (ATC) service, where an Air Traffic Controller (ATCO) passes instructions and clearances to the aircraft.

ATC services can be provided in controlled or uncontrolled airspace. Uncontrolled airspace permits aircraft to fly freely without talking to the ATCO, but aircraft that wish to be controlled (ie and be deconflicted) can do so, subject to the ATCO knowing about them. In controlled airspace, depending on the exact classification, traffic flying certain flight rules must abide by the controller clearances.

Finally, the service may benefit from surveillance, giving the ATCO or AFISO surveillance information on the aircraft position and identity. A service may be provided without surveillance, which means relying on voice reporting alone, using pre-defined procedures to assure separation if a control service is provided.

HIAL has been able to maintain its operating model for ANS provision for many years, predominantly providing an approach procedural (APP) service without the benefit of surveillance in uncontrolled airspace. APP is a service where “the controller provides restrictions, instructions, and clearances, which if complied with, will deconflict aircraft from other aircraft participating in the APP service. Neither traffic information nor deconfliction advice can be passed with respect to unknown traffic." [44]. In other words, APP is a non-surveillance based form of ATC, which uses position reports to deconflict participating aircraft. At the smaller airports with lower traffic levels, HIAL provides an Aerodrome Flight Information Service (AFIS) to aircraft. The service is provided by an AFISO.

Scope, objectives and approach of the study

The key objective for HIAL is the long-term sustainability of the ANS provision. The sustainability of the current service provision is being called into question and can no longer rely on short-term solutions that fail to address underlying structural issues. The key issues include:

- retention and recruitment challenges across many of the airports in the HIAL portfolio;
- the risk that HIAL will be unable to train controllers for the procedural approach service on which the current ANS provision relies;
- continued downward pressure on subsidies, leading to deferred investment in ANS; and
- little opportunity for economies of scale or scope.

There are lesser challenges, including HIAL’s ability to extend the operating hours of the airport to service the flexible demands of airspace users, whether tactically such as for delayed flights or strategically with new late-night traffic due to emerging oil and gas operations. To the company and its staff’s credit, they do aim to meet the customer needs where possible, but this typically relies on the goodwill of staff rather than ANS being ‘flexible by design’.

Specific drivers and constraints are outlined in the following section.

HIAL’s response to the key issues can follow two paths:

- put significantly more money into the existing ANS structural model to alleviate issues, for example by paying staff more to make the jobs more attractive in a competitive ATCO marketplace, and by investing more in infrastructure;
- change the structure of how ANS is provided.

HIAL’s Air Traffic Management 2030 Strategy seeks to envision the second of these paths to future-proof the provision of Air Navigation Services by improving resilience, reducing cancellations, and offering a safer, more flexible and more environmentally friendly operating environment. Within this strategy, HIAL identified four potential elements for implementation. These elements were:

- Introduction of controlled airspace (CAS) at all Air Traffic Control (ATC) airports that currently have no control zone/area.
- Replacement of standalone approach procedural (APP) services with approach surveillance (APS) services to create a known traffic environment where aircraft that are currently not visible to ATC will then be displayed. This service could be provided from individual airports, or from a centralised surveillance facility.
- Introduction of remote towers (RT) at up to 11 airports, using a Remote Tower Centre potentially co-located with the centralised surveillance facility.
- Introduction of a single Out Of Hours (OOH), on-call Flight Information Service (at the 5 airports that currently have an OOH service, namely Benbecula, Kirkwall, Stornoway, Sumburgh and Wick), due to the possibilities created by the Remote Tower Centre.

HIAL asked Helios to evaluate the feasibility and impact of implementing these elements (and their combinations) to develop a recommended, well-evidenced option that would future-proof HIAL's provision of ANS.

We did this by assessing viable combinations of the elements above, using the drivers and constraints to long-term sustainability as criteria. We talked to many of HIAL's staff, travelling to each airport, and understanding the reality of the operations and challenges. We also held consultations with several stakeholders, including the UK CAA, military, suppliers and airspace users. This initial process led to four down-selected implementation options.

We then developed a detailed Cost-Benefit Analysis to compare the options, and put this into the context of a Balanced Scorecard approach to be able to develop a recommended option for HIAL. Finally, an outline implementation plan was developed, including timelines and short-term next steps.

Drivers and constraints

HIAL's Air Traffic Management 2030 Strategy was developed in response to several drivers for change. These were clarified to assist with the assessment of each of the implementation options, and include:

- Maintaining lifeline services to remote communities: ensuring that airports remain open and that air navigation services are provided is fundamental to HIAL's mission to support connectivity and tourism to the remote communities that HIAL operates in.
- Continually improving safety: HIAL must meet minimum safety standards but also must strive to continuously improve safety levels.
- Complying with regulation: upcoming regulatory changes from EASA (European Aviation Safety Agency) will require HIAL to introduce controlled airspace at several airports. The timescale and extent of this controlled airspace is not yet known.
- Remaining financially sustainable: HIAL is expected to reduce its reliance on subsidies and to operate more as a commercial business where revenues as a percentage of total income increase over time.
- Optimising ANS: HIAL must also continue to modernise to be able to support the changing requirements of airspace users, including support for new technical and operational concepts that benefit aircraft, such as the implementation of more direct (time and fuel saving) routes.

Air Traffic Management 2030 Strategy is also subject to several constraints to change:

- Addressing the impact on staff: some of the ATM 2030 strategic projects involve centralising operations from the current airports to a centralised location, which involves significant personal change for ATS staff.
- Proving technical and operational feasibility: remote towers and, to a lesser extent, the introduction of an approach surveillance service (APS) at each airport can present significant technical challenges specific to the HIAL environments, most obviously in the availability of viable communications and power infrastructure.
- Achieving stakeholder acceptability: each of the changes being examined may need to be subject to a level of public scrutiny, either through a political committee or via a full public consultation.
- Ability to handle the scale of change: The ability to handle a large-scale change will rely on significant resources and experience. HIAL may therefore be constrained in what is realistically achievable, or at least in how quickly it is achieved.

Feasible options for analysis

Considering the drivers and constraints, and using information received from the consultations, we produced four potential implementation options for detailed assessment. The option IDs refer to the main report body.

These were:

- CAS and APP – Implement controlled airspace (CAS) and some limited surveillance at all HIAL ATC airports, maintaining the current procedural approach control (APP) (option 1b);
- Local APS – Implement CAS and surveillance based approach control (APS) at each ATC airport (option 2b);
- Centralised APS – Implement CAS and surveillance based approach control (APS) at a single approach facility for all ATC airports (option 2c);
- Remote Towers and centralised APS – Implement CAS and a remote tower for each aerodrome (ADI), including a Remote Tower centre and single approach (APS) control unit (option 3).

We discounted the “do nothing” scenario as it did not reflect the requirement to implement controlled airspace when providing ATC services, arising from the EU regulation 2017/373 (Part-ATS). The “do nothing” scenario was therefore not a viable way forward, and keeping it would have led to an unhelpful and unrealistic comparison being made, since it is never a viable option. This position was confirmed during discussions with the UK CAA, with the controlled airspace requirement due to be transposed into UK law post-Brexit. Therefore, the first implementation option “CAS and APP” represents a “baseline” for HIAL. It does not resolve the core issue of sustainability, but would provide some safety benefits from the introduction of limited surveillance through Aerodrome Traffic Monitors (at a relatively low cost).

We also discounted options based on the introduction of an APS service using new primary and secondary surveillance radars. Such options would be cost prohibitive and a more feasible option would be to provide an APS service with newer and more cost-effective surveillance technologies such as Wide Area Multilateration (WAM) and ADS-B. This would be dependent upon CAA approval, but a precedent has already been set in Norway where APS is provided without primary radar. The APS service could then be provided either: from the local towers, potentially as a combined ADI/APS position in low traffic periods (option 2b), or from a single centralised approach facility (option 2c).

Finally, we consider that the current AFIS airports should continue to provide their current services and see no clear drivers for centralising the AFIS service and no reason why the AFIS airports may not continue to provide an AFIS to commercial aircraft under an exemption from the CAA, assuming traffic levels do not markedly change.

Options assessment

We carried out an assessment of the four selected options in detail, including a cost benefit perspective. The aim was to identify the preferred option using an adapted version of the UK Government Green Book approach [58] and a 'balanced scorecard'. This provided a more holistic assessment and considered strategic elements such as HIAL's mission, vision, core values and strategic focus areas as well as the more operational and technical elements impacted by each option.

The balanced scorecard approach specifically considered four perspectives. These are presented below, together with a mapping to the identified drivers and constraints.

Table 1 Overview of the balanced scorecard approach

Balanced scorecard assessment category & description	Key drivers and constraints considered
Financial: the impact of the options on financial performance and the use of financial resources.	• Remaining financially sustainable
Customer/Stakeholder: this perspective viewed impact of the options from the point of view of the customer (airlines) and other key stakeholders such as the Scottish Government and the UK CAA.	• Continually improving safety • Optimising ANS • Achieving stakeholder acceptability
Internal Process: considered the impact of the change through the lenses of the quality and efficiency related to HIAL services.	• Maintaining lifeline services to remote communities • Proving technical and operational feasibility
Organisational Capacity (originally called Learning and Growth): assessed the options through the lenses of human capital, infrastructure, technology, culture and other capacities that are impacted.	• Complying with regulation • Addressing the impact on staff • Ability to handle the scale of change

Financial

The financial analysis is a comparative one and therefore only captures a sub-set of overall HIAL operating costs, namely those that are affected by the investments undertaken in the options[1].

The least costly option of the four is the CAS and APP (baseline) option. In this baseline option, the cost of the relevant elements equates to £94.9M in real terms over 15 years. The implementation of a local APS at each of the ATC airports would be £22.2M more expensive than the baseline option at £117.1M over 15 years. The centralised APS function is £29.8M more at £124.7M and a Remote Tower and centralised APS solution would be £28.4M more expensive at a total cost of £123.3M, again measured over a 15-year period.

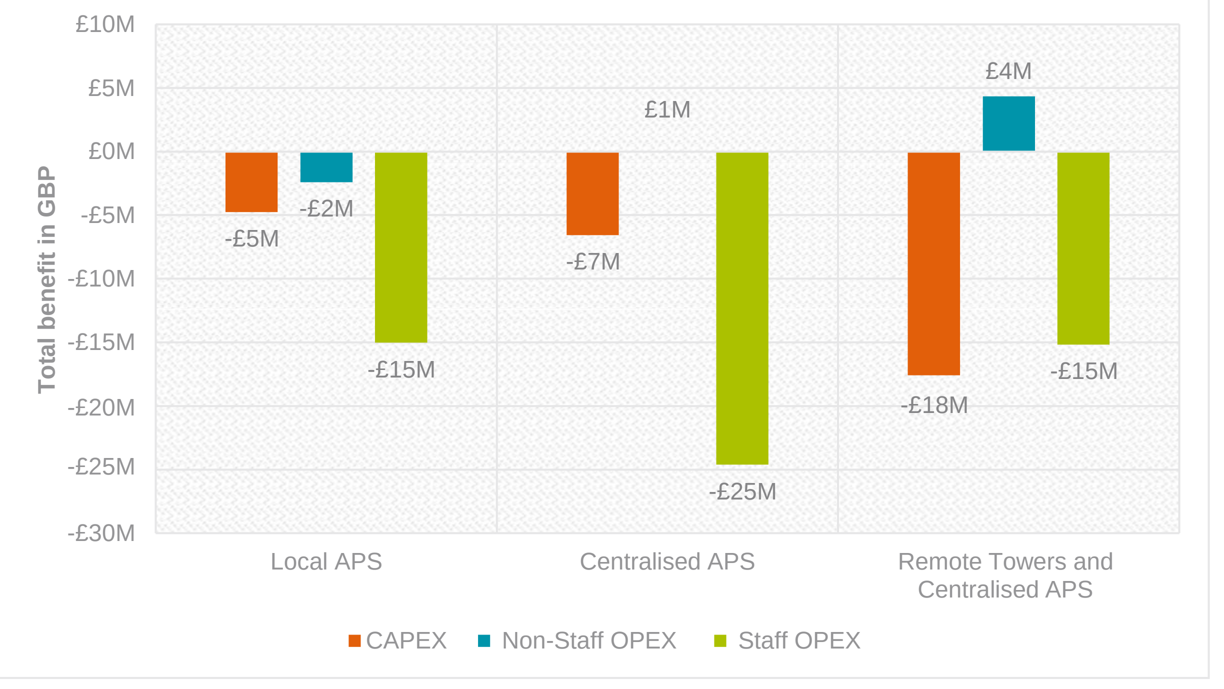

Figure 2 Cumulative saving from implementing non-baseline options, broken down by cost categories

The relative cost savings in the CAS and APP option arise from a lack of any large training programmes, additional recruitment or large capital expenditure projects (other than the assumed tower refurbishment & replacement in the capital plan).

The introduction of an APS function in all other options (2b, 2c and 3) is a major cost element, with capital investment of £1.4-£4.4M in surveillance infrastructure, £3.0M on surveillance data processing infrastructure and £0.5M - £3.0M in building infrastructure (depending on whether the data processing is centralised).

In addition to the capital expenditure, the introduction of local APS significantly drives staff operating costs. In this option, we estimate that HIAL would require an additional 11 ATCOs to support the additional working positions, in line with UK CAA CAP 670. Additionally, most of the existing ADI/APP ATCOs would be required to complete an APS validation, which would further drive training costs. Over the course of the 15 years, this would result in an additional cost of £12.2M in employment and training cost (in real terms).

[1] The study only costed those elements which change due to the implementation of ATM 2030 Strategy. This includes ATS staff salaries, cost of additional staff where necessary, applicable training costs, cost of new surveillance and remote tower installations and the cost of a new centralised facility.

For centralised APS we have estimated that an additional 25 ATCOs and 4 supervisors would be required, which translates to an increased ATCO employment and training cost of £19.3M over 15 years.

The Remote Tower and centralised APS option increases the capital expenditure by £17.5M compared to the “baseline” CAS and APP option, but allows for the introduction of an APS service without significantly increasing the staffing pool. Based on the CAP670 guidelines, and when considering the required senior ATCO oversight, we have estimated that the APS and ADI services could be provided with 3 additional ATS staff than the current configuration. Nonetheless, HIAL would be required to pay relocation and training costs (estimated at £7.3M).

If we compare the real cost of the options, local APS is 23% more expensive than the baseline option of CAS and APP (1b), centralised APS 31% more expensive than the baseline option and Remote Towers and centralised APS roughly 30% more expensive than the baseline.

The core analysis was limited to a 15-year time-span, but a sensitivity analysis of the impact of looking at different time-spans was carried out. This analysis shows that as we increase the term of the Cost and Benefit analysis, the gap between the cost of the local APS and the Remote Towers and centralised APS options diminishes, with the centralised APS becoming relatively even more expensive.

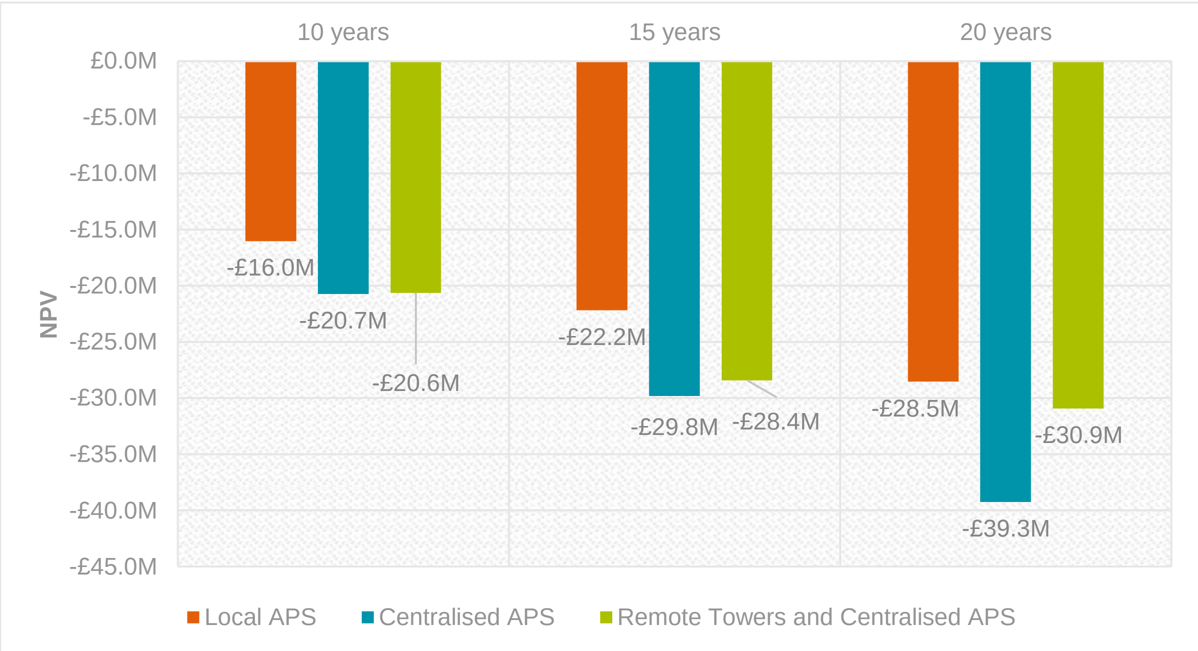

Figure 3 CBA timespan sensitivity analysis

Therefore, the main message from the financial analysis is that any significant change to HIAL's operating model for ANS provision would introduce a step change in costs, but this change is roughly similar for each of the down-selected options. In the longer term, efficiencies related to lower staff operating costs observed in the Remote Towers and centralised APS option start to outweigh the high up-front capital expenditure. The option still requires circa £1m per annum additional to today's budget in the long-term.

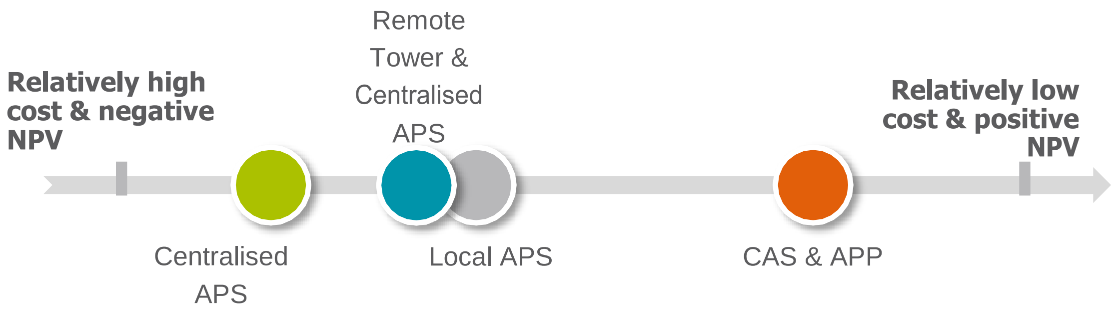

Figure 4 Financial assessment outcome

Customer/stakeholder

All options introduce controlled airspace and have a resultant positive impact on safety arising from greater ATCO knowledge of the operational environment.

The baseline option (1b) assumes an APP service is maintained and that separation would still be provided through procedural means. This means controllers would still be limited in their ability to control the risk of airborne conflict as they would only be able to use surveillance information for situational awareness and not deconfliction.

All other options introduce an APS service which will improve safety by enabling a surveillance-based separation minima to be applied, and giving the ATCO full surveillance information to be able to recover errors by the aircraft or ATCO effectively. For some airlines, a surveillance service is a minimum requirement to operate (eg KLM in Inverness) so these options will also potentially remove a barrier to attracting new routes and airlines. This directly impacts HIAL's aim of improving connectivity and encouraging new entrants to the region, which may be particularly important as the attractiveness of the Highlands and Islands as a tourist destination continues to grow.

Surveillance could also enable more direct routes, enable continuous climb and descent operations decreasing average track miles per flight thus reducing fuel burn and flight-time. These efficiencies are likely to be largest in the options where APS is centralised, easing the coordination between sectors. The flight efficiency benefits would not be observed at all in the baseline option (CAS and APP). The benefits observed will depend on exact procedures used (eg specific routings and separation standard), but will almost certainly increase the aircraft flow rate.

The Remote Tower and centralised APS option enables more flexibility in the hours which ATS is provided at airports through a centralised facility. This could prevent situations in which extensions cannot be provided, and make HIAL's service provision more attractive from a user perspective. Safety benefits may also accrue due to the remote tower's cameras' ability to better detect wildlife and other aircraft, particularly in low visibility (eg infra-red visibility, motion detection, identification & labelling of aircraft etc).

The potential in this option for losing the ability to provide an ATC service due to technical connectivity failures is assumed to be no less than it is today, but there could be safety risks in cases where a comparable level of service availability is not possible (eg due to insufficient infrastructure). We assessed the viability of appropriate communications being available, and found feasible solutions for each airport. The additional costs were taken into account in the CBA.

On a wider stakeholder level, the political considerations of moving jobs away from remote communities is beyond the scope of this technical report, but clearly there is the potential for this to impact the acceptability of the option. It will have to be duly considered by HIAL, Transport Scotland and Scottish Ministers.

On balance, we believe that the CAS and APP option ("baseline") is the least favourable option from a customer / stakeholder perspective as it offers the least significant safety and operational improvements. All other options introduce an APS service which will improve safety and has the potential of fuel savings for the airlines. Additionally, the Remote Tower and centralised APS option enables more flexibility in the hours of ATS provision at the airports, further increasing the potential benefits to the users, making it the most favourable option from a customer impact perspective.

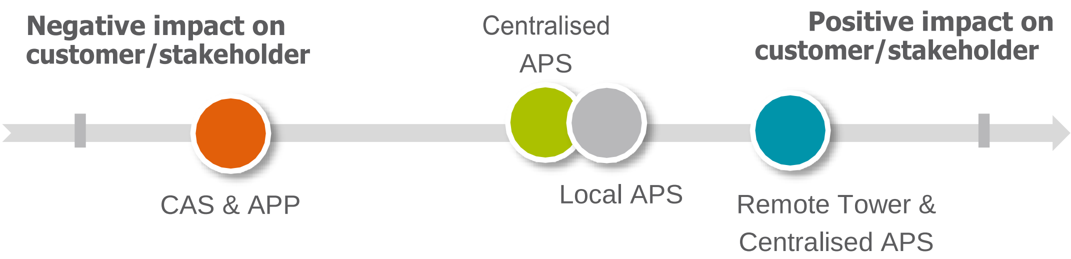

Figure 5 Customer/stakeholder assessment

Internal Process (service quality and sustainability)

Long term sustainability

The CAS and APP option, where the number and location of ATCO working positions will not change, will not allow HIAL to address ongoing recruitment issues, training issues and insufficient staffing levels. It also continues to expose HIAL to the risk that APP training courses will continue to increase in cost and may be withdrawn in the UK market as demand diminishes, or the need for non-APP training needs increases.

However, both APS-only options (local APS and centralised APS) would put further pressure on recruitment and retention challenges due to either: relying on new staff for the APS centre (2c); or to potentially replace existing staff that are unable to validate on the more highly skilled APS role in the case of the local APS (2b). For the local APS option, in line with CAP670, we estimate that HIAL would require an additional 11 ATCOs to support the additional working position. In the centralised APS option, we have estimated that an additional 8 ATSAs, 25 ATCOs and 4 supervisors would be required.

The move to Remote Towers and centralised APS (3) would allow HIAL to introduce a full APS and remote ADI service with a similar number of ATS staff as at present. Due to the rostering efficiencies that could ultimately be realised through a centralised remote centre it is expected that 8 additional ATCOs and 4 supervisors would be required but that the ATSA pool would be reduced by 9, resulting in a net ATS staffing increase of 3. As above for APS-only options, there could be challenges in validating staff at the remote centre, but this would be partially mitigated by increased flexibility (eg the possibility to validate as an ADI at multiple airports rather than an ADI/APS ATCO).

Considering long-term sustainability, the Remote Towers and centralised APS option is the only way of solving HIAL's recruitment issues and ensuring that insufficient staffing does not have a detrimental effect on the airport opening hours which would hinder regional growth. HIAL would however need to carefully manage the transition and bear the cost of providing staff with relocation packages and any alternative arrangements for those unwilling to relocate.

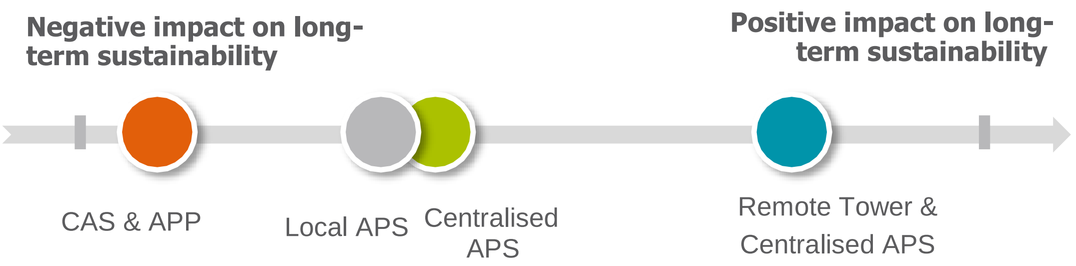

Figure 6 Long Term sustainability assessment

<u>Technical and operational feasibility</u>

In terms of technical and operational feasibility, the baseline option CAS and APP is relatively straightforward with the main challenge being to introduce controlled airspace (which would apply to all options).

The feasibility of the introduction of APS (all other options) relies upon CAA approval of: a surveillance solution for an APS service based on Wide Area Multilateration (WAM) and ADS-B rather than conventional radar. Developing a safety case without primary radar will rely on providing sufficient assurance that aircraft operating in the relevant airspace will be equipped and that any equipment failures can be suitably detected and mitigated, or that the traffic is known to the ATCO via radio contact.

In addition to the risks related to the APS service introduction, the Remote Tower and centralised APS option introduces several new technical and operational challenges due to the relatively recent emergence of Remote Towers. The availability of communications was identified early as a particular issue. In discussions with potential suppliers, we are reassured that solutions do exist. Costs of these solutions (eg laying of new fibre optic) have been taken into account in the financial analysis.

Many of the broader technical and operational challenges will have been addressed by those who will implement Remote Towers in similar environments before HIAL, including in Sweden (already operating Remote Towers since 2015) and Norway (due to enter operations in the next few years). In the UK and Channel Islands, many of the challenges in the approval process will have been resolved by London City, Cranfield or Jersey, which have already signed contracts for the equipment and are due to enter operations before HIAL.

On balance, we see CAS and APP carrying the lowest level of technical and operational risk with the Remote Tower and centralised APS option carrying the highest.

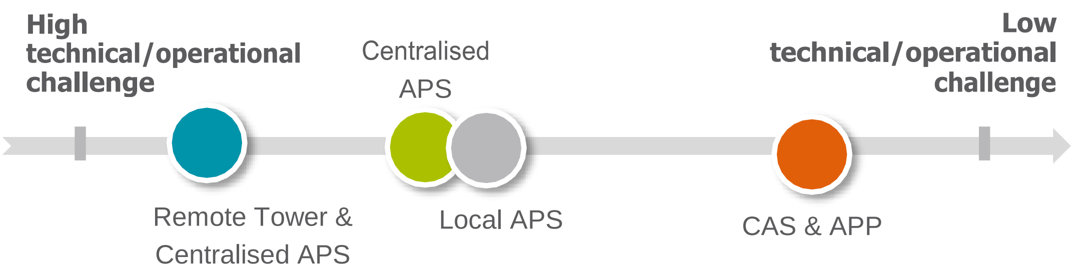

Figure 7 Technical and operational feasibility assessment

Organisational Capacity

Impact on operational staff

All options will impact on staff, with the evidence from our consultations being that individual situations and perceptions will lead to a variety of responses to the implemented strategy.

The baseline option (CAS and APP) is unlikely to have material impact on ATCO job satisfaction, retention or recruitment ability, as ATCO ratings and job locations remain the same as current. There will still be a change in working environment with the introduction of controlled airspace and Aerodrome Traffic Monitors, but this is unlikely to pose any issues for existing staff.

A local APS service (2b) could create opportunities for the existing ATCOs through the requirement for dual ratings. There is however a risk that some of the existing workforce would be unable to achieve the APS rating, leading to further challenges with recruitment and retention.

The relocation of the APS service to a centralised location (centralised APS, 2c) would mean that ADI ATCOs would no longer be able to provide an approach service (APP or APS) and this may[2] remove some of the interest and satisfaction in the job. It would also create new vacancies to be filled, either at the APS centre (for the newly created positions) or at the airports (where existing staff transfer to the APS centre). The situation would also exacerbate challenges with recruitment and retention.

The introduction of Remote Towers and centralised APS creates the largest change to the ATCOs' operational environment, requiring most ATS staff to relocate to a centralised location and potentially qualify to control traffic at more than one airport.

Overall, we expect the local APS option to be received relatively favourably. The options involving centralised APS (with or without Remote Towers) would have significant impact on current job roles and locations, and therefore will be seen as opportunities to some ATS staff and threats to other. The CAS and APP option maintains the status quo and is therefore a more comfortable option for staff.

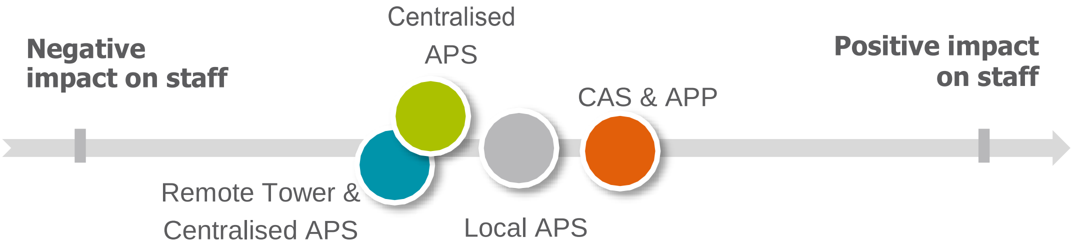

Figure 8 Impact on staff assessment

Ease of Regulatory Approval

All options require a change to HIAL's provision of ANS, namely the introduction of controlled airspace, likely requiring multiple Airspace Change Proposals at considerable internal effort.

The options introducing APS will require significant additional time and effort as they involve obtaining regulatory approval for a concept that has not yet been achieved anywhere else in the UK, namely that of providing an APS service without conventional radar[3]. Regulatory approval would be further complicated by the aim to provide a combined ADI/APS position during low traffic periods for the local APS option.

[2] Based on feedback from ATS staff visits
[3] Although it has been approved in other European States and globally.

The inclusion of Remote Towers would involve the most substantial effort of all, requiring all the above and additional effort to approve the Remote Towers, initially in single 1:1 (one airport to one remote module) mode but also, when appropriate, in multiple 2:1 (two airports to one module) mode. Whilst some of the regulatory risk would have been removed by the first movers (particularly NATS, Jersey and Cranfield in the UK), HIAL's implementation would nevertheless be expected to come under close scrutiny by the CAA, particularly given the high reliance on the relatively limited infrastructure at some of the HIAL airports. This makes it the least favourable option from the perspective of ease of regulatory approval, and recognising HIAL's limited organisational capacity.

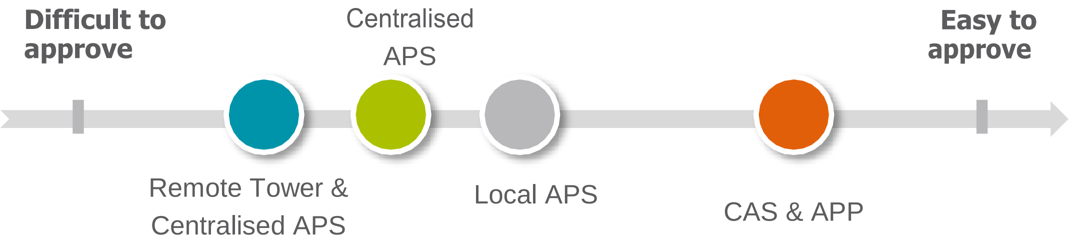

Figure 9 Regulatory approval assessment

Ability to handle the scale of change

All options will require significant effort and time to implement. HIAL is not a large organisation and currently has little spare capacity. The anticipated effort required for this major change programme will test the organisational capacity at all levels.

Even the baseline option (CAS and APP) involves introducing CAS on a scale not previously undertaken by HIAL, including the time and effort of certification and approval. This apart, the baseline option involves the least change.

The local APS option requires much greater effort and resource to procure and implement surveillance infrastructure as well as to manage training and transition to APS. Further effort will also be needed to provide evidence for the proposed move to APS without primary radar. The centralised APS option is similar, but with the added complexity of establishing, recruiting, training, and transitioning some staff to a centralised facility;

Including Remote Towers and centralised APS would present a major change on a scale never attempted by HIAL and will require very careful planning and phasing.

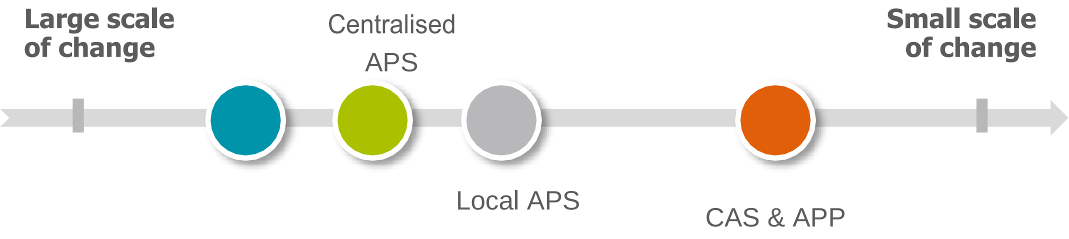

Figure 10 Ability to manage the scale of change assessment

Conclusions and recommendations

The criteria above can be summarised within the Balanced Scorecard as follows:

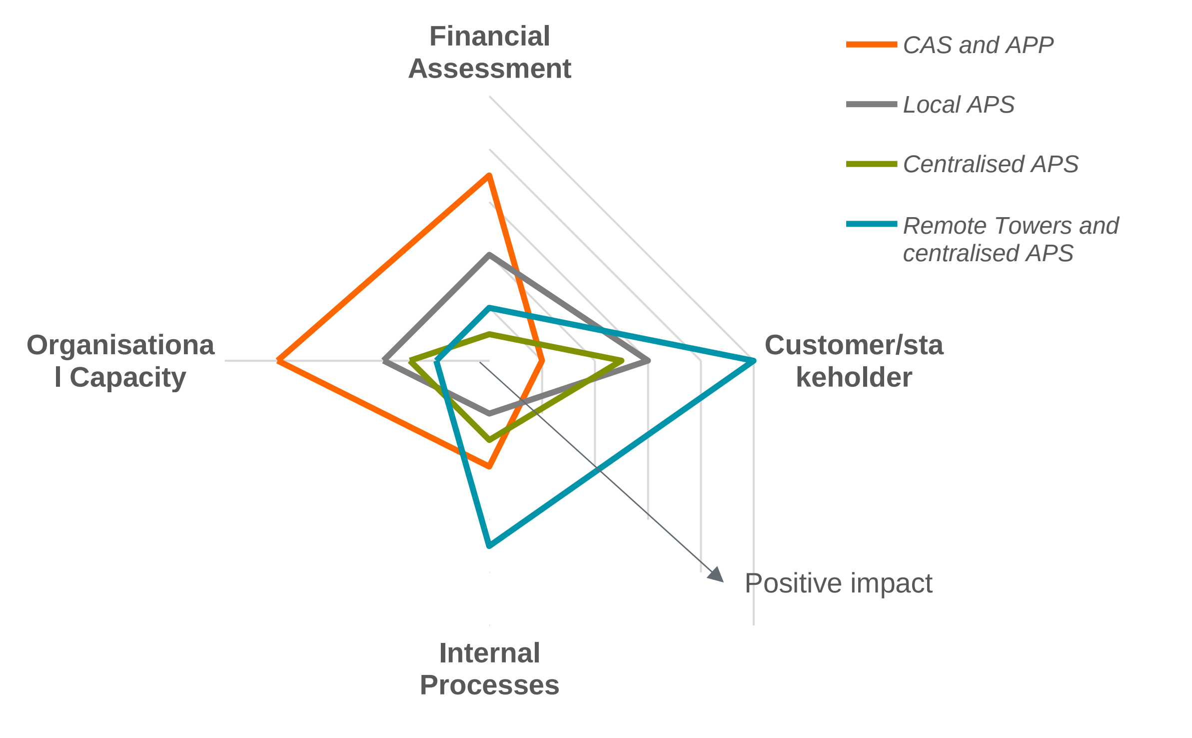

Figure 11: Summary of options assessment against balanced scorecard categories

In our capacity as an independent assessor of the options available to HIAL under ATM 2030 Strategy, **we make an overall recommendation that HIAL pursues the Remote Tower and centralised APS option.**

Our reasoning for this is as follows:

Business as usual (CAS and APP) is not a viable long-term option

The structural challenges outlined at the start of this summary would not be addressed by "business as usual". Lifeline services must be provided, and improved connectivity is a key goal for HIAL to ensure that both tourism and the region can grow and prosper. Based on the evidence, the provision of an APP service by HIAL will only become harder over time as: the availability of APP ATCOs reduces; as training costs increase and availability in the UK potentially disappears; as the competitive market for ANS grows; and as APP continues to act as a barrier to traffic growth (as some airlines will not operate in a non-surveillance environment), flight efficiency and safety improvement. In our view, the question of moving away from APP is therefore one of 'when' rather than 'if'. In the medium-long term, the baseline option of CAS and APP is not judged to be feasible.

We asked the question whether HIAL could keep with the current baseline option until absolutely forced to change. The baseline option seems a viable option in the short term, since it most closely represents the current situation. It is the least disruptive of the options, and therefore may seem the easiest. However:

- It continues to rely on the flexibility and goodwill of staff to support services during frequent extension requests to opening hours and in situations where available number of staff is below requirements. The tenability of this situation depends on the probability of that goodwill to continue and the likelihood of external factors that could increase reliance on it (for example the potential for controllers to be attracted to other jobs, a fall in the number of applicants or pass rate; the likelihood of staff unavailability; or demand for different opening hours, ATS service or frequency of extensions).

- Recruitment and retention would not be addressed by the baseline option (or the local or centralised APS options). At the time of writing, HIAL expect to need to replace around 25% of the workforce in the coming 2-3 years. This is a significant challenge when extrapolated across all airports, and may lead to delays or cancellations if the positions cannot be filled.
- Finally, the disruption to APP training in the UK may happen at short notice. HIAL do not want to be in the position of not providing ANS for lifeline services by not having enough APP rated controllers. The current turnover of staff suggests that any disruption to recruitment and training would have an operational impact reasonably quickly. A forced move to an APS service basis would take time, for example in recruiting APS rated ATCOs and procuring and installing the surveillance equipment.

Therefore, we recommend moving away from APP as the basis for ATC services in the HIAL region as soon as feasible.

<u>The introduction of APS (local or centralised) can help, but does not solve the structural issues</u>

Moving to an APS service in controlled airspace would offer improvements in safety and flight efficiency (thus bringing environmental benefit and potentially attracting new operators in the long term). The recruitment pool of available controllers would also be larger as more APS ratings are achieved in the UK. However, both APS-only options would put further pressure on recruitment and retention challenges; this is due to relying on new staff for the APS centre (2c), or to potentially replace existing staff that are unable to validate on the more highly skilled APS role in the case of the local APS (2b). Recruitment and retention would be further impacted by a competitive recruitment market with higher paying alternative employers and, in the case of 2c, because the interest and satisfaction of the remaining role at the airport (ADI-only) would be reduced. HIAL would need flexibility over how fast any transition could be implemented, and may look at natural attrition as one way of implementing the necessary role changes.

The options also introduce substantial cost, not only of the new APS ATCOs, but also due to the procurement and certification of the necessary surveillance infrastructure. Based on our discussions with CAA, we anticipate the certification and approval process for a combined ADI/APS position in the local APS option to be especially challenging. Both APS-only options also bring long term increases in operational expenditure, higher even than option 3.

<u>Remote Tower and centralised APS addresses the structural issues, is cost-comparable with APS-only options (due to cost efficiencies), but involves significant risks which need to be managed proactively</u>.

Remote Tower and centralised APS is the only option to fully tackle the recruitment issues that threaten HIAL's long term sustainability and the only option to fundamentally address HIAL's aim to be flexible for airport out of hours services ensuring that the lack of access does not impede the growth potential of the region.

The option brings a significant capital investment cost, and an increase in operational expenditure in the long-term compared to the current situation. That is the price of solving the structural issue of long-term sustainability.

More positively, the Remote Tower and centralised APS option enables the provision of ADI services at a lower staff cost than any other option and the lowest overall operating cost of the non-APP scenarios. It also offers the potential to reduce costs and generate revenue, for example through grants, sharing costs with others, striking a more innovative deal with suppliers, reducing reliance on NATS and offering new services. Whilst we have taken a conservative approach and not modelled these aspects, they present clear opportunities that, in the longer term, could help HIAL to reduce their reliance on a Scottish Government subsidy.

An area, to be considered further is the potential for HIAL to recover approach fees. Although not the focus of this study (it is a possibility in all options) it would impact on the potential for outsourcing which has otherwise been discounted on the basis that: it would not be commercially attractive (landing fees would not cover the costs alone, and there is no fee recovery for approach); economies of scale would be unpicked; boundaries would be complex to define; and because it's unlikely to be attractive to the market. If HIAL were to move to a similar model to Sweden, for example, there might be opportunities to recover some of the approach fees from the enroute cost base or through establishing a terminal charge for the HIAL region.

We have aimed to be conservative in our costing assumptions. Some of the cost assumptions with the most impact and uncertainty include: the additional staff overhead associated with a centralised facility; the communications costs - which could increase where insufficient contingency or diversity is available; staff relocation costs; and the potential efficiencies that could be introduced through multi-mode operations.

Taking this into account, we are confident that the Remote Towers and centralised APS option would need significant initial investment, but recognise that innovative financing and partnership arrangements could reduce the values outlined above. The ongoing operational expenditure figure relies on several assumptions. We have tried to be conservative, but these assumptions could clearly change during implementation. Any financial argument must of course be weighed up against the ability for HIAL to maintain its purpose and objective.

We recognise this option brings the most implementation challenges, so HIAL would need to address the risks proactively, particularly with regards to impact on staff and achieving regulatory approval (through HIAL assuring itself of the safety impact). HIAL would also need to identify and recruit significant resources to handle such a large-scale change, especially when factoring in the social and political impact on the many staff and local communities that are likely to be impacted.

Despite these risks, the option offers the best answer to HIAL's strategic aspirations to ensure a long-term, sustainable provision of air navigation services. By choosing this option now, a solution to manage risks can be phased in strategically, costs managed over a reasonable timeframe, and lessons learnt at each phase to de-risk future operations.

Implementation plan

There are many open questions in determining an implementation path for the Remote Tower and centralised APS option. A HIAL priority will be to de-risk the change as far as possible, building in appropriate contingency. Based on the assumptions made during the financial assessment, the following key implementation dates are assumed (see Figure 12 below).

Please note that the proposed implementation plan is a flexible suggestion, open to alteration. However, the order in which the implementation will be undertaken may be crucial from a strategic perspective, and should be thoroughly assessed by HIAL management considering the following:

- Traffic volume and complexity;
- Ease of transition;
- Communications technical capabilities and connectivity;
- Human resource issues.

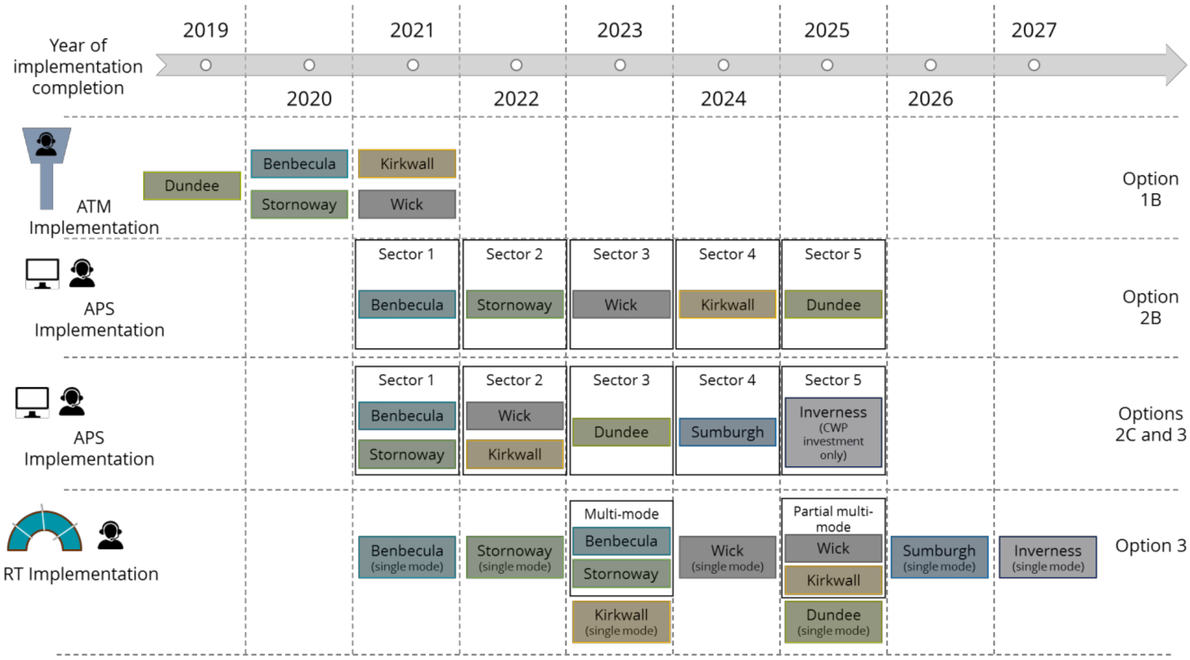

Figure 12: Timelines for key implementation activities in the options

In achieving these proposed implementation dates, there are certain actions on the critical path. If a Board decision to proceed with Air Traffic Management 2030 Strategy is taken (where option 3 is representative of the final decision), the following actions would be on the critical path in 2018:

a) Determine a UK Government approach for controlled airspace (liaison with Department for Transport), enabling HIAL to scope the development of the Airspace Change Proposals and associated concept of operation.

b) Develop a specification for the multilateration (including ADS-B) surveillance solution. Note that an initial draft of the safety case should be developed early on, ensuring safety requirements are taken forwards into the specification and procurement.

c) Proceed with discussions on viable communications solutions (enabling the new surveillance sources and remote towers), including with Scottish Wide Area Network (SWAN) [20] and with microwave link suppliers.

d) Develop a high-level concept of operation and strategy for the combined approach (APS) and Remote Tower centre. This will include functional requirement setting (eg number of positions, toolsets) and an understanding of the content of the new MATS (Manual of ATS) Part II.

e) Analyse options for geographic location of approach centre and remote tower centre. Co-location would obviously bring benefits, but is dependent on the options available.

f) Start initial HR consultation, ensuring planning considers staff views in full.

g) Explore the options to reduce costs and generate revenue, for example through grants, sharing costs with others, striking a more innovative deal with suppliers, reducing reliance on NATS, offering new services and investigating the potential for HIAL to recover approach fees.

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1 Introduction

1.1 Purpose

This document is prepared by Helios, an independent consultancy specialising in aviation and air traffic management. It is the final report of a scoping study into the strategic options for Air Navigation Service (ANS) provision at the 11 airports operated by Highland and Islands Airports Ltd (HIAL). The scoping study will inform HIAL's Air Traffic Management 2030 Strategy.

Specifically, the purpose of this report is to test the appropriateness of HIAL's Air Traffic Management 2030 Strategy in light of the drivers and constraints and to outline all feasible options. The strategy is ultimately a change programme intended to future-proof HIAL's provision of Air Navigation Services by improving resilience, reducing cancellations, offering a safer and more flexible operating environment while creating an environmental benefit. A shortlist of options has also been taken forwards to a full cost benefit assessment and business case allowing us to put forward a recommendation to the HIAL management on which option should be taken forward and what the associated risks and opportunities are.

1.2 Definitions and Acronyms

Whilst this report is written to address a non-technical audience, it does necessarily cover several technical aspects of air navigation services. The following key definitions are therefore provided to aid the reader. A full list of acronyms used in this report is provided below also. Where possible, these are taken from CAP 1430 – UK Air Traffic Management Vocabulary [52], unless otherwise referenced.

Table 2 Key definitions

Term	Definition
Aerodrome control instrument or "ADI" ATCO	A rating, indicating that the licence holder is competent to provide an air traffic control service to aerodrome traffic at an airport that has published instrument approach or departure procedures and shall be accompanied by at least one of the rating endorsements described in ATCO.B.015(a) [47]
Aerodrome Flight Information Services Officer or "AFISO"	A person properly trained, competent and duly authorised and licensed to provide a Basic Service [46].
Aerodrome Traffic Monitor (ATM)	An electronic display indicating the position and distance from touchdown of arriving aircraft relative to the extended centreline of the runway in use. It may also be used for other purposes. It is also known as the Distance From Touchdown Indicator (DFTI). An ATM is provided at certain airports to assist in achieving maximum runway utilisation and airport capacity. Operation of an ATM is not associated with a particular rating and, unless authorised by the CAA, must not be used as an ATS surveillance system to provide Approach Radar Services [44]
Air Navigation Services	Air traffic services; communication, navigation and surveillance services; meteorological services for air navigation; and aeronautical information services

Term	Definition
Air Traffic Control Officer or “ATCO”	A person authorised to provide air traffic control services [45]
Air Traffic Control Service	A service provided for the purpose of preventing collisions between aircraft, and on the manoeuvring area between aircraft and obstructions; and expediting and maintaining an orderly flow of traffic
Air Traffic Service	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)
Approach control procedural controller or “APP” ATCO	A rating indicating that the licence holder is competent to provide an air traffic control service to arriving, departing or transiting aircraft without the use of surveillance equipment; [53]
Approach Control Service	Air traffic control service for arriving or departing controlled flights
Approach control surveillance controller or “APS” ATCO	A rating, indicating that the licence holder is competent to provide an air traffic control service to arriving, departing or transiting aircraft with the use of surveillance equipment [53]
Control Area (CTA)	Controlled airspace extending upwards from a specified limit above the earth.
Control Zone (CTR)	Controlled airspace extending upwards from the surface of the earth to a specified upper limit
Electronic conspicuity	An umbrella term for a range of technologies that can help airspace users to be more aware of other aircraft in the same airspace. It includes transponders and radios [48]
Flight Information Service (FIS)	A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights
Incident	“An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.” [59]
Known traffic	Traffic, the current flight details and intentions of which are known to the controller/FISO.
Multi Mode Operations	Remote Tower Operations in which one ATCO provides an ADI service to more than one airport at a time. A number of multi-mode operational concepts are being developed and tested, and more analysis would be required in the implementation phase to ascertain which would be best suited to HIAL’s operating environment. Existing projects (see Annex G) provide a good base of experience.

Term	Definition
Single Mode Operations	Remote Tower Operations in which one ATCO provides and ADI service to only one airport.
Surveillance	A generic term meaning variously, ADS-B, PSR, SSR or any comparable system that is used to determine the position of an aircraft in range and azimuth
Primary Surveillance Radar (PSR)	A surveillance radar system which uses reflected radio signals
Secondary Surveillance Radar (SSR)	Secondary Surveillance Radar (SSR) A surveillance radar system which uses transmitters/receivers (interrogators) and transponders.
Uncontrolled airspace	In the UK class G airspace is uncontrolled. This means there are no restrictions on: which aircraft can enter it; what equipment the aircraft must carry; the routes taken by the aircraft. [54] *Note: Regardless of the ATS being provided, pilots are ultimately responsible for collision avoidance and terrain clearance. ATS provision is constrained by the nature of the airspace environment in which the flight takes place. It is not mandatory for a pilot to be in receipt of an ATS in Class E/G airspace and this generates an unknown traffic environment in which controller/FISO workload cannot be predicted and where pilots may make sudden manoeuvres, even when in receipt of an ATS [42]*

Table 3 Acronyms

Acronym	Definition
ACP	Airspace Change Proposal
ADI	Aerodrome Control Instrument
AFIS	Aerodrome Flight Information Services
AFISO	Aerodrome Flight Information Services Officer
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
APP	Approach Control Procedural
APS	Approach Control Surveillance
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Aerodrome Traffic Monitor
ATS	Air Traffic Services
ATSA	Air Traffic Services Assistant
BT	British Telecommunications
CAS	Controlled Airspace
CAT	Commercial Air Transport
CCO	Continuous Climb Operations
CDO	Continuous Descent Operations
CWP	Controller Working Positions
EASA	European Aviation Safety Agency
GA	General Aviation
GNSS	Global Navigation Satellite System

Acronym	Definition
HIAL	Highlands and Islands Airports Limited
IAP	Instrument Approach Procedure
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IR	Implementing Regulation
ITO	Initial Training Organisation
MLAT	Multilateration System
NPA	Notice of Proposed Amendment
NPV	Net Present Value
OOH	Out of Hours
PBN	Performance Based Navigation
PSR	Primary Surveillance Radar
RT	Remote Tower
RTC	Remote Tower Centre
SATCO	Senior Air Traffic Control Officer
SRATCOH	Scheme for the Regulation of Air Traffic Controllers' Hours
SSR	Secondary Surveillance Radar
TCAS	Traffic Alert and Collision Avoidance System
TMA	Terminal Manoeuvring Area
TWR	Tower Air Traffic Control
VCR	Visual Control Room
VFR	Visual Flight Rules
WAM	Wide Area Multilateration

1.3 Overview of HIAL

HIAL runs and provides Air Traffic Services (ATS) to 11 Scottish Airports: Barra, Benbecula, Campbeltown, Dundee, Inverness, Islay, Kirkwall, Stornoway, Sumburgh, Tiree and Wick. HIAL provides the following services:

- Aerodrome Air Traffic Control (ADI) services are provided from Benbecula, Dundee, Inverness, Kirkwall, Stornoway, Sumburgh and Wick by licenced Aerodrome control instrument or “ADI” ATCOs
- Approach control procedural (APP) services are provided from Benbecula, Dundee, Inverness, Kirkwall, Stornoway and Wick by licenced Approach control procedural controller or “APP” ATCOs
- Approach control surveillance (APS) services are provided from Inverness (and by a third party to Sumburgh) by licenced Approach control surveillance controllers or “APS” ATCOs
- Aerodrome Flight Information Services (AFIS) are provided from Barra, Campbeltown, Islay, and Tiree by Aerodrome Flight Information Services Officers or “AFISOs”. An out of hours (OOH) AFIS is also provided at Benbecula, Kirkwall, Stornoway, Sumburgh and Wick by part-time AFISOs.

HIAL is owned and subsidised by the Scottish Government and serves an important role in providing a lifeline service to remote communities. The company’s stated mission is: "to provide and operate safe, secure and efficient airports which support the communities we serve". Around 50% of HIAL’s total budget is provided by the Scottish Government. The remainder is primarily commercial income from the airport operations and landing fees from the airports. Some grant income is also received for specific projects (eg trial surveillance at Dundee airport), as well as loans where State aid rules apply. In the most recent years however, there has been a drive to reduce the reliance on the public subsidy, even whilst recognising the public benefits from the lifeline services continue to be a priority for HIAL.

For airports like Dundee, Inverness and Sumburgh for example, connectivity is particularly important – i.e. attractiveness to commercial operations. The figures below show the trend in both passenger numbers (Figure 13) and movements (Figure 14) over the past five years.

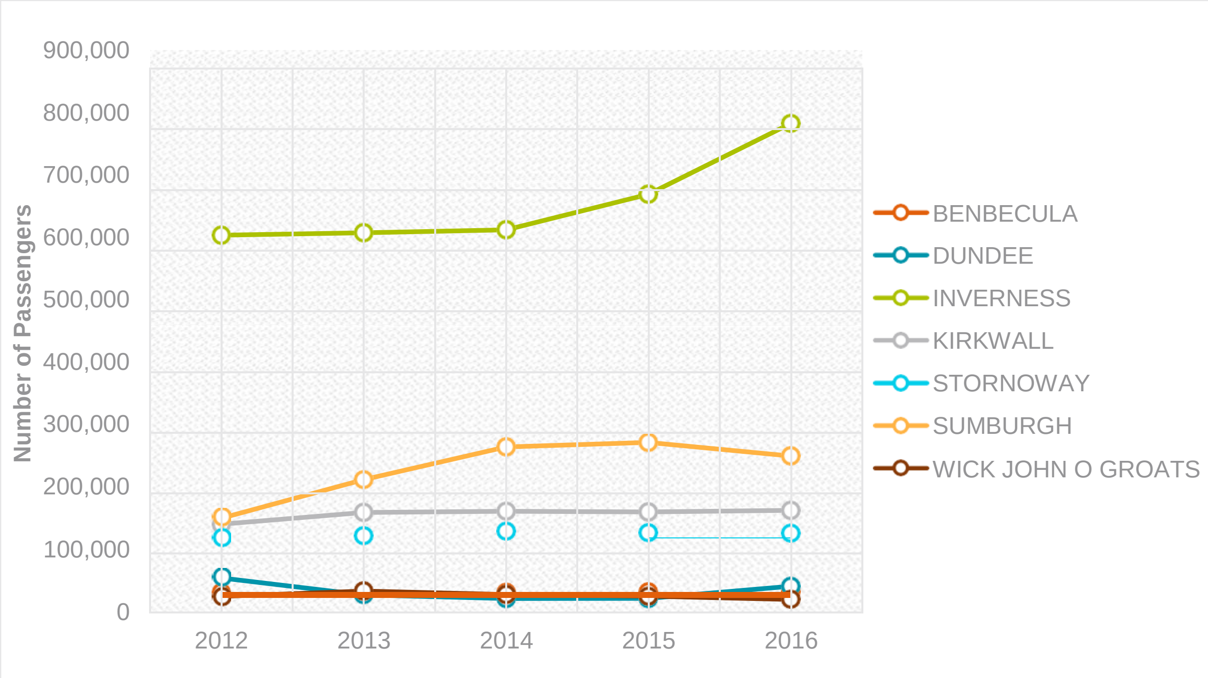

Figure 13 Passenger numbers across all HIAL airports between 2012 and 2016

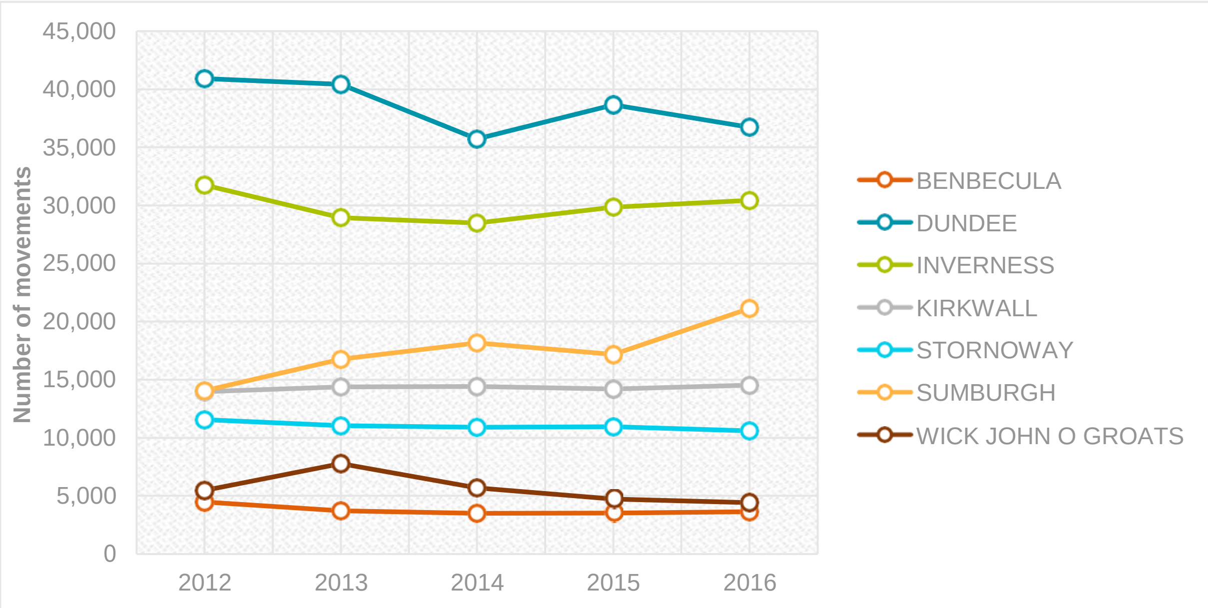

Figure 14 Number of movements (fixed + rotary) across all HIAL airports between 2012 and 2016

The graphs above show a modest upward trend in aircraft movements and a slightly more varied picture for passenger numbers. Inverness for example has experienced quite substantial growth in passenger numbers, and Sumburgh was showing similar trends until the oil and gas market dropped. In the summer of 2017 (July-September), HIAL observed a 7.4% movement growth in comparison to the analogous period in 2016. HIAL expects this upward trend to continue into the future through increased connectivity (eg at Inverness and Dundee), and as driven by oil and gas operations on an individual airport basis such as at Sumburgh. The recent announcement that Loganair and FlyBe (operated by Eastern Airways) will compete head to head on some routes could increase traffic in the short term but this is not expected to have any longer-term impact on passenger numbers.

1.4 Air Traffic Management 2030 Strategy

HIAL has been able to maintain a similar business model for ANS provision over the past 30-40 years which predominantly provides Air Traffic Service without the benefit of surveillance in uncontrolled airspace.

This model will be forced to change due to upcoming regulatory requirements for controlled airspace. It is further threatened by pressures to maintain service performance (eg airport opening hours, safety) whilst applying a low cost base.

1.4.1 Aims and objectives of the Air Traffic Management 2030 Strategy

HIAL embarked on a process of defining a longer term strategic vision, based on a target date of 2030 – the so called "Air Traffic Management 2030 Strategy", which forms part of the wider HIAL strategy. HIAL's stated[4] objectives are:

- To mitigate against the risk of airborne conflict occurring within HIAL's area of operation.
- To help manage business risk whilst supporting business continuity and future business development.
- To ensure operational and commercial sustainability of all HIAL airports.
- To meet stakeholder expectations and support Performance Based Navigation[5] (PBN) operations within HIAL's area of operations.
- To enable HIAL to successfully transition to EASA Part-ATS (IR) requirements post 2020.
- To position HIAL as an Industry leader in ATM.

The strategy is ultimately a change programme intended to future-proof HIAL's provision of Air Navigation Services by improving resilience, reducing cancellations, offering a safer and more flexible operating environment while creating an environmental benefit. The following table, taken from the Air Traffic Management 2030 Strategy communications plan, provides details on the overarching aims and high-level views on how these aims will be delivered.

[4] As specified in the Invitation to Tender for the scoping study
[5] PBN, in simple terms, redefines the aircraft's required navigation capability from sensor (equipment) based to performance based (https://www.icao.int/safety/pbn/Miscellaneous%20Items/PBN%20FAQs.pdf)

Table 4 Air Traffic Management 2030 Strategy aims

The Air Traffic Management 2030 Strategy is a change programme that:	How to achieve
Puts safety first and foremost, delivering safe and secure Air navigation services now and into the future	HIAL's objective is to continually enhance safety and security standards through proactively managing risk as air traffic demand changes.
Facilitates an environmentally friendly Air Traffic Management System	HIAL is committed to enabling aircraft to fly in the most environmentally efficient way, for example through more direct routes using precision navigation and through more fuel-efficient arrival and departure procedures. The environmental footprint of infrastructure will be minimised wherever possible, through rationalisation or removal and by better integrating it with renewable energy sources.
Delivers resilient air navigation services that support airport sustainability, growth and long-term job security	HIAL has an important role to play in sustaining airports within the rural communities, for example by promoting growth in air routes and enhancing connectivity through improved services and infrastructure. This delivers long-term job security both in the aviation sector, and also through enhanced economic access to remote communities.
Enables more flexible and continuous operations, delivering opportunities for both staff and customers	HIAL is dedicated to ensuring that employees enjoy rewarding careers with opportunities to continuously develop and excel in their fields of speciality. As a provider of services to airspace users, HIAL is constantly seeking ways to deliver value. For example by supporting enhanced levels of safety, flexibility and sustainability, reducing delays and cancellations and ensuring more environmentally friendly air traffic operations.
Ensures sustainable, modern and future-proof services that meet evolving requirements	HIAL's long term future relies on anticipating and delivering services that respond to evolving local, national and international air traffic management requirements. HIAL is therefore striving to pro-actively adopt international best practice air navigation services delivery.
Is shaped and defined by those that are most impacted by it	Stakeholders' inputs will be a key part of the programme decision making process.
Delivers a harmonised standard of service delivery	HIAL is aiming to deliver more uniform standards of service that meet or exceed minimum regulatory requirements to deliver performance improvements.

1.4.2 Strategic projects

As part of the Air Traffic Management 2030 Strategy, HIAL is considering a number of interdependent enabling projects that could be part of its future operational strategy. These projects are:

- Introduction of controlled airspace (CAS) at all ATC airports that currently have no control zone/area, in compliance with EU regulations.
- Replacement of standalone APP service with a single Approach Surveillance (APS) service. Surveillance will create a known traffic environment where aircraft that are currently not visible to Air Traffic Control Officers (ATCOs) will be displayed to ATCOs on surveillance displays. This is anticipated to provide safety benefits such as the ability to detect non-compliance by aircrew.

- Introduction of Remote Towers (RT) at up to 11 airports, through a Remote Tower Centre (RTC) potentially co-located with a single surveillance centre. A single integrated platform with scalable architecture through an incremental and coordinated rollout, assuming a period of dual/contingency operations.
- Introduction of a single Out Of Hours (OOH), on-call Flight Information Service, enabled by the RTC.

It is generally assumed that readers will be familiar with the nature of these projects. However, due to the relatively recent emergence of the RT concept, an overview is provided in Annex G.

1.5 Scope of this report

As part of the Air Traffic Management 2030 Strategy, HIAL defined a set of potential implementation options for the strategic projects, stating them in the Invitation to Tender for this scoping study.

The over-riding drive for this scoping study is to gain an independent perspective on the strategic drivers, constraints and options for HIAL. A key question is whether the strategic projects are really necessary in light of the context and business realities of HIAL.

Therefore, Helios has derived its own set of potential options for HIAL's medium to long term strategy in air traffic management, and shown the logic of why the preferred options have been taken forward into a full business case.

1.6 Study approach

This report has been developed based on views from key impacted stakeholders, data collected from HIAL, and the independent expert analysis and judgement of Helios (Table 5), overleaf, summarises the key workshops and stakeholder consultation meetings that have been held in collating this report; a full list is provided in Annex B.

Table 5 Key workshops and meetings held

Meeting/purpose	Attendees	Date	Location
Airport site familiarisation visits	ATS staff	19th June to 6th July	HIAL Airports
Hazard Identification workshop to identify the key hazards and mitigations introduced	HIAL operational staff HIAL project team	27th June	Inverness
Options Definition Workshop for Helios to present initial views on feasibility	HIAL project team ATS operational staff	25th July	Inverness
Dedicated meetings with HIAL managers of HR, Finance and Procurement departments	HIAL managers	26th July	Inverness
Consultation with Remote Tower Suppliers	Saab digital ATS Frequentis Searidge NATS	2nd August 7th August 8th August 11th September	Via teleconference and Swanwick (NATS)
Consultation with the union representing ATS staff in HIAL	Prospect	9th August	Glasgow
Civil Aviation Authority (CAA), the regulator for HIAL's operation	CAA	8th August	Stirling
Risk Assumptions Issues and Dependencies (RAID) workshop	Senior HIAL management	9th August	Inverness
Aircraft operators, the main commercial users of the services provided by HIAL	Airlines	10th August	Glasgow
Discussion with NATS regarding the engineering contract at HIAL	NATS	2nd August	Inverness
Discussion with NATS regarding the London City Remote Tower implementation	NATS	11th September	Swanwick
Review of the connectivity of the Highlands and Islands	University of the Highlands and Islands	28th July	By phone
	Scottish Wide Area Network (SWAN) experts	26th September	
Consultation with Dundee City Council	Dundee City Council	27th September	Dundee
Consultation with the RAF	RAF	20th October	By phone

Several other meetings have also been held with the HIAL project team, including regular face to face progress meetings. Other activities during the course of the scoping study have included the development of a communications plan as well as several briefing documents and outputs in support of the activities listed above.

1.7 Structure of this document

The remainder of this report is structured as follows:

- The drivers for change are described in Section 2
- The constraints to change are captured in Section 3
- The options are defined in Section 4
- A high-level assessment of the options is presented in Section 5
- A detailed assessment of the short-listed options is presented in section 6
- Conclusions and recommendations are summarised in Section 7.

2 Drivers for change

HIAL's Air Traffic Management 2030 Strategy was developed in response to a number of drivers for change. This section considers those drivers, providing an independent Helios view on the need for change.

2.1 Maintaining lifeline services to remote communities

Ensuring that airports remain open and that ATS are provided is fundamental to HIAL's mission to support connectivity to the remote communities that HIAL operates in.

However, the ability to match ATS provision with aircraft operating schedules is a real challenge, and one that is increasingly difficult for HIAL to manage. The challenge is twofold:

- Aircraft are often delayed beyond their scheduled time of arrival, meaning that the airport will either: extend its ATS hours to accommodate the delayed arrival; or on rare occasions have to close, leaving the flight to be diverted or cancelled;
- Whilst ATS staffing levels are currently sufficient to meet the airports' published hours of operation, recruitment and retention is an ongoing challenge, as is the challenge of efficiently staffing a small airport whilst complying with regulations (eg SRATCOH) designed for larger operations.

These two aspects are discussed separately below.

2.1.1 Extensions are a frequent occurrence

Tactical airport extensions, to accommodate aircraft that have been delayed, occur relatively frequently, on average 22 times a month in 2016 and 10 times a month in the first 5 months of 2017 across the HIAL airports and on average require the airport to be open for an additional 39 minutes. Between June 2015 and May 2017, HIAL has extended the ATS hours at all airports a total of 442 times for over 270 hours (see Figure 15). One airport extended 28 out of the 30 days in a recent month.

Local agreements have been made to manage the expectations and capacity related to the tactical extensions. From conversations with the units, it appears that HIAL staff aim to ensure that these tactical extensions are handled in the course of day-to-day business. It is worth noting that the facilitation of delayed flights also depends on the availability of security and fire services.

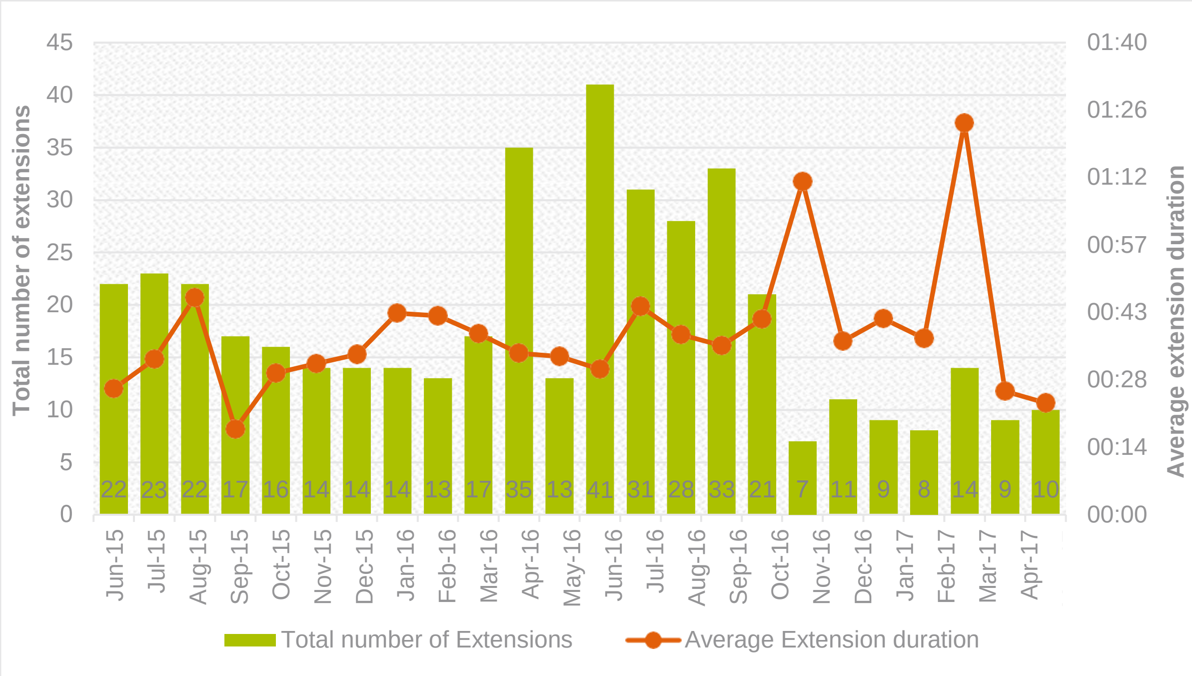

Figure 15 Total number of extensions

Whilst HIAL has started developing a new fatigue risk management system (which will be part of the safety management system) the current situation is that ATCO hours are not regulated on a risk basis. ATCO hours are instead regulated as part of the Scheme for the Regulation of Air Traffic Controllers' Hours (SRATCOH) which aims "to ensure, so far as is reasonably possible, that ATCO fatigue does not endanger aircraft and thereby to assist ATCOs to provide a safe and effective service" [41]. For the ATCOs to accommodate an extension therefore relies on them being willing to extend their shift while still being within the limits of the SRATCOH guidelines. Provided ATCOs are satisfied that they are not fatigued (Annex D Cap 670) they may agree to exceed the limits of the regulation, but must subsequently file a SRATCOH Breach (to the UK CAA), but this is clearly not ideal.

An extension also has cost implications for HIAL. Although some is recovered from the delayed aircraft paying a prescribed amount per airport for each 15 min interval of required extension [2], the costs of ATC, security, fire services etc are not covered by the amount received. HIAL ends up footing the cost.

Whilst tactical extensions are generally accommodated, it usually relies on goodwill and circumstances beyond HIAL's control. On some occasions, this inevitably means that extensions can't be granted.

Strategic extensions, for example to extend the published opening hours, have generally been accommodated and only on rare occasions have they been denied (eg at Sumburgh [4], twice in 2014 and once in 2015 as shown in the next section and Table 6, due to the time required to increase staffing to offer the extended service). A potential impact for Sumburgh could be that these operators (typically travelling to and from the oil rigs in the North Sea) consider alternative hubs in the medium term, such as airports in Norway.

While there is limited evidence to support a permanent change to operating hours, there is a clear driver to increase the flexibility of operations to more easily offer extensions without necessarily relying on the goodwill of staff to work overtime.

2.1.2 Insufficient staffing

For some airports, staffing has had a significant impact on the airport's ability to stay open even during normal opening hours.

Stornoway is a particular example where in 2013 [redacted[1]] meant that the airport had to be 'strategically' closed earlier than published on 147 separate days within the year. The problem continued into 2014, with 175 strategic closures and services consequently reduced to an AFIS only at weekends. By 2015, enough ATCOs were available to reintroduce the ATC service at weekends and reduce the strategic closures to 37 days of the year, but closures continued with a further 46 in 2016. Throughout this time, recruitment was attempted for eight separate positions. Despite 41 applicants (on average) and four interviews (on average) for each post, only two positions were successfully filled.

A similar situation occurred at Wick airport, where the average number of days affected by closures between 2012 and 2016 has been 33 per year. Seven positions have been advertised and four successfully filled, based on 21 applications and 3 interviews (on average) per post.

The following table provides a summary of strategic closures, reduced services or extension refusals as a result of ATS resource related issues for ATC airports that have provided data.

Table 6 Number of days of strategic closures, reduced services or extension refusals as a result of ATS resource related issues

Airport	Number of days of strategic closures, reduced services or extension refusals as a result of ATS resource related issues				
	2012	2013	2014	2015	2016
Benbecula (BEB)	No extension refusals				
Dundee	No strategic closures. No withdrawal of services. Extension refusals due to ATS availability are rare (perhaps 1 or 2)				
Inverness (INV)	Airport closures for Inverness have been rare from 2013 (approximately 3 closures on a tactical basis with no operational impact). Radar closures on the other hand (tactical with reversion to APP) occur approximately ten times per year due mainly to short notice staff sickness or, in the case of 2014 due to staff shortages at Stornoway that required Inverness to provide support and in turn resulted in 3 radar closures. Radar opening hours were also impacted by the introduction of a night shift in 2010 to cover mail flights out of hours [5].				
Kirkwall (KOI)	8	12	8	1	4
Stornoway (SYY)	0	147	175	37	46
Sumburgh (LSI)	0	0	2	1	0
Wick (WIC)	52	22	9	72	19

Looking more generally at HIAL's recruitment data it is clear that recruitment for ATCO staff has been challenging with several years of vacancies. For example, in the past financial year only 67% of all ATCO positions were filled, whereas in 2014/15 this indicator was as low as 20% (see Figure 16).

Note: prior to 2015, the recruitment system allowed unsuitable candidates through the initial part of the process, therefore to be counted in the overall figures of applicants per post. Post-2015, the screening of suitable candidates was more effective, Therefore, the *number of applicants per position will have been higher pre-2015, without indicating any change on the attractiveness of the individual positions.*

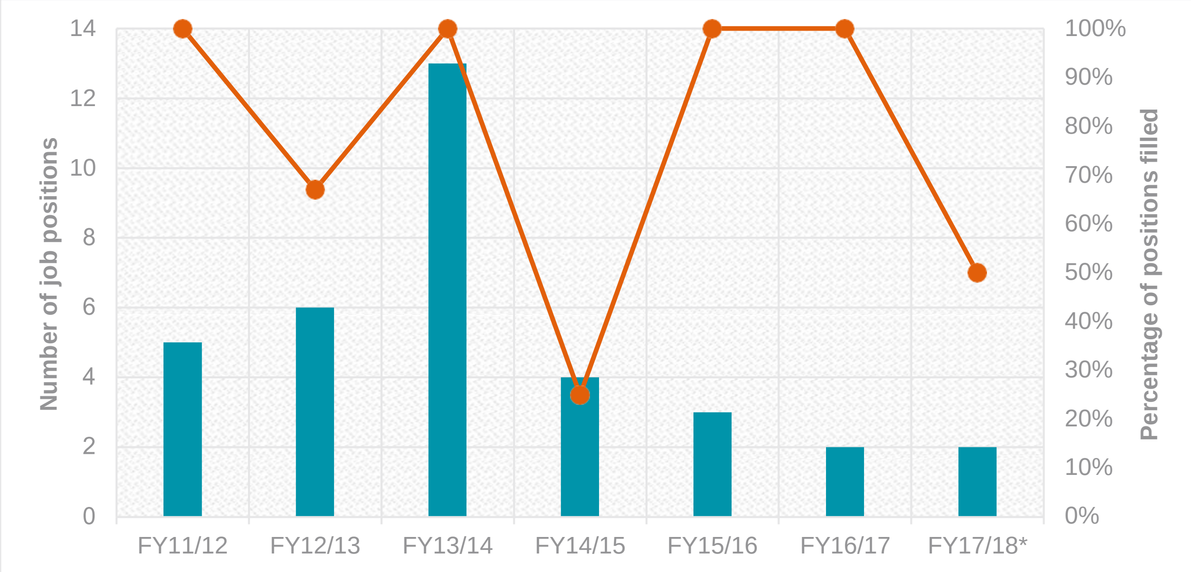

*Figure 16 Recruitment Success Overview (*note that FY17/18 data is only partial due to year not having ended yet)*

Between April 2011 and July 2017 HIAL had an average appointment rate of 83%: for a total of 35 job adverts 29 ATCOs have been recruited of which 83% passed the ATCO validation process. On three occasions HIAL was required to reissue the job advert due to a lack of sufficient applications, but the data doesn't reveal an obvious pattern or trend in the recruitment success rate. However the average ATCO turnover rate of 5.9% is somewhat higher than other ANSPs, which averaged (in a sample of 13) a turnover rate of 3.24% [32]. It is therefore difficult to say whether recruitment problems are getting worse or not and whether they are related to the lack of appropriate candidates (for example due to the location of the job), or to the recruitment practices applied (for example because of a partially decentralised human resource process or lack of recruitment resources). At present, the responsibility for sourcing candidates lies with each individual airport, who perhaps may not have sufficient knowledge or resources to attract the best candidates. ATCO jobs however are well respected and relatively well-paid (amongst the highest available to many of the communities HIAL serves, although lower than other Air Navigation Service Providers (ANSP)). Subject to a successful selection process, ANSPs should not normally be faced with a lack of appropriate candidates.

There is no easy comparison to draw in terms of benchmarking HIAL's recruitment with others as its provision of an APP service in the uncontrolled environment is a rather unique operation. Nevertheless the average number of applicants per post (see Figure 17) shows that the interest in the positions across the entire HIAL region is relatively low - normally below 40 applicants per position, or just above 40 for entry level (ab-initio) ATCOs. In comparison, NATS claim that every year they receive approximately 12,000 entry-level applications of which only 100 are invited to undertake ab-initio training [27]. In other words, NATS observes an application rate of 120 per entry-level ATCO position, compared to an average of 41 observed by HIAL.

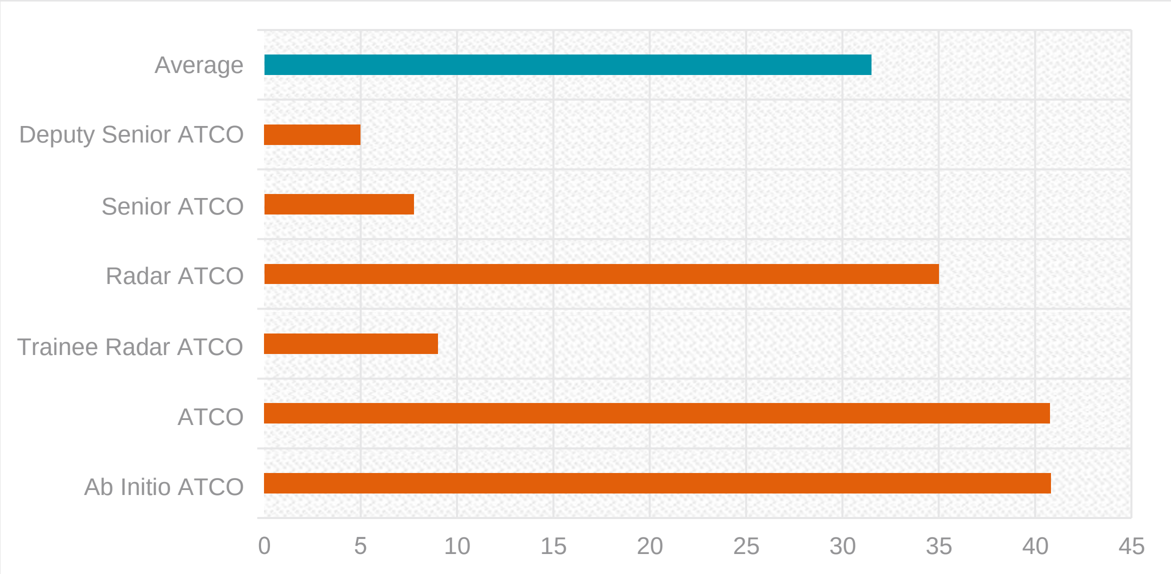

Figure 17 Average number of HIAL applicants per ATS position (2011-2017)

What is clear is that in the coming years the pressure on HIAL to be able to successfully fill positions will increase due to a high proportion (16%) of the ATS workforce reaching retirement age in the coming 10 years (See Figure 18).

[Redacted[1]]

Figure 18 HIAL ATCO age

Ultimately, the challenge of ensuring a sufficient number of ATS staff is a real one that shows no sign of reducing. The inability to maintain a sufficient number of ATS staff has a tangibly detrimental impact on the ability of HIAL to provide services to lifeline communities. Our discussions with HIAL management[6] confirmed that the number of strategic closures was already considered to be too high, and must be reduced as part of the Air Traffic Management 2030 Strategy. Furthermore, a number of high profile airport ATC contracts in the UK (Gatwick and Edinburgh for example) have recently been won by a new market entrant (Air Navigation Solutions Ltd) which has created some pressure and demand for ATCOs (for example as the new entrant looks to recruit and the incumbent is unable or unwilling to transfer the existing staff across), meaning that the 'recruitment

[6] RAID workshop, as per Annex B.8

market' for ATCOs is particularly competitive. Addressing staff shortages is therefore a key driver for change. Succession planning is being carried out, with new deputy roles being created across HIAL and local plans being put in place by airport managers.

2.2 Continually improving safety

HIAL also recognises that safety levels are not only crucial from a regulatory compliance perspective, but are also a measure of success for the organisation and an important driver for airlines. Furthermore, safety ambitions are generally ever increasing as airlines, HIAL and the wider aviation community all strive to improve safety year on year.

The HIAL environment contains operations which are unusual in terms of European norms, in particular the operation of Commercial Air Transport (CAT) through uncontrolled airspace but in receipt of an ATC service without the benefit of surveillance. Each airline will make its own operational safety case for ongoing operations into these airports.

- For some, an acceptable mitigation is their experience operating into such an environment, and the accompanying training on local airspace environments giving the flight crew appropriate competence to operate safely.
- For others, the HIAL airports are only a small part of their overall network, and therefore flight crew will generally not be experienced in the unique airspace environment. For those commercial airlines, other mitigations may apply, such as the provision of a "known" traffic environment via controlled airspace with an ATC service. These become conditions on their operations into the HIAL airports. For example, some of the airlines operating into Inverness require a radar service (APS), or they will not fly into the airport.

If new airlines were to commence operations in HIAL's airspace, it is likely that more standardised mitigations would be required. In other words, experience of local airspace environments would not be sufficient for a new carrier operating a route to a HIAL airport.

The decision of a commercial airline operator in 2016 to withdraw operations between Dundee and Amsterdam had the potential of negatively impacting HIAL's commercial performance. The decision followed a number of incidents that the airline was unable to sufficiently mitigate against in its risk register. However, it seems that the introduction of surveillance and/or CAS would have made a significant impact and potentially (though not categorically) reversed the operators' decision.

The airspace around Dundee, as for all but two HIAL airports[7], is a procedural environment without any form of surveillance. This means that an aircraft can fly in the vicinity of the airport without being required to contact ATC or declare its position. The consequence is that ATCOs cannot guarantee de-confliction between all aircraft, and pilots must therefore take responsibility for separating themselves from other aircraft.

Our discussions with airlines operating at HIAL locations recognised that this type of environment requires additional training and experience compared with controlled airspace[8]. Airlines also recognised that, outside of the UK, it is an unusual environment and one that is increasingly difficult to train for in a non-regional airline, as fewer pilots are familiar with it. Site visits to ATC units also noted the views of some ATS staff that some

[7] Radar surveillance means that a de-confliction service is provided at Inverness, and an approach radar service (by NATS) at Sumburgh

[8] Airline workshop, as per Annex B.9

pilots, particularly foreign pilots, would not always be familiar with a APP in uncontrolled airspace (and UK FIS in general), and that this problem was only likely to get worse.

A further concern exists for out of hours (OOH) operations, in which an operator can use the airport when there is no ATC service. This is permitted by HIAL only under the condition that the operator indemnifies HIAL from any resulting incident by completing an ‘Out of Hours Indemnity Application Form’ [3]. This however does not remove the risks to safety, and nor does it necessarily remove all the corporate risks to HIAL, where perceptions of responsibility may be as important as legal responsibility in the event of any accident. The risk associated with OOH are recognised by HIAL as a high priority in their corporate risk register, and include the potential abuse of their conditions. For example, one recent safety report involved an aircraft flying instrument flight rules (IFR) and using an Instrument Approach Procedure (IAP) in marginal weather conditions to an unmanned airport (which is prohibited under OOH rules).

The number of class G airspace recorded safety incidents over the past 5 years is presented in Figure 19. This chart solely represents the reported occurrences which have been classified as “incidents”. No accidents have been observed during the period, and the last serious incident was in 2011.

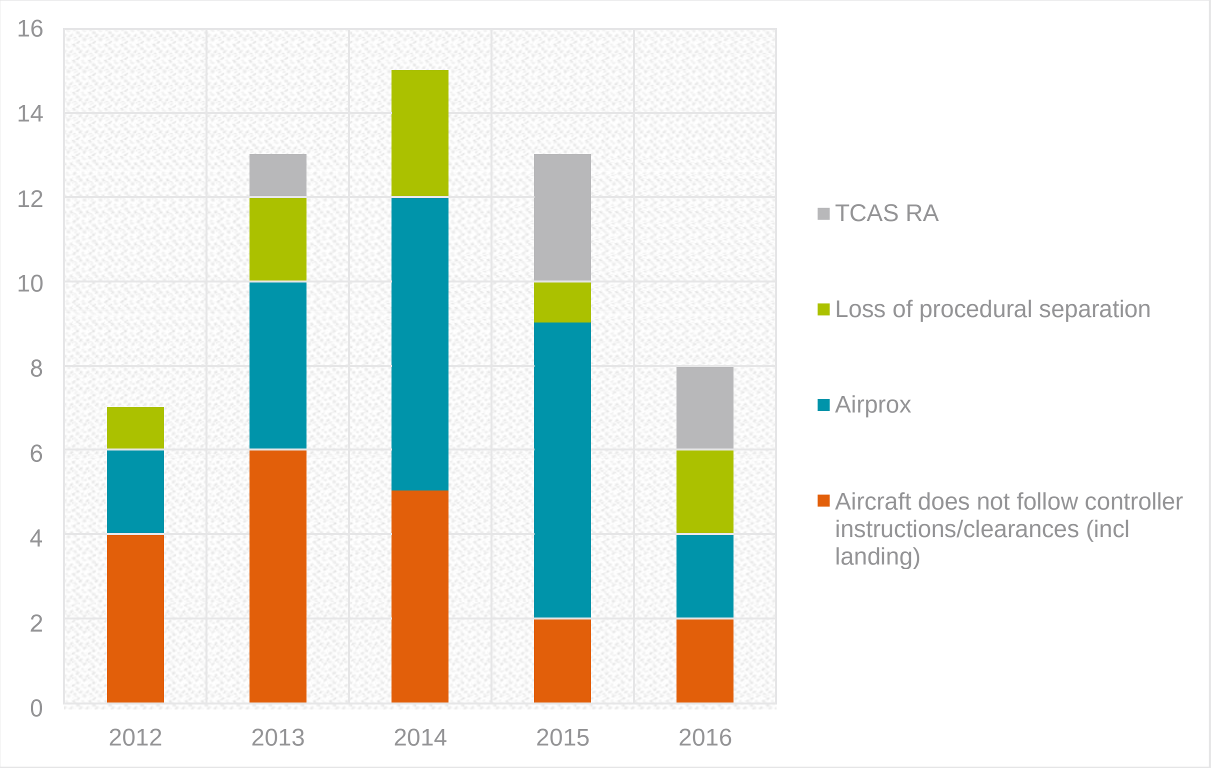

Figure 19 Number of incidents in class G airspace around HIAL airports since 2012

There has been a clear improvement in the reporting culture at HIAL over the past 5 years, meaning any trends in the data are difficult to analyse for causality, since increases in incident numbers may solely be due to improved reporting.

HIAL’s focus on the issues around integrating traffic in the vicinity of airports appears to be reducing the number of Airproxes reported each year (from 2014). There is an existing stream of work to mitigate against the risk of airborne conflict, including the Airspace Change Proposal at Inverness, the electronic surveillance trial at Dundee (MLAT-lite), and the continual training, peer review and safety reporting culture improvements.

The trends observed are promising, but there is a limit to how far the improvements can continue in the existing airspace configuration. The underlying issue is that HIAL is not able to directly control the risk of airborne conflict under the current environment of uncontrolled (Class G) airspace. It can work on the causal factors such as ATCO training, pilot awareness, etc, but there is no guaranteed way of detecting and recovering situations as they occur. This significantly reduces the effectiveness of a key layer in the safety of the overall air traffic management system.

There are also a series of technical failures impacting operations shown in the figure above. This is dealt with further in section 2.4.1.

Ultimately, HIAL therefore wishes to improve safety, both to reduce a clear risk and to ensure commercial carriers are attracted to the HIAL airports.

2.3 Complying with regulation

Upcoming regulatory changes imposed by the European Aviation Safety Agency (EASA) will result in significant operational changes. These changes will be introduced regardless of the Brexit outcome, since they are planned to enter into force prior to any changes in the regulatory structures.

The new Commission Implementing Regulation (Commission IR 2017/373) establishes, under a single regulatory source, the common requirements for the provision and oversight of ATM/ANS, including ATS (repealing several previous regulations, including 1035/2011). This regulation is now published (March 2017) with a general entry into force of 2nd of January 2020, and a specific entry into force of Part-ATS (Annex IV of the IR), as it currently stands, of 1 January 2019.

In 2016 EASA also published a Notice of Proposed Amendment (NPA) aiming to ensure consistency between International Civil Aviation Organisation (ICAO) documents and European legislation. The NPA was consulted on in two parts (NPA 2016-09(A) and (B)) [50]. This NPA sets out the condition that in the “presence of an aerodrome where ATS is provided, it is expected at all times to have an associated airspace (classification)”.

Following consultation earlier in 2017, it is expected that this condition will be published in the final amendment to the Implementing Regulation. The UK CAA agrees with this, but notes that transition may take several years [49].

HIAL operates seven ATC airports of which only Sumburgh has controlled airspace, with Inverness currently undergoing an airspace change proposal with the UK CAA. In other words, **this change to the European regulations will require HIAL to introduce controlled airspace at the Benbecula, Dundee, Kirkwall, Stornoway and Wick airports** (See Table 23).

The NPA regulation, particularly Amendment B, is not clear on how this change will be applied to AFIS airports. This is currently being clarified with EASA by the UK CAA. The original text of the amendment seemed to suggest that any ATS would be impacted by the need to provide controlled airspace, and therefore the AFIS airports may also be affected. The CAA aims to provide proportionate risk-based decision-making, and is seeking to clarify whether a fully standardised ACP is appropriate in this context.

2.4 Remaining financially sustainable

HIAL is wholly owned and subsidised by the Scottish Government. In the past five years, the subsidy has constituted proportionally less with HIAL’s overall income increasing by

15%, commercial turnover by 18% and subsidy increasing only 12% (see Figure 20). In other words, the commercial and aviation related turnover is growing faster than the size of the subsidy and this trend is expected to continue. Indeed, discussions with HIAL management[9] clarified that pressure to reduce the subsidy (in nominal terms) will continue and therefore commercial revenue must increase to keep pace with increasing costs. HIAL has also stated a strong reluctance[10] to increase landing charges due to the negative impact this could potentially have on traffic numbers.

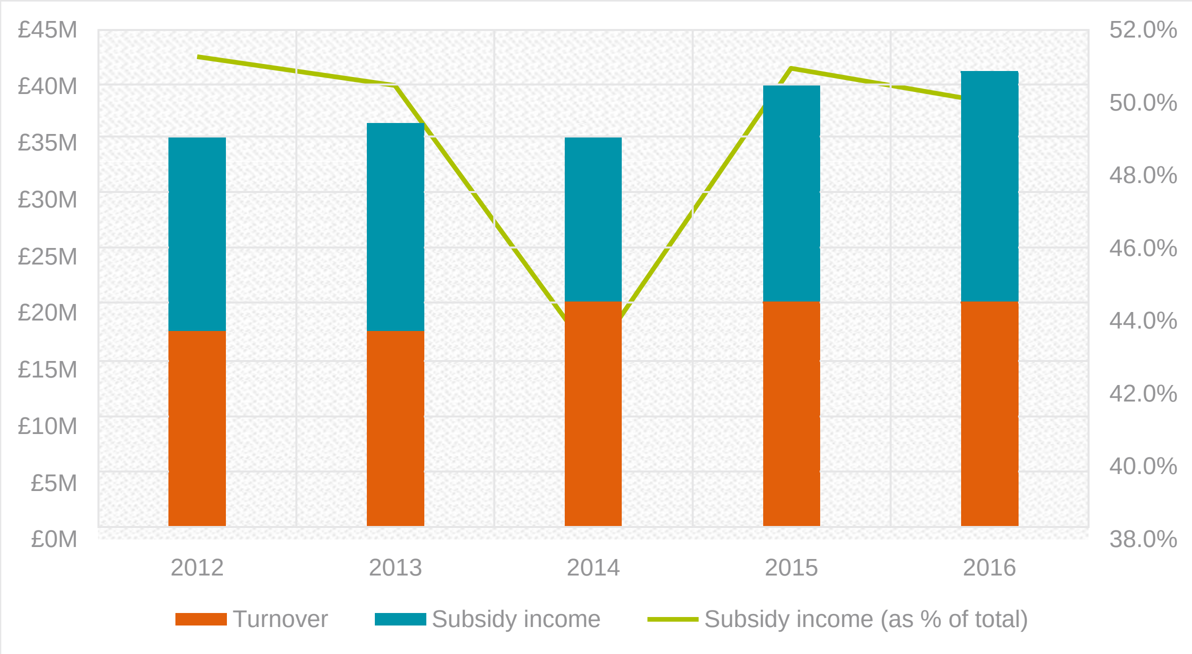

Figure 20 HIAL cumulative percentage income growth from 2012

In summary, HIAL is increasingly required to reduce its reliance on subsidies and to operate more as a commercial business where revenues as a percentage of total income increase over time. This is set against a background of increasing costs, described below.

2.4.1 Infrastructure costs

Infrastructure costs are detailed in a rolling 10 year capital plan, which is regularly reviewed and updated annually. Budget approval is on an annual basis, and approval for anything beyond two years is, according to HIAL[11], difficult to guarantee. For some costs this can result in deferring to future years. For example the 2017/18 capital plan [14] shows that £1M for the Inverness car park extension is deferred, together with £500k covering items such as vehicles (£200k), equipment (£260k) and runway rehabilitation (£30k). HIAL has explained [11] that deferring capital expenses has been a growing problem over time and that an increasing volume of capital expense requirements has been building up. The high-level estimation in the capital plan suggests that the anticipated cost of the tower buildings to 2030 is in the region of £5-8M [17] (see Annex O.3 for more detail[12]).

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[9] RAID workshop, as per Annex B.8
[10] Options workshop, as per Annex B.3
[11] Input from finance manager, as per Annex B.4
[12] Please note that these figures exclude costs associated with the ATE contract and Inverness radar

Furthermore, our review of the Air Traffic Engineering replacement plan provided by NATS and dated September 2016 [12] shows that there is a clear trend of growing cost to replace the ageing infrastructure. This is shown in the figure below.

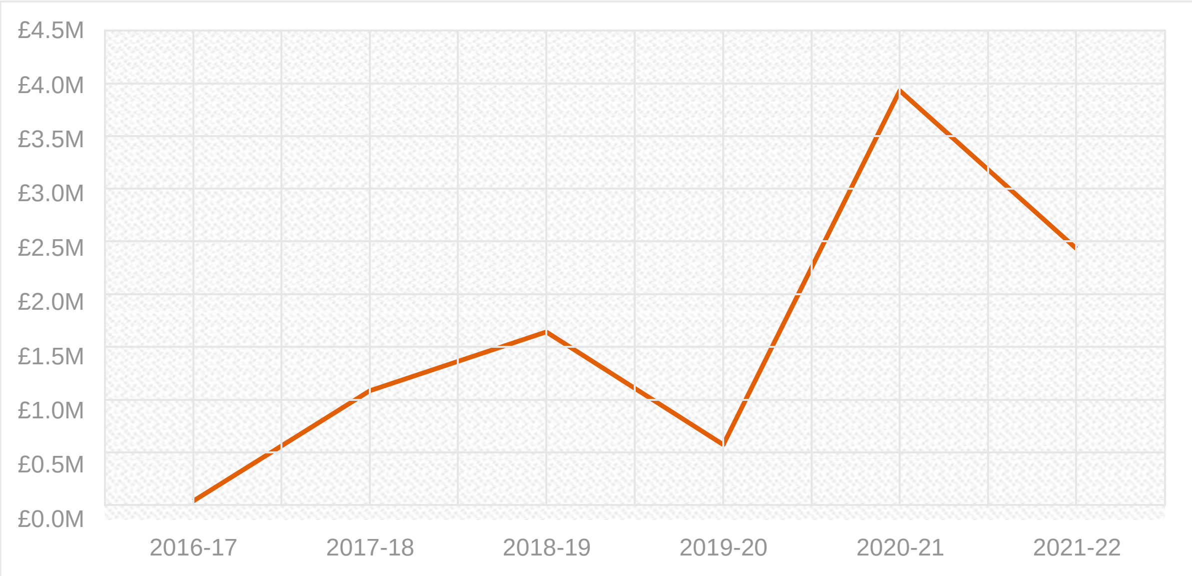

Figure 21 Air Traffic Engineering replacement plan costs

It was also clear from our site visits (Annex F) that the tower buildings across the HIAL estate are typically very old and in need of repair. Some are in the region of 30+ years old. For example, the windows of the Sumburgh tower were leaking and had been in need of replacement for some time, until recent action was taken. At present, we are not aware of any firm investment plans being made for tower replacement, but significant investment will clearly be needed to upgrade or replace the towers. For example, the estimate for Kirkwall tower refurbishment, provided by HIAL [14] as part of the development of the 10 year capital plan, is £488k. Similarly, the replacement of windows at Sumburgh was estimated to cost £370k in the capital plan, and £350k was allocated in previous years for Sumburgh tower cladding.

These costs will be modelled in the business case. It will help show the likely increase in costbase in the coming years, assuming a similar operational model was employed by HIAL. This increasing cost base will need to be met by total income. It is expected that the increasing turnover will not be able to meet the full additional costs, and therefore hikes in subsidies would be required.

Whilst HIAL's remit is to provide lifeline services to the Islands, the need for public funding is clear. Nevertheless, it must be shown to be cost-effective and an efficient use of the public purse.

2.4.2 Training costs

A further aspect that influences HIAL's financial sustainability is the cost of training. Global ATS is an Initial Training Organisation (ITO) that provides initial training for HIAL ATS staff under a two year training agreement. Since 2013 (when a previous provider left the market), Global ATS has been the only ITO offering procedural approach control (APP) training.

An exchange [65] between HIAL and Global ATS confirmed that Global ATS were *"aware for many years that the demand for this particular rating is likely to diminish especially as*

Radar systems become more affordable". The prices for APP courses have increased by a factor of 41% in only 18 months since January 2016. Over the past three years (2014-16 inclusive), HIAL ATS training costs have been £658k meaning a significant price increase will have a notable impact on HIAL finances going forwards.

[Redacted[2,3]]

In the longer term HIAL could consider training candidates abroad, and completing a conversion training to the UK environment. However, experience shows that this would be a complex and costly process, as for example, bridging the gap between DFS (who are a certified training organisation and providing training in compliance with EU regulations) and the UK CAA requirements has already taken two years and has not yet been completed.

Alternatively, HIAL could set-up a training facility themselves (compliant with EU Reg 2015/340), but this would require a significant level of effort and cost to create a new certified Initial Training Organisation (ITO). This would be prohibitively expensive and time consuming, especially given the existing managerial resource constraints that HIAL is facing. The creation of such a training facility would be unlikely to cover its costs (for example by selling courses to other ANSPs), since the APP course is not in high demand as evidenced by the fact there is only one UK provider at present.

None of these options provides future-proofing for HIAL or offers an ability to ensure training continuity in the short and medium term. A move away from APP would be the only way to overcome this.

2.5 Optimising ANS

Outside of the subsidy mentioned in the previous section, the main revenue source of HIAL is from commercial carriers, either directly through landing fees, or indirectly through passenger revenue at the airports. HIAL also serves a wide range of other airspace users including medical flights, search and rescue, military operations, business aviation, training and recreational flyers.

Ensuring that HIAL's air navigation services meets user demands is a fundamental part of HIAL's business model. In addition to the issues of opening hours and safety, HIAL must also continue to modernise to be able to support the changing requirements of airspace users and the expectations of the Scottish Government.

In particular, this drives HIAL to support new technical and operational concepts that benefit aircraft, such as the implementation of Continuous Climb (CCO) and Continuous Descent Operations (CDO), more direct (time and fuel saving) routes and by enabling Global Navigation Satellite System (GNSS) IAPs in-line with the mandate on Performance Based Navigation (PBN) implementation [51]. Loganair estimated that the implementation of GNSS across the whole Loganair network would save approximately 100 tonnes of fuel, a saving in flight time of 230 hours and a reduction in CO2 emissions of approximately 320 tonnes annually [16]. This benefit, estimated for only one airline, would be larger if was used by all operators.

The clear environmental and efficiency benefits from GNSS acts as a context for this study; they are assumed to exist as a baseline environment. Nevertheless, there are further improvements in the use of PBN and route efficiency which could be gained. The transitions to the new IAPs may not be as efficient as they could be, and de-confliction of aircraft may engender efficiency improvements. For example, where two aircraft arrive at the same time, the application of APP service will usually lead to one aircraft holding. Likewise, separating an arrival and departure will usually lead to inefficient flight profiles. The current rate of handling movements varies between six and seventeen arrivals per hour. Consequently, in certain sectors, peaks in aircraft arrivals and/or departures will likely lead to delays.

Elements of the ATM 2030 strategic projects would improve the service received by the end user. For example, controlled airspace (CAS) and surveillance would offer added protection for commercial aircraft but in general might be perceived as being restrictive to certain segments of the General Aviation (GA) and the military community, compared to the current situation, dependent upon the extent (volume) of the CAS. We recognise that for certain environments (eg Inverness), the military appear to support the introduction of proportionate sectors of CAS where warranted for safety reasons and where required by under the provisions of EASA Part ATS.

ATM 2030 projects could also improve the deconfliction of aircraft, by changing the separation standard being applied. This would mitigate many of the route extensions or holding from handling multiple arrivals or departures, leading to flight efficiency gains and environmental gains (from reduced fuel burn). Traffic flow into the HIAL airports could be better smoothed by enhancing integration with the en-route environment, meaning less holding in the vicinity of the airport.

Furthermore, the commercial operating environment for ANSPs such as HIAL, particularly in Europe, is beginning to change. EU economic regulation is forcing national ANSPs to reduce costs. International competition for tower and IAP services is also beginning to gain momentum, with new entrants gaining traction in markets outside of their national base, particularly in the UK and Scandinavia, where many airports have changed their ANSP recently. ANSPs are typically responding by finding new revenue sources or innovative ways, such as RTs, to introduce cost savings. HIAL will not be immune to these pressures.

2.6 In summary, HIAL needs margin

HIAL must continue to provide lifeline services to the Highlands and Islands of Scotland. Therefore, it needs to manage any risks to these services proactively.

2.6.1 Operational margin

HIAL is operating close to its margins. Investment in critical infrastructure is being delayed. Staffing levels are low, with little contingency. In each case, any perturbation in the system (eg equipment failure, or a long-term illness of an ATCO or AFISO) may lead to near-immediate impact on the core services, and occasionally service downgrading (ATC->AFIS) or airport closures.

At present, in systems-based language, HIAL is aiming to operate a reasonably inflexible system in a flexible manner, for example through staff changing their working patterns and hours to maintain the service.

Knowingly operating in this manner does not fit with the stated goals of providing sustainable, safe and resilient ANS.

The solution to this is to add margin to the system in a cost-effective manner. That could be via more staff, or via a system of back-ups (redundant systems) which ensure the services can continue in the event of a single failure.

2.6.2 Safety margin

There has been a clear improvement in the reporting culture at HIAL over the past 5 years and a focus on the issues around integrating traffic in the vicinity of airports and mitigating against the risk of airborne conflict (eg Airspace Change Proposal at Inverness, the electronic surveillance trial at Dundee, and the continual training, peer review and safety reporting culture improvements). Nevertheless there is a limit to how far the improvements can continue in the existing airspace configuration and there is continued pressure on safety margin. Safety margin is the difference between the achieved level of safety and a targeted tolerable (or acceptable) level of safety. It does not just measure accidents and serious incidents, but all aspects of an organisation's safety performance.

Although no accidents have occurred, the incident rate is acting as an early warning signal. In addition, the progress in implementing safety culture is varied across the HIAL units. Finally, the method of providing operational margin (above) is occasionally at the expense of safety margin, for example putting pressure on fatigue risk management.

HIAL is unable to directly control the risk of airborne conflict under the current environment of Class G airspace and there is a reliance on for example safety nets, such as Traffic Alert and Collision Avoidance System (TCAS), rather than operating a system appropriately designed for the context. Best practice in aviation safety recommends designing in additional margins to mitigate HIAL's key risks (eg mid-air collision). Although traffic levels are low, the presence of regular public transport demands an air traffic management system designed to protect them (mitigate risk) to similar levels as anywhere else they might travel. The issue identified earlier in section 2.2, that the current environment does not enable the detection and recovery from errors, is a key gap.

There is a question about the cost-effectiveness of these additional safety margins – the so-called protection vs productivity trade-off. For example, HIAL may indeed wish to install new Aerodrome Traffic Monitors (ATMs) to utilise the situational awareness given by surveillance, but these need to be budgeted and agreed.

HIAL only change (delay) capital expenditure plans after testing items against safety management plans – in other words, safety critical improvements are kept as priority investments. This is positive, but the underlying pressure remains to control costs and therefore delay positive change which could impact safety performance.

3 Constraints to change

Air Traffic Management 2030 Strategy is also subject to a number of constraints to change. This section considers and tests those constraints in order to provide a Helios view on the need for change.

3.1 Addressing the impact on staff

Some of the ATM 2030 strategic projects involve centralising operations from the current bases to a centralised location. This entails moving the location of roles and relocating them away from the existing airports. This applies to both the centralised surveillance centre and Remote Tower centre:

- In the case of centralised surveillance, APP would no longer be provided from the Visual Control Room (VCR), as it currently is in most ATC airports, but instead would be replaced by a separate APS function and performed from a new facility.
- In the case of Remote Towers, both the ADI and APS would be moved from the airports to a centralised facility, and provided from stand-alone positions or as a combined position.

HIAL airport locations are often very remote and, through the unit visits, it appears that the communities are home to a limited number of highly-skilled work places. Consequently, any attempt to move such jobs away from these places must be carefully considered and its impact must be assessed, not only on the individual but also on the organisation and wider society. The two scenarios above are considered below from the perspective of both organisational and individual challenges of relocation.

3.1.1 Individual challenges of relocation

For many staff, there is a strong sense of attachment to the existing airports and their location, particularly for those on the island locations [redacted[1]]. This feedback was given from a number of the site visits (Annex F). In particular, many felt aggrieved by any threat to move jobs away from the airports when HIAL's recruitment process had previously challenged individuals on their willingness to commit to the airport location for the long term.

The impact on existing staff would need to be managed very carefully. Even in the centralised surveillance scenario, splitting out the APS function would mean that the ADI ATCOs' role would change substantially. During the site visits, some staff commented that this would be acceptable for them, but for others it would be an unacceptable change that would take away some of the most interesting parts of their role.

For the RT option, existing staff would broadly be faced with the option of re-locating or accepting a different role, at a comparable salary, at the airport. At present, it is not thought such a role exists for ATC staff.

3.1.2 Organisational challenges of relocation

From an organisational aspect, in any ATS re-location scenario, there would be a need for a clear and phased transition and there would inevitably be a period in which services would be provided from both locations as one takes over from the other. In both scenarios above, there is likely to be a need for additional staff to fill any new positions created and that can't be filled by relocating or re-training existing staff. Whilst the opportunity of validating as an APS ATCO might be considered a viable option for some, many will not want to re-locate and some of those that do may not pass the training.

[Redacted[2]]

As noted above, a strong human resources strategy managing a transition through natural turnover would be one option for HIAL. This would impact the implementation timelines of the Air Traffic Management 2030 Strategy, generally leading to a longer transition period.

Furthermore, there are likely to be strong political pressures towards maintaining highly-skilled employment in the remote communities. This has already been evident in the attention paid to HIAL's Air Traffic Management 2030 Strategy by members of parliament[13].

3.2 Proving technical and operational feasibility

Some of the strategic projects present significant technical challenges, in particular the idea of Remote Towers and, to a lesser extent, the introduction of an approach surveillance service (APS) at each airport. These are discussed in turn below.

3.2.1 Surveillance

The challenges associated with providing an APS will depend on the technology chosen. Traditional radar (primary and secondary) is perhaps the most well recognised technology, but would require careful siting analysis to minimise interference/obstructions and to

[13] A Ministerial briefing has been given by HIAL (see [7]) in writing and in person

maximise coverage. Radar would also need highly available and redundant connections to distribute the data for processing and display at the airports. We would anticipate that careful placement of radars would mean that multiple airports could be covered, rather than needing a separate radar at each airport. Furthermore, there is already substantial coverage available from NATS radars (see Annex D). However, this applies primarily over 3000ft, and therefore would not be suitable for the provision of an APS at several HIAL locations.

For other potential surveillance technologies, such as Wide Area Multilateration (WAM) and Automatic Dependant Surveillance -Broadcast (ADS-B), the technical feasibility will hinge on being able to meet the safety case requirements. The CAA policy on providing an APS [41] is currently that primary surveillance is needed. This is to ensure a known traffic environment, ensuring surveillance of aircraft not fitted with a transponder.

Developing a safety case without Primary Surveillance Radar (PSR) will therefore rely on providing sufficient assurance that aircraft operating in the relevant airspace will be equipped and that any equipment failures can be suitably detected and mitigated, or that the traffic is known to the ATCO via radio contact. It is highly dependent on the specific local context. It will also rely on sufficient accuracy and availability of the ground infrastructure and may require duplicate coverage. Safety cases have already been approved for APS without PSR in Norway and we anticipate that in the coming years, the technology and aircraft equipage levels[14] will have matured substantially to enable such cases to be developed and approved in a greater range of contexts.

3.2.2 Remote Towers

The most obvious technical constraint for Remote Tower (RT) operations, which was raised by nearly all ATS staff, is the reliability of the connection between the airport and the Remote Tower Centre (RTC). When based at the airport, ATCOs are able to mitigate against several failures through local means, such as using a handheld radio in case of the main radio failure, or a light gun in case that fails. The usage of a Remote Tower relies on a connection to the airport. For example, the radio transmitter and receiver would remain at the airport (in order to be within line of site of the aircraft) and would then be relayed, together with other data (such as video data, local weather information, NAVAID status etc) to the RTC. This means that the connection between airport and RTC provides an additional point of failure to operations. Without changes to the reliability or redundancy of airport based equipment, the connection would need to be 100% reliable just to maintain the existing failure rates. Practically speaking, a communications link with 100% reliability could be cost prohibitive; so any implementation will need to consider the operation as a whole and what procedural and technical mitigations will need to be in place in order to maintain or improve the overall resilience of the operation. The options may be particularly limited considering that:

- Independent, redundant dual communications links do not exist between all airports and any potential location for the RTC – our view, which was shared by the CAA, is that it is very unlikely that any RT operation could be operated over a single line communications link without redundancy. One of the communications link could be a micro-wave link

[14] Specifically referring here to the aircraft’s ability to be conspicuous electronically, via a low-cost transponder. The market for these is maturing, and we therefore expect equipage rates to increase.

- It is unclear what level of availability would be needed, or is possible. The answer is likely to be a key driver on cost
- The bandwidth required would depend on the solution chosen and the traffic levels at the given airport, but it is unlikely that ATCOs would support a solution in which the quality of display varies across airports (especially if in the case of two airports being managed from a single remote tower module).

Furthermore, RTs probably require a high-bandwidth (and therefore high cost) communications link to transmit live video feeds from multiple airport cameras to the RTC. Our discussions with suppliers suggested that this could vary from anywhere between 30mbit/s to 100mbit/s per airport and would depend on a range of implementation factors such as

- number of cameras (for example 14 cameras are used an existing implementation in Sweden)
- quality of image which is impacted by number of pixels, number of colours, compression techniques etc
- frames per second, which has been debated widely in RT standardisation forums and will most likely be driven by end users. Existing implementations vary from 5fps (Norway) to 20fps (Sweden).

The data will also need to be sent with minimal delay, in addition to resilience and fail-safe requirements to ensure service continuity. Doubts have been cast on whether the existing communication lines will be sufficient and this will need to be further examined with British Telecommunications (BT), the communications infrastructure supplier to HIAL.

RTs are still a relatively new technology, which will significantly change the operating environment in which ATCOs work. Introducing any new technology must be done carefully and with the close involvement of the users, not only to ensure the safety of any transition, but also to ensure there is buy-in to the concept. Whilst HIAL may not be the first in the world, or even the first in the UK (see Annex G) to implement RTs, they could still be an early mover and the first in the UK to roll it out across a large number of airports. This could translate to an early mover risk and should be considered carefully. Details of the key considerations such as human factors, together with a series of case studies, are provided in annex G.

3.3 Achieving stakeholder acceptability

Recognising that the Air Traffic Management 2030 Strategy has a wider impact beyond HIAL staff is an important constraint. The extent of consultation performed in this scoping study (see Annex B) is only the start as there are many other impacted parties, for example specific military units, general aviation businesses and individuals, and local communities to name a few.

Each of the changes being examined may need to be subject to a level of public scrutiny, either through a political committee or via a full public consultation. The process is already standardised for airspace changes, and even though the change is being driven through EU regulation, it is expected that a set of airspace change proposals would still need to be developed and consulted on. It is recognised that UK Government assistance may be given in resourcing this.

Similarly, the changes involving relocation of functions may also be scrutinised. No existing regulatory requirement for consultation exists for these projects. Rather, it will be a political decision on the level of consultation required and whether this is carried out by HIAL or an independent party. Initial indications from the staff union, local press and politicians suggests the level of scrutiny will be high, and gaining wider acceptance from stakeholders may be a barrier to change.

3.4 Ability to handle the scale of change

Compared to most ANSPs in Europe, HIAL is relatively small. The ability to handle a large scale change will rely on significant resources and HIAL may therefore be constrained in what is realistically achievable, or at least in how quickly it is achieved. This constraint becomes even more acute for relatively new technology such as RTs where there can be an early-mover disadvantage in order to tackle relatively unknown or new issues such as regulatory approval.

Our discussions with HIAL management[15], and with Prospect both inferred that the head office management and human resources team would need to be expanded to be in the order of 2-3 times its current size to handle the scale of a change as complex as a centralised RT facility. Similar discussions with HIAL procurement manager (Annex B.4) recognised that the complexity of procuring something like a RT would require full-time resources to develop the technical specification alone. ATS staff during the site visits raised doubts that HIAL had sufficient resource to handle the scale of the strategic projects considering how thinly spread they already perceived the management to be.

[15] RAID workshop, as per Annex B.8

4 The options

Based on the drivers and constraints outlined previously, this section justifies the feasible options available to HIAL as well as introducing some of the potential opportunities and challenges that each would bring.

4.1 The 'status quo' is not an option

HIAL has been able to maintain a similar business model for ANS provision over the past 30-40 years. With the exception of Inverness and Sumburgh airports which have surveillance, ATC provides an APP service without the benefit of surveillance at the other 5 (ATC) airports which are located in uncontrolled (Class G) airspace.

HIAL is well aware of the risks in this environment, and has been carrying out a stream of work to mitigate risk, including the Airspace Change Proposal at Inverness, the trial surveillance at Dundee, and regular training, peer review and operator interactions. This study also comes in the context of the introduction of GNSS procedures across the HIAL airports.

At EU level, ATC in uncontrolled airspace is perceived to create a safety risk that Regulators wish to address. Specifically, EASA has defined a regulation which stipulates that in future, ATC services can only be provided in controlled airspace (CAS). The UK CAA agrees with this, but notes that transition may take several years [49].

As the relevant EU regulation (Part ATS / ATM IR) has already entered into force, it is likely[16] to be transferred to UK law following Brexit, and therefore the requirement would remain regardless of the exact Brexit approach. Furthermore, EASA is seeking to standardise a common Manual of AFIS (consistent with ICAO) which could alter HIAL's ability to provide AFIS in the current manner, particularly regarding ground movement instructions.

A side-note: Article 183 of the UK ANO currently states that where an instrument approach (IAP) is provided, there must be an approach control service, and thus controlled airspace. Exemptions are given by the UK CAA at present, allowing approaches to be flown without an approach control service at HIAL AFIS units and during out- of-hours AFIS provision at the ATC airports. The CAA believes these exemptions will be maintained, and that where new GNSS approaches (IAPs) are implemented in Class G airspace, they will be similarly applied. If anything, the ANO may be updated to reflect current practice, rather than removing the current exemptions.

We consider that the current AFIS airports should continue to provide their current services and see no clear drivers for centralising the AFIS service and no reason why the AFIS airports may not continue to provide an AFIS to commercial aircraft under an exemption from the CAA.

A further threat to the model of ANS provision at HIAL airports is seen in the attitude to risk of the commercial airlines and their insurers. The recent decision of a commercial airline operator to withdraw from Dundee was partially attributed[17] to the risk of flying in an 'unknown' environment with neither CAS nor surveillance. With the evolving European and ICAO standardised context, insurers and flight operations departments[18] may also require that commercial airline operations are kept within controlled airspace and benefit from an

[16] Discussion with CAA held on 8th August 2017, Stirling
[17] Based on explanations given by Dundee airport manager and SATCO on 28th June 2017
[18] Responsible for deriving a safety case for operations into each airport

ATC service at all times, or at the very least are under surveillance that ensures a known traffic environment.

We recognise that both elements (operator and insurer) are subjective and opinion-based and that different operators may assess differently risk levels and conclude different requirements. Indeed, Loganair's contention,[19] that its safety case for current operations into uncontrolled airports is mitigated by pilot specific training on local operations and experience operating into these environments, appears reasonable. Similarly, we recognise the views of KLM Cityhopper, based on their safety assessments, that support the establishment of CAS and a known surveillance environment (eg in Inverness), as "the most effective measures" to mitigate the additional risks associated with providing Commercial Air Transport (CAT) through uncontrolled airspace.

HIAL's own risk register notes that there have been some incidents over the past five years partly attributable to the environment of APP (non-surveillance) control. Surveillance has been identified as a potential mitigation.

Note: this driver has always been present, and is used to help make decisions on the level of service to be provided at each facility. The decision on whether an airport should provide AFIS or ATC services is independent of the overarching HIAL strategy, and therefore not part of this study. Nevertheless, where clear trends are seen, a strategic response may be appropriate.

Finally, there is continuing pressure on the financial side of the business, in particular in the form of the Scottish Government subsidy. Whilst this has remained roughly constant in real terms, HIAL are under pressure to reduce the percentage reliance on subsidised income in the coming years. This comes in the light of deferred spend on infrastructure replacement, meaning that the capital and operational costs are likely to increase significantly in the years ahead.

To be clear, the basic reason that the status quo is not an option, is that regulatory changes are forcing the issue. Whilst there are clear drivers for change, and the recent decision of the commercial airline operator crystallised the impact of those safety drivers, these do not in themselves force change.

4.2 The minimum requirement is to introduce controlled airspace at ATC airports

Based on the above sections, and particularly considering the regulatory requirements, HIAL will need to introduce CAS at all current ATC airports. Current AFIS airports may continue to provide an ATS (AFIS) to commercial IFR aircraft under an ANO exemption from the CAA, and are not thought to be required to change this strategy.

As the provision of CAS is likely to be an imposed requirement through regulation, it may be driven through a Department for Transport (DfT)/CAA programme. This could impact resourcing requirements and costs, but not the underlying operational changes.

In conclusion, we believe the 'minimum' option for HIAL is therefore:

- **Option 1a "only implement CAS at all HIAL ATC airports"**

Whilst controlled airspace requires aircraft to comply with ATC instructions, it does not always require all aircraft to contact ATC (for example VFR in Class E). For safety, route

[19] Input from Loganair at airline operators workshop on 10th August 2017

efficiency and airspace access reasons, HIAL considered that surveillance would be required in order to create a known traffic environment for the ATCO.

The surveillance requirement for the provision of ATC is dependent on the context and is set as part of a safety argument. In our discussions, the CAA confirmed they would, on the basis of suitable evidence, continue to permit an APP service in a CAS environment. Surveillance as an informational aid, eg through an Aerodrome Traffic Monitor (ATM), may therefore be sufficient to meet the safety requirement. This is in line with the electronic conspicuity drive in the UK. The ATM gives a certain level of safety and efficiency benefits in line with the abilities outlined in the MATS Part 1 (CAP 493), but its performance is unlikely to be sufficient for an approach control surveillance (APS) service. This is assuming that an ATM and associated surveillance infrastructure (eg MLAT, ADS-B) is installed, rather than relying on existing radar. For avoidance of doubt, this assumption relies on appropriate certification from the UK CAA (for a surveillance solution of lower specification than that required for an APS).

We therefore derive a further ‘minimum’ option which also involves no relocation:

- **Option 1b “only implement controlled airspace and ATMs at all HIAL ATC airports”**: This option enables the ATCO to provide the approach control service with the aid of enhanced situational awareness achieved through the installation of an ATM (and necessary surveillance) at all ATC airports.

4.3 An approach control surveillance service could offer a feasible alternative

Whilst both variants of option 1 would address the regulatory requirement to introduce CAS, neither would address the increasingly unsustainable nature of procedural approach control (APP) training and recruitment. In particular, there is only one training provider in the UK (Global ATS) offering APP training, and the prices for courses are indicative of a monopoly with costs having increased by a factor of 41% in only 18 months since January 2016.

Pilots and ATCOs consulted during this study[20] were generally of the opinion that APP in uncontrolled airspace is an increasingly unusual operation, and particularly unfamiliar to pilots not routinely operating in such an environment (eg non-UK based pilots). It is our view that this will only increase the safety risk over time. The lack of surveillance also leads to flight inefficiency through the application of increased procedural separation standards.

A reasonable, though not necessarily minimum, option would therefore be to introduce an approach control surveillance (APS) service within CAS at all ATC airports. In addition to offering a more sustainable ATS training basis and recruitment pool for the future, it would also enable HIAL to offer further safety improvements over option 1, such as the ability to see non-communicating aircraft (particularly in 1a) and would improve the potential route efficiency for users – for example by allowing more direct routes than would be possible in a APP environment.

However, to introduce an on-site APS would require validated radar ATCOs. The existing complement of staff would be insufficient to cover both APS and ADI so an increase in staff would be required. Additionally, for rostering efficiencies to be generated, the majority

[20] Airlines were consulted on 10th August 2017, ATCOs were consulted between 19th June and 6th July 2017

of ATCOs would have to successfully validate on both the ADI and APS positions, which may be challenging.

Furthermore, the current principle of the CAA (CAP 670) is that an APS would require a primary surveillance radar. Whilst several HIAL airports benefit from nearby primary radar coverage, none of them, except the one in Inverness, are currently owned by HIAL. The costs to obtain primary radar coverage would therefore be significant, whether paying for a feed from existing infrastructure, or by introducing new primary radars.

This leads to the following option being defined:

- **Option 2a "implement radar-based approach control (APS) at all ATC airports"**: This option is in line with current CAP 670 requirements, including primary surveillance radar – eg from existing facilities or via new PSRs.

Building on option 2a above, a case could be made for an APS service that wouldn't rely on the costly primary radars. This would require a compelling safety case, but it has already been implemented successfully elsewhere in Europe. For example, in Norway, a 3NM APS service has been introduced using only secondary surveillance radar (SSR) on the basis of the ANSP providing compliance with the performance requirements in the Eurocontrol Specifications for ATM Surveillance System Performance[21].

An SSR only option may not lower costs significantly, so a further argument would probably need to be made for lower cost surveillance means such as ADS-B or Wide Area Multilateration (WAM). The latter is already used as a surveillance means in the North Sea and is implemented in several places across Europe as a surveillance layer (i.e. alongside SSR).

Nevertheless, costs would certainly be higher than the low-specification multilateration infrastructure currently being trialled in Dundee. It also implies additional costs to set-up APS positions and in staffing to recruit and train new ATCOs. HIAL would need to make the case that the environment was sufficiently "known" and may need to factor in costs to ensure this.

A further key impact on cost in the provision of an APS is the location of Controller Working Positions (CWP). Locating the APS positions in the existing towers (in a separate room) as has been done in Inverness, would involve creating a new 'radar' (surveillance) room and would also imply an additional role and roster – thus decoupling the economies of scale that exist in a combined ADI/APP position. With ATCOs in HIAL typically using dual ratings (ADI and APP), splitting the location of the aerodrome (ADI) and approach (APP or APS) service provision would mean a radical restructuring of the roster and unit strategy. Initial considerations are that this would be difficult to do in a cost-effective manner.

A potential, though riskier variation, could be to put a case to the regulator for a combined ADI and APS in the visual tower. Since the legal change that now permits ADI and APS to be provided by a single ATCO if traffic and complexity permits, it could be possible for current ADI ATCOs providing APP services to be re-trained to include an APS licence in their rating, and to then provide both services when on duty.

This type of operation is starting to gain traction as a concept and is already applied for low periods of traffic (eg "night time" periods) at Aberdeen and Newcastle. It would likely require limitations on applicability (eg traffic density or complexity) and would also require

[21] Discussion with Norwegian CAA, August 2017

a process of training and validation to gain approval from the CAA. CAA's feedback from the 8th of August 2017 suggested that APS ATCOs would need to gain experience at busier IAP environments (eg INV) before being able to validate on such a concept at their home units. The number of existing ATCOs able to validate on combined APS and ADI may therefore limit the potential for savings in this option. It is likely that the current general model of an ATCO and ATSA at the ATC airports would be continued.

Therefore, a further sub-option is defined as follows:

- **Option 2b: "implement non-radar based approach control (APS) at all ATC airports"**: This option involves developing argument for non-radar surveillance technologies (eg MLAT, ADS-B) for an approach surveillance service at all ATC airports (with APS and ADI to be provided by the same ATCO during low density/complexity operations).

Finally, there may be benefits in centralising the APS, to a combined APS centre. This could be based at Inverness, Dundee, or indeed any suitably connected location. An obvious disadvantage is the staff change in moving the APS function to a different location, although this could be done through recruitment over time rather than redeployment. There may also be challenges in ensuring the communications links, mitigating the loss of responsibility/workload for ADI ATCOs, and dealing with a potential single point of failure.

On the other hand, the benefits over having an APS at each unit could include: the ability to provide services to multiple sectors, potential for rostering and training benefits based on combined ADI/APS, reduced requirement for ATSAs (as the ADI ATCO is now focused on that role), maintenance harmonisation, and operational harmonisation (service provision).

The impact on recruitment and retention could therefore be both positive and negative. Negative in that it may even exacerbate the issue for ADI ATCOs who would be still based at the airport, but with less responsibility. Positive as it would mean that APS ATCOs could be recruited from a bigger pool.

This leads to the following option being considered:

- **Option 2c: "implement remote centre to provide non-radar based approach control (APS) at all ATC airports"**: In this option the surveillance means are as per option 2b, but with all APS ATCOs based at a central facility. Aerodrome (ADI) ATCOs would remain at the airport.

4.4 A fully centralised facility would solve issues around recruiting, retaining and operating a fragmented organisation, future-proofing HIAL

Whilst the options above address some of the drivers, none would address the longer-term issue of recruiting and retaining operational ATS staff at many of the airports. The remote location of many islands has meant the recruitment and retention has continually been an issue (as noted in section 2.1)

The consequences for airlines and passengers are borne out in data that shows a significant number of airport closures due to insufficient ATS staff, reduced radar operations at Inverness, and cases of downgrading the ATS from ATC to AFIS at weekends.

The technical and operational feasibility of RTs mean that a solution of centralising aerodrome service provision is now available. This would apply to the current ATC airports only. As well as potentially offering improved recruitment, a centralised facility would also offer opportunities to harmonise service provision standards, to extend hours of ATS provision and to introduce improved ATS technology, such as electronic flight strips, automated weather systems and safety aids such as wildlife tracking and infra-red cameras. A more radical concept, currently undergoing trials in other countries, is the potential for an ATCO to handle multiple airports from a single position, offering even further potential for rostering efficiencies and services.

These benefits would allow HIAL to "future-proof" its operations, enabling it to be in line with its peers in ANS provision such as Avinor, LFV and IAA. It would mitigate the risks identified above, giving a sustainable long-term scenario with achievable recruitment and retention processes. It would also allow flexibility of service provision according to changing demand, and enable HIAL to respond to the challenges of reduced subsidies by providing a cost-efficient service in the long-term.

However, moving the ATS function from the airport to a centralised facility also has obvious challenges. First are the significant staff concerns and costs associated with re-location. We expect a significant proportion of staff to want to remain in the local community and family situation, rather than re-locating[22]. Second would be the communications infrastructure, which under RTs would become a critical enabler to ATS and would also consequently become a much more significant cost, both to guarantee sufficient availability and also to accommodate the significant bandwidth associated with a remotely provided service. The costs associated with the infrastructure and the challenges around transition and approval are also potential negatives for this scenario.

- **Option 3 "implement remote centre for aerodrome (ADI) & approach (APS) control"**: this option implements the centralised approach control (APS) as per option 2c, but expands the centre to a 'Remote Tower Centre', from where all aerodrome (ADI) services would be provided. It is anticipated that an OOH AFIS[23] could also be provided from this central facility.

Future challenges may result in a need for the centralisation of ATS services provided at the four AFIS-only airports. A future driver could be that operators flying into the AFIS airports do not accept the safety implications of that service (eg if Loganair stops operating from these airports, who would fly these routes, and would they be able to use the same "local knowledge" mitigation for safety in uncontrolled airspace). As of today however, there are no significant drivers for this centralisations (eg the dispensations from the CAA are expected to be maintained).

Sub-options of this scenario include the precise location of the central facility, and ownership issues.

[22] We note this could be mitigated by a longer time frame of transition, allowing "natural" attrition through retirement and moving on, and recruiting ATCOs specifically for the transitional situation and new location.

[23] At the 5 ATC airports that currently have an OOH AFIS – Benbecula, Kirkwall, Stornoway, Sumburgh and Wick

5 High level assessment

We do not believe that all six of the options above satisfactorily address HIAL's drivers and constraints. Not all options should therefore be taken forwards to the detailed analysis (including cost benefit assessment). This section provides a high level qualitative assessment followed by a rationale for the options that will be taken forwards for further analysis.

5.1 Comparison of options: Key drivers

Based on the justification outlined in the previous section, the following table compares the options side by side, from the perspective of their most significant impact on the key drivers.

Driver	Option 1a	Option 1b	Option 2a	Option 2b	Option 2c	Option 3
Maintaining lifeline services to remote communities (see 2.1)	No significant impact	Same as for 1a	Clear impact as it will require increase in staff, that will exacerbate some recruitment challenges (potential opportunities for those looking to and able to validate on radar, but negative impact on those not wanting to lose APP license)	Same as 2a, but mitigated in some cases where the same ATCO is able to validate to provide both APS and ADI	Similar to 2a, but even greater increase in staff. Likely to be easier to recruit (or to relocate those happy to move) and retain APS ATCOs at a central location. Also centralisation provides more flexibility and cover for APS ATCOs	Significant impact, with centralised facility enabling more sustainable and flexible services with significantly fewer strategic closures (assuming connectivity requirements are sufficient) Transition likely to be challenging with many staff unlikely to transfer and several new recruits likely to be needed
Continually improving safety (see 2.2)	Improves safety through providing a more known environment	In addition to 1a, it gives more significant benefit by creating a known environment for all *transponding* aircraft	Increased safety margin through *all* aircraft being displayed in a known environment (via primary and secondary)	Better than 1b, but relies on cooperative targets and high transponder equipage to achieve full safety benefits	Same as 2b, but physical separation between ADI and APS could marginally increase workload in coordination	Introduces new risks (eg loss of cameras/connectivity) but also offers potential for improved wildlife management, aircraft/drone detection (especially low vis) and improved training possibilities. Also enables more flexible services which could reduce OOH risks
Complying with regulation (see 2.3)	Meets minimum regulatory requirements	Same as 1a, with ATMs offering ‘better practice’	Same as 1a, with surveillance offering ‘best practice’ and best level of harmonisation with other EU airports	Meets part ATS but requires regulatory approval of MLAT/ADS-B only APS	Same as 2b, but with easier approval due to not pursuing APS & ADI by same ATCO from same location	Same as 2b, but with additional challenges of proving a large scale RT deployment. Other ANSPs will have gained approval beforehand (using existing regulations) but still an early-mover risk, particularly for their environment

Driver	Option 1a	Option 1b	Option 2a	Option 2b	Option 2c	Option 3
Remaining financially sustainable (see 2.4)	Will involve costs not only for airspace change (~£150k for Inverness ACP for example) but also for the replacement and upgrade of obsolete infrastructure (see 2.4). Training costs expected to increase too	Same as 1a, with the additional cost of ATMs and low cost surveillance (eg MLAT/ADS-B) infrastructure	Significant additional cost due to the PSR/SSR equipment and associated training. For example, the Inverness installation included radar equipment (£4 million), radar processing (£500k) and additional costs for facilities, infrastructure changes and consultants (~£60k)	A lower cost alternative to 2a, but still higher than option 1. The cost will be driven by the quality of the solution to meet the safety case (eg number of sensors, potential to combine with ADI etc)	Same as 2b, but with added cost of a centre, which could involve new building costs as well as recruitment and /or relocation costs	Substantial initial cost, though possibility for service models to spread capex. The transition (relocation, training, approval) will be high, together with the airport equipment and remote centre. Bandwidth/communications costs will also be a major factor. Training is easier and cheaper so will lead to savings in the long run, particularly with multiple validations. It will be easier to spread the costs of future infrastructure replacement. There may also be possibilities to generate revenue from this option
Optimising ANS (see 2.5)	No impact, though may require some work to optimise IAP considering CAS and GNSS IAPs	Greater certainty on the position of other aircraft may allow more efficient routings to be given, although recognising separation standards will not change using an ATM	Enable HIAL to meet the necessary risk thresholds that will allow them to attract airlines such as FlyBe and KLM. May lead to a decrease in average track miles per aircraft resulting in a decreased fuel burn, although this will depend on exact procedures used (eg specific routings and separation standard)	Same as 2a	Same as 2a	Same as 2a. Additionally, for ADI the loss of local knowledge and interface with airport could reduce ‘added value’ of ATS to airspace users

5.2 Comparison of options: Key constraints

Based on the justification outlined in the previous section, the following table compares the options side by side, from the perspective of their most significant impact on the key constraints.

Constraint	Option 1a	Option 1b	Option 2a	Option 2b	Option 2c	Option 3
Addressing the impact on staff (see 3.1)	No significant impact on staff, most seem happy to accept controlled airspace	Same as 1a, but with even further support for ATMs	Increased number of staff needed, and additional opportunities will be created, though some staff have questioned the need for a surveillance service	Same as 2a	Similar to 2a, but centralised APS would leave staff with choice of staying at airport providing only ADI or relocating & re-training to provide APS from elsewhere. ATSA role in the centralised facility and at the towers may change	Significant impact. Some staff see benefits, opportunities and an “inevitability” about digitisation, but many are very reluctant to move away from the airport. ATSA role in a centralised facility also needs to be considered. Careful transition and recruitment strategy would be needed to handle the change and related costs
Proving technical and operational feasibility (see 3.2)	No significant risk, main issue is that HIAL will not have sufficient time to implement the changes before the deadline (which is yet to be established)	Same as 1a, but complexity increases slightly due to the need for ATMs	PSR/SSR is proven technology, but could be challenging to provide resilient data connections and weather resilience.	Relies on a strong safety case for non-PSR Instrument Approach Procedure. Could require avionics equipage as a condition for use	Same as 2b, but with greater reliance on connectivity between surveillance sensors and centre	Significant issues will need to be resolved, particularly the availability of reliable, dual redundant communications. To be investigated further
Achieving stakeholder acceptability (see 3.3)	Likely to be welcomed by commercial airlines but with concerns from others (eg military and recreational flyers), dependent on the conditions for controlled airspace (eg requiring radio, transponder, etc)	Same as 1a	Same as 1a, with further support from commercial airlines. PSR/SSR may add additional impact depending on location	Same as 2a, but MLAT/ADS-B perhaps less likely to cause location impact. Potential requirement for avionics equipage as a condition for use, could be an issue	Same as 2b	Airspace users unlikely to have significant opposition (assuming no negative impact on service or price), but could be a challenge if public perceptions are negative
Ability to handle the scale of change (see 3.4)	Modest, compared to other options, but still a significant change considering the time taken for the ACP at Inverness	Same as 1a, but with additional effort required for the introduction of ATMs	Same as 1a, and with much greater effort and resource required to procure and implement surveillance infrastructure as well as to manage training and transition to a new type of ATS	Same as 2a, with further effort likely to be needed to create the argument for non-PSR	Same as 2a, with added complexity of establishing, recruiting, training, and transitioning to a centre	A major change on a scale never before attempted by HIAL. Will need careful planning and phasing

5.3 Options to be taken forward for detailed analysis

Based on our high level assessment above, we believe that two of the options should not be taken forwards, this is explained below.

As outlined in section 4, there is clear evidence that maintaining the status quo is not an option. Indeed HIAL will be required to comply with EU laws that will require the introduction of controlled airspace at all ATC airports before 2030. The feasible minimum options are therefore options 1a and 1b. The difference between these options could be relatively minor in cost terms (they would both require the same level of investment in existing tower buildings and infrastructure). This is because the increasing availability of lower cost surveillance technologies mean that the introduction of Aerodrome Traffic Monitors (ATMs) in option 1b will in the future be a relatively small cost for a significant safety benefit and increased ATCO situational awareness. External grant funding (such as from EU sources, or from the CAA as recently provided for the surveillance infrastructure in Dundee) could be made available for the ATMs, though this is dependent on factors outside HIAL's control. **We therefore discount option 1a in favour of option 1b. Option 1b will be taken forwards to the cost benefit as the baseline and feasible 'minimum' scenario.**

The 'minimum' option 1b would not however address the changing nature of APP control. It is an increasingly rare form of ATC provision that is expected to become progressively unfamiliar to pilots and more difficult (and expensive) for HIAL to provide training for in the coming years. Nor would option 1b provide a fully known environment that would enable ATS staff to see all aircraft and control the risk of airborne conflict that ultimately limits HIAL's ability to further improve safety. Finally, it wouldn't deliver on any efficiency or environmental benefits as procedural separation would still be applied.

We therefore believe that an option to introduce an approach surveillance control (APS) service should be considered, recognising HIAL's need to be future-proofed (in training ATCOs) and the incremental safety benefit. Although it is common to provide such a service using primary and secondary radar (option 2a), we believe that this would be cost prohibitive and that a more cost effective and feasible option will be to support this service with a combination of MLAT and ADS-B – particularly considering the CAAs recent recognition of the value of ADS-B [57]. The APS could be provided either: from the tower (option 2b), potentially as a combined ADI/APS position in low traffic periods; or from a centralised facility (option 2c). **Option 2a will therefore be discounted and both options 2b and 2c will be taken forwards to the cost benefit analysis.**

The final option that will be taken forward is the most ambitious, but also the only option that addresses the fundamental threat HIAL is facing to airport sustainability due to its inability to maintain appropriate staffing and provide acceptable operating margins. By centralising the ADI and APS control (option 3) HIAL could potentially address the recruitment and retention issues that have been the underlying cause of frequent airport closures. **Option 3 will therefore be taken forward to the cost benefit analysis.**

In summary, the options taken forwards into the detailed analysis and cost benefit assessment are:

- **Option 1b "only implement controlled airspace and ATMs at all HIAL ATC airports"**
- **Option 2b: "implement non-radar based approach control (APS) at all ATC airports"**

- **Option 2c: "implement remote centre to provide non-radar based approach control (APS) at all ATC airports"**
- **Option 3 "implement remote centre for aerodrome (ADI) & approach (APS) control"**

We consider that the current AFIS airports should continue to provide their current services and see no clear drivers for centralising the AFIS service and no reason why the AFIS airports may not continue to provide an AFIS to commercial aircraft under an exemption from the CAA.

6 Detailed options assessment

6.1 Introduction

This section assesses the selected options in detail, including from a cost benefit perspective. It aims to identify the preferred option using and adapted version of the UK Government Green book approach [58] and a ‘balanced scorecard’. This provides a more holistic assessment that considers high level strategy elements such as HIAL’s mission, vision, core values and strategic focus areas as well as the more operational and technical elements impacted by each option.

The balanced scorecard approach [114] specifically considers four perspectives. These are presented below, together with a mapping to the relevant drivers and constraints presented in earlier sections.

Table 7 Overview of the balanced scorecard approach

Balanced scorecard assessment category & description	Key drivers considered in this category	Key constraints considered in this category
Financial: often renamed Stewardship or other more appropriate name in the public sector, this perspective views the impact of the options on financial performance and the use of financial resources	Remaining financially sustainable (see 2.4)	
Customer/Stakeholder: this perspective views impact of the options from the point of view of the customer (airlines) and other key stakeholders such as the Scottish Government and the CAA.	Continually improving safety (see 2.2) Optimising ANS (see 2.5)	Achieving stakeholder acceptability (see 3.3)
Internal Process: views the impact of the change through the lenses of the quality and efficiency related to HIAL services	Maintaining lifeline services to remote communities (see 2.1)	Proving technical and operational feasibility (see 3.2)
Organisational Capacity (originally called Learning and Growth): assesses the options through the lenses of human capital, infrastructure, technology, culture and other capacities that are impacted	Complying with regulation (see 2.3)	Addressing the impact on staff (see 3.1) Ability to handle the scale of change (see 3.4)

6.2 Financial

6.2.1 Overview

This section considers which of the options would be most beneficial for HIAL from a financial point of view. We have undertaken a quantitative analysis which compares the costs of Local APS (2b), Centralised APS (2c) and Remote Towers and centralised APS (3) options with the CAS and APP (baseline, 1b) option. The analysis forecasts over a period of 15 years, from 2018 until 2032, to allow the investments to accrue benefits. Results are expressed in terms of the net present value (NPV) where a positive NPV represents a saving and a negative NPV represents a cost compared to the baseline option. The analysis was based on a number of assumptions, which are all documented in Annex O. The financial analysis only captures a sub-set of overall HIAL operating costs, namely those that are affected by the investments undertaken in the options. Specifically, the costs analysed within the scoping study are presented in Figure 22.

Costs captured within the financial model	Costs outside of the scope of the financial model
• ATCO & ATSA employment costs • ATCO training cost related to the required new licenses/endorsements • Tower building running & refurbishment cost across all ATC aerodromes • Building costs related to the centralised facility and new APS rooms • Surveillance, data processing and remote tower system purchase and running cost • Communications cost related to the centralised service	• Any costs related to the AFIS-only aerodromes • Ab-initio and refresher training cost • CNS infrastructure outside of the scope of the analysis (e.g. runway lights, ILS system etc) • Airport operating and capital costs • Head Office costs • All non-ATS employment costs • ACP costs, as these are expected to be constant across the scenarios

Figure 22 Scope of the financial assessment analysis

6.2.2 Key outcomes

The results of the analysis are presented in Figure 23 overleaf. The chart shows a comparison against the least costly option. The least costly option of the four is the CAS and APP (baseline, 1b) option. In this baseline option, the cost of the relevant elements (please see Figure 22for a breakdown of costs included in this analysis) equates to £94.9M in real terms over 15 years .The implementation of a local APS (2b) at each of the ATC airports would be £22.2M more expensive than the CAS and APP baseline option at £117.1M over 15 years. The centralised APS (2c) function would be £29.8M more expensive at a total cost of £124.7M and a centralised APS and Remote Tower (3) solution would be £28.4M more expensive at a total cost of £123.3M.

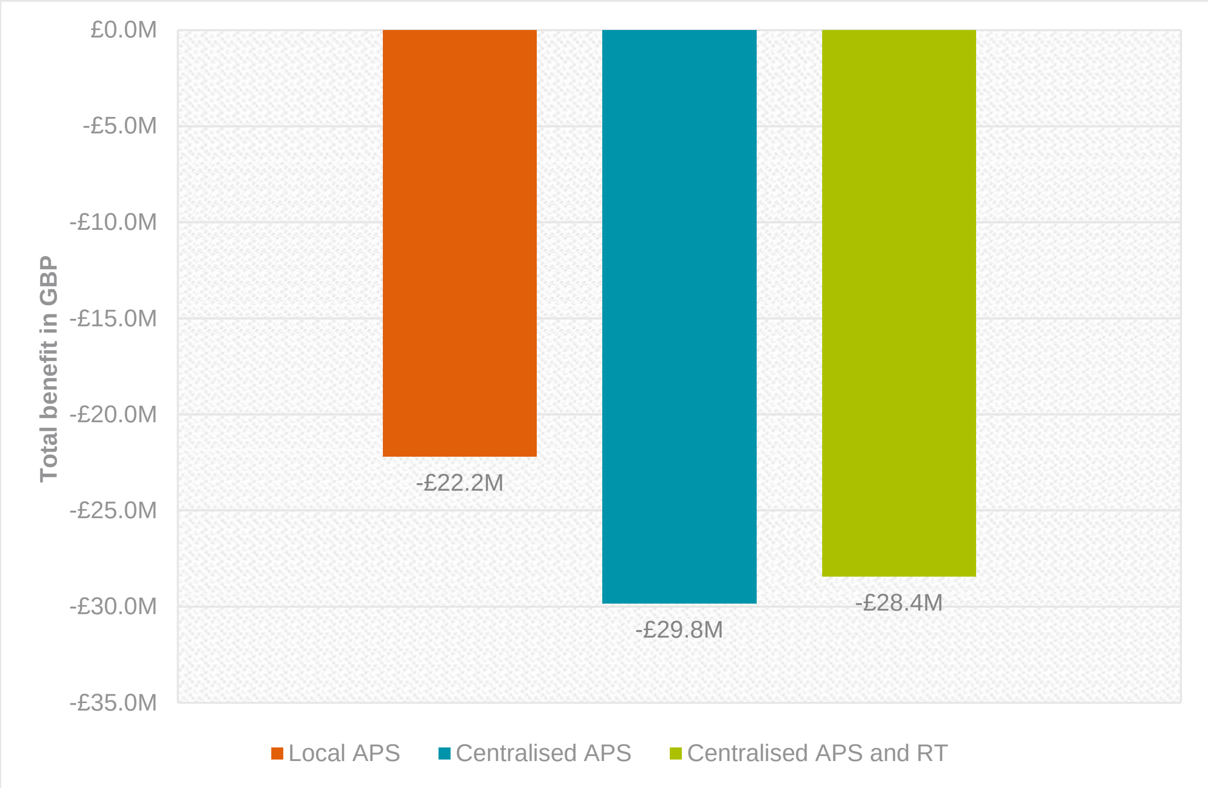

Figure 23 Cumulative net cost comparing Local APS, Centralised APS and Remote Towers and centralised APS options to the minimum option CAS and APP

The cost savings in the CAS and APP (1b) option (at least £22.2M compared to any of the other options) arise from a lack of any large training programs, additional recruitment or large capital expenditure projects (other than the assumed tower refurbishment & replacement in the capital plan).

The introduction of an APS function in all other options (2b, 2c, 3) is a major cost element, due to a required investment of £1.4-£4.4M in surveillance infrastructure, £3.0M surveillance data processing infrastructure and £0.5M - £3.0M in building infrastructure (depending on whether the data processing is centralised or not).

In addition to the capital expenditure, the introduction of APS alone significantly drives staff operating costs. In the local APS (2b) option, in line with CAP670, we estimate that HIAL would require an additional 11 ATCOs to support the additional working position. Additionally, the majority of the existing ADI/APP ATCOs would be required to complete an APS validation, which would further drive training costs. Over the course of the 15 years, this would result in an additional cost of £12.2M in employment and training cost (in real terms).

Where the APS provision is centralised (2c) we have estimated that an additional 25 ATCOs and 4 supervisors would be required, which would translate to an additional ATCO employment and training cost of £19.3M over the course of 15 years.

The Remote Towers and centralised APS (3) option increases the capital expenditure by £17.5M compared to option 1b with the introduction of a remote tower centre, but allows for the introduction of an APS service without significantly increasing the staffing pool. Based on the CAP670 guidelines, and when taking into account the required senior ATCO oversight, we have estimated that the APS and ADI services could be provided with

3 additional ATS staff on top of the current configuration. Nonetheless, HIAL would be required to pay relocation and training costs (estimated at £7.3M).

If we compare the real cost of the options, local APS (2b) is 23% more expensive than CAS and APP (1b), centralised APS (2c) 31% and Remote Towers and centralised APS (3) roughly 30%. These percentage increases only apply to costs within the scope of the Air Traffic Management 2030 Strategy, as explained in Section 6.2.1.

Figure 24 shows how the cost described above breaks down in terms of capital expenditure (CAPEX), staff operational expenditure (staff OPEX) and non-staff operational expenditure (non-staff OPEX)[24].

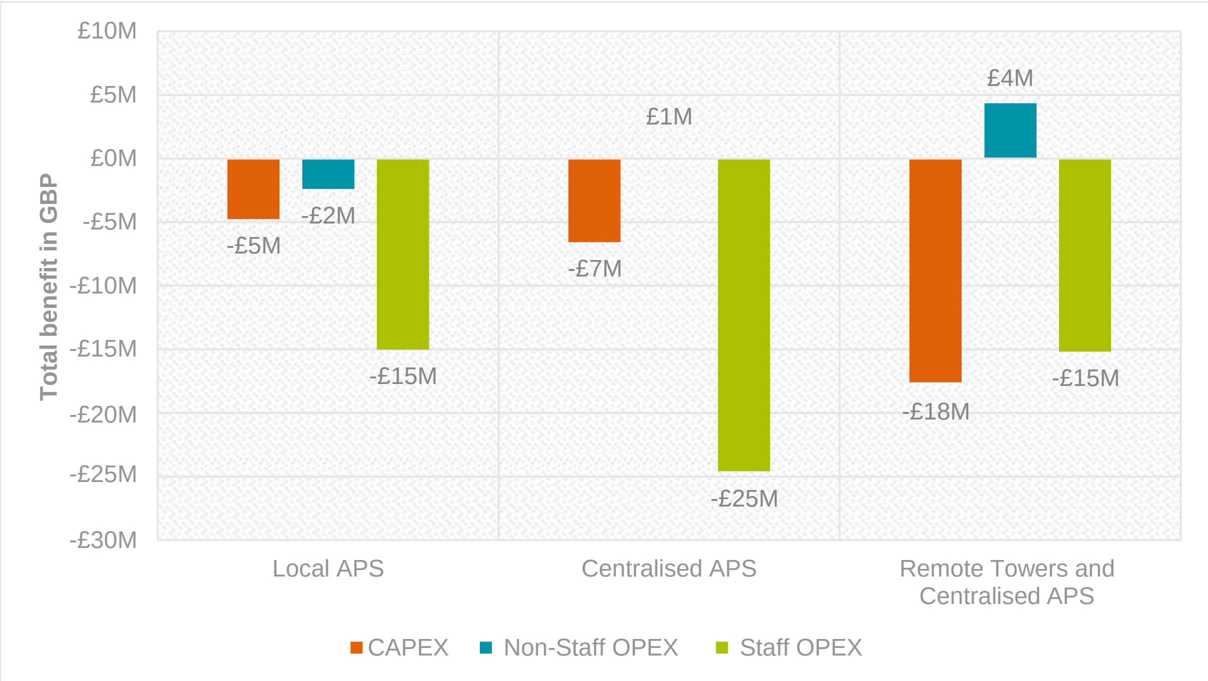

Figure 24 Cumulative saving from implementing non-baseline options, broken down by cost categories

The core analysis was limited to a 15-year time-span, but a sensitivity analysis of the impact of looking at different time-spans was carried out. This analysis shows that as we increase the term of the Cost and Benefit analysis, the gap between the cost of the local APS and the Remote Towers and centralised APS options diminishes, with the centralised APS becoming relatively even more expensive.

[24] CAPEX covers the expected infrastructure acquisition costs across the options as well as upgrades expected in a more distant future; Staff OPEX captures any ATS and Management related costs; Non-Staff OPEX covers system and building running cost

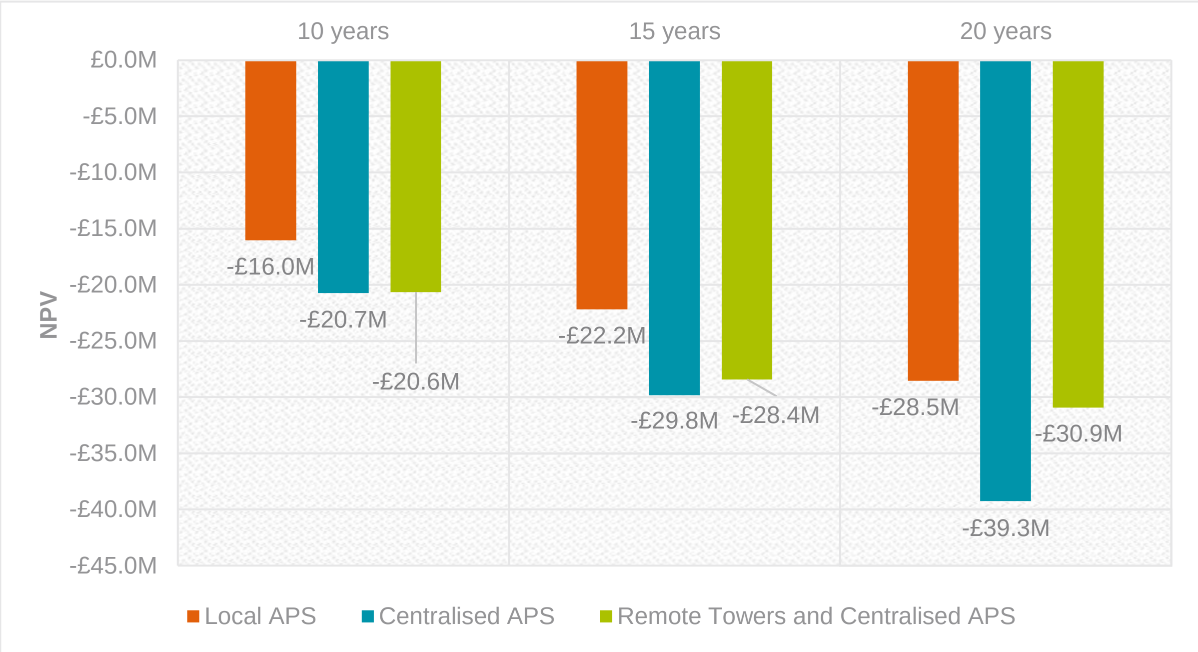

Figure 25: CBA timespan sensitivity analysis

Ancillary benefits, such as HIAL's ability to leverage early-adopter advantage from implementation of remote towers in the UK, are not modelled and are not expected to significantly impact upon the NPV or strategic decision.

6.2.3 Summary

The least costly option is the baseline CAS and APP (1b) option. However, the relevant cost is nevertheless substantial and equates to £94.9M in real terms over 15 years. The implementation of a local APS (2b) at each of the ATC airports would be £22.2M more expensive than the CAS and APP (1b) option at £117.1M over 15 years. The centralised APS (2c) function would be £29.8M more expensive at a total cost of £124.7M and a centralised APS and Remote Tower (3) solution would be £28.4M more expensive at a total cost of £123.3M.

The Remote Tower and centralised APS (3) allows to introduce an APS service with a minimal addition of 3 ATS staff, which creates a benefit when comparing this option to both the Local APS (2b) and centralised APS (2c) options. However, due to the additional ATS and managerial staff required in this option, it remains more expensive than the CAS and APP (1b) option.

On average, options including the introduction of APS (options 2b, 2c and 3) would require around £1.0 -£2.0 million per annum additional to the CAS and APP (1b) option.

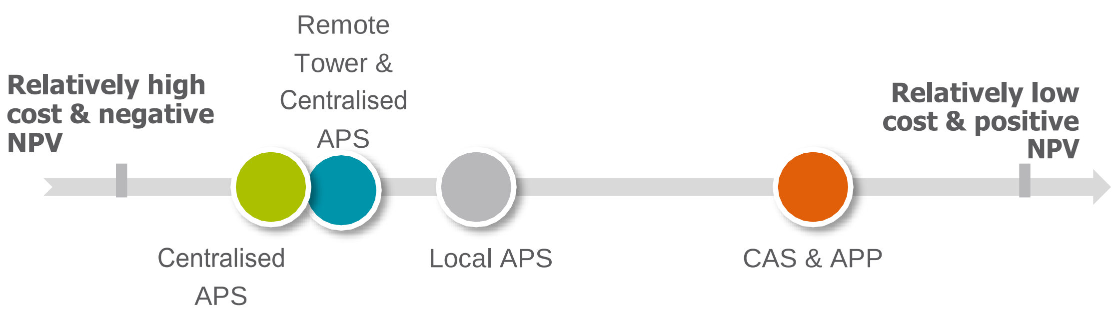

Figure 26 Financial assessment outcome

6.3 Customer / stakeholder

6.3.1 Overview

The customer/stakeholder category compares the overall impact of the options on the airspace users, in particular regarding the:

- Impact on operational safety
- Potential to improve ANS
- Ability to achieve stakeholder acceptability.

6.3.2 Key outcomes

All options introduce controlled airspace, and have a positive impact on safety arising from greater knowledge of the operational environment in real-time.

Each option then has a distinct safety risk profile, and therefore a hazard identification workshop was held as part of the scoping study. This resulted in a high-level assessment of the potential operational safety benefits and risks, as presented in Annex L.

The baseline (CAS and APP, 1b) option assumes an APP service is maintained. This option fails to address the underlying issue that HIAL is unable to directly control the risk of airborne conflict under the current environment of Class G airspace, as there is no reliable way of detecting and recovering error situations as they occur (whether pilot or ATCO error). This option also continues to expose HIAL to the risk of pilot unfamiliarity, a risk that whilst not a significant concern at present, is only likely to increase as APP services becomes scarcer throughout Europe.

All the alternative options (local APS (2b), centralised APS (2c) and Remote Towers and centralised APS (3)) introduce an APS service which will improve safety by enabling a surveillance-based separation minima to be applied, and giving the ATCO information to be able to recover errors by the aircraft or ATCO.

For some airlines, a surveillance service is a minimum requirement to operate (eg KLM at Inverness) so these options will also potentially remove a barrier to attracting new routes and airlines.

Surveillance could also enable more direct routes, enable continuous climb and descent operations decreasing average track miles per flight thus reducing fuel burn and flight-time. These efficiencies are likely to be largest in the centralised APS (2c) and Remote Towers and centralised APS (3) options, where APS is centralised easing the coordination between sectors, but would not be observed at all in the CAS and APP (1b) option. The benefits observed will depend on exact procedures used (eg specific routings and separation standard), but will almost certainly increase the base procedural flow rate, which can be as low as 6 arrivals per hour at some airports.

On the other hand, the introduction of an APS service is likely to impact on the acceptability to some stakeholders, particularly those that would be required to purchase or upgrade avionics to access the airspace in which the APS is provided (for example general aviation or military aircraft). To some degree the same impact is likely to apply even in the baseline, where the introduction of controlled airspace is likely to set new equipage requirements on aircraft.

The centralised APS (2c) option could potentially result in some additional coordination issues between ADI and APS ATCOs, but this is not expected to have any noticeable impact on services provided to airspace users.

Remote Towers and centralised APS (3) enable a more flexible service provision, with the potential for accommodating more flexibility in the hours which ATS is provided at airports through a centralised facility. For example, it could be possible for a smaller number of ATCO or AFISOs to provide an OOH service across a number of airports. This would not only reduce cost, but potentially also prevent situations in which extensions are refused and make HIAL's service provision more attractive from a user perspective. Cost recovery from the charges to the aircraft would then be a greater percentage of the actual cost accruing to HIAL.

Safety benefits may also accrue in the Remote Towers and centralised APS (3) option due to the remote tower's cameras' ability to better detect wildlife and other aircraft, particularly in low visibility (eg infra-red visibility, motion detection, identification & labelling of aircraft etc). Whilst airspace users we spoke to generally didn't have concerns about remote towers, the potential loss of local knowledge (as the ATCO moves offsite) was recognised as an area that could marginally impact airspace users, at least in the early phases of operation for a remote tower. The potential in this option for losing ATS due to connectivity failures is assumed to be no less than it is today, but there could be safety risks in case a comparable level of ATS availability is not possible (eg due to insufficient infrastructure). This must be mitigated during the design phase, and may impact the cost effectiveness of the remote towers.

The wider political consideration of moving jobs away from remote communities in the Remote Towers and centralised APS (3) option is beyond the scope of this technical report, but clearly there is the potential for this to impact the acceptability of the option at a wider level. It will have to be duly considered by HIAL and then Transport Scotland and Ministers. Indeed each of the options may need to be subject to a level of public scrutiny, either through a political committee or via a full public consultation. Ultimately it will be a political decision on the level of consultation required and whether this is carried out by HIAL or an independent party. Initial indications from the staff union, local press and politicians suggests the level of scrutiny will be high, and gaining wider acceptance from stakeholders may be a barrier to implement such a solution.

6.3.3 Summary

On balance, we believe that the baseline (CAS and APP, 1b) is the least favourable option from a customer / stakeholder perspective as it offers the least significant safety and operational improvements. The local APS (2b), centralised APS (2c) and Remote Towers and centralised APS (3) options introduce an APS service which will improve safety and has the potential of fuel savings for the airlines.

Additionally, the Remote Towers and centralised APS (3) option enables the possibility for more flexible service provision allowing to accommodate more flexibility in the hours of

ATS provision at the airports hence further increasing the benefits to the users, making it the most favourable option from a customer/stakeholder impact perspective.

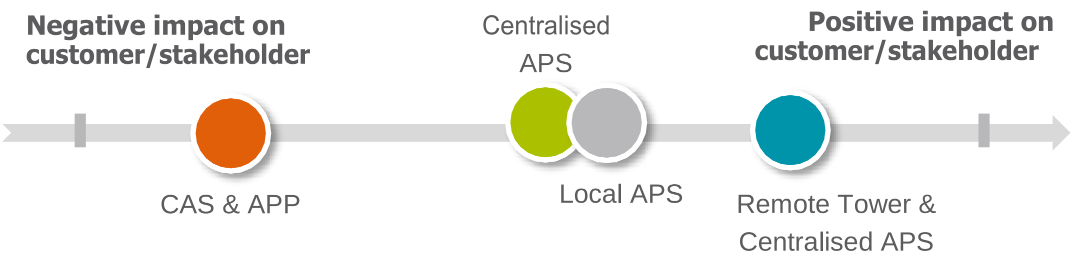

Figure 27 Customer/stakeholder assessment

6.4 Internal Process (service quality and sustainability)

6.4.1 Overview

This category considers the impact of each option in terms of the quality and efficiency of HIAL services. In particular it focuses on the longer-term sustainability for HIAL to provide services as well as the technical and operational feasibility of each option.

6.4.2 Key outcomes

6.4.2.1 Long term sustainability

Maintaining lifeline services to remote communities is at the heart of HIAL's long term strategy. The key challenges are ATS resource related issues (that cause strategic closures, reduced services or extension refusals) and to successfully recruit enough ATS staff to handle the demand.

The CAS and APP (1b) option, where the number and location of working positions will not change, will not allow HIAL to address ongoing recruitment issues or insufficient staffing levels. Furthermore, overall demand for APP training is continuing to decline such that there is now only one provider remaining in the UK. This not only impacts the price of training (costs have increased by a factor of 41% in only 18 months since January 2016) but it also continues to expose HIAL to a risk that training courses may be withdrawn. Recent discussions between HIAL and Global ATS (the single remaining provider of APP training in the UK) indicate that current demand for other courses (that are potentially more lucrative than APP) is particularly high, due to gaps in NATS' training pipeline caused by ATS staff transferring to ANS Ltd who have displaced NATS at airports such as Gatwick and Edinburgh.

In the local APS (2b) option (and to a lesser degree the two centralised options 2c and 3), the creation of separate APS positions could exacerbate the recruitment challenges because it would create additional positions to be filled at the airports (or centralised facility). In the local APS (2b) option, in line with CAP670, we estimate that HIAL would require an additional 11 ATCOs to support the additional working position. If the APS provision is centralised (2c) we have estimated that an additional 8 ATSAs, 25 ATCOs and 4 supervisors would be required. Recruiting individual positions in the centralised APS option is likely to be easier than in the local APS one as they will be drawn from a central location, that is likely to be more attractive to candidates and provide a bigger pool to recruit from. However the absolute number to recruit is much larger. The number of new staff required is nevertheless likely to cause issues and may result in delays in implementing the option.

The move to Remote Towers and centralised APS (3) would allow HIAL to introduce a full APS and remote ADI service with a similar number of ATS staff as at present. It is expected that even though option 3 assumes the creation of APS CWPs, only 8 additional ATCOs and 4 supervisors would be required to enable this service. Additionally, the ATSA pool could be reduced by 9, resulting in a net ATS staffing increase of 3, due to the efficiencies that could ultimately be realised through a remote centre. In the longer term this option is the only one that provides a solution to current recruitment problems. This is because this is the only option with the APS service, which does not result in a significant increase of the ATS staff pool, and because the centralised location and work environment are likely to attract more candidates. HIAL would however need to carefully manage the transition and bear the cost of providing staff with relocation packages and any alternative arrangements for those unwilling to relocate (see later sections).

6.4.2.2 Technical and operational feasibility

In terms of technical and operational feasibility, the local APS (2b) would be relatively straightforward with the main challenge being to introduce controlled airspace (which would apply to all options). The introduction of ATMs using only MLAT/ADS-B could introduce some challenges in terms of approval and the hazards of responding to data that it is only for situational awareness.

The feasibility of the introduction of APS (options 2b, 2c and 3) relies upon CAA approval of:

- A secondary surveillance only solution (primary radars are too expensive for the operations in the HIAL environments) for an APS service;
- A secondary surveillance solution comprising Wide Area Multilateration and ADS-B rather than a radar.

Developing a safety case without primary radar (PSR) will rely on providing sufficient assurance that aircraft operating in the relevant airspace will be equipped and that any equipment failures can be suitably detected and mitigated, or that the traffic is known to the ATCO via radio contact. This is highly dependent on the specific local context. For low complexity, it might be argued sufficiently when in a controlled environment with known traffic, but where known complexities exist, other mitigations may need to be explored. For example, if Military aircraft operate in the vicinity, can perhaps by extending controlled airspace using SIDS/STARs, and requiring the Military to operate outside that. It will also rely on sufficient accuracy and availability of the ground infrastructure and may require duplicate coverage.

Safety cases have already been approved for APS services without PSR in Norway and we anticipate that in the coming years, the technology and aircraft equipage levels will have matured substantially to enable such cases to be developed and approved in a greater range of contexts. In particular as CAS is implemented at more and more smaller airports across Europe it will force many to choose between APP and APS. Most airports won’t want to buy expensive radars if they only have a few commercial flights a day and we therefore anticipate that an MLAT/ADS-B only solutions will become more commonplace.

Making the case will nevertheless take time (eg to certify) and cost money, though in the latter case grant funding may be possible due to the potential to promote the UK as one of the first to approve such a concept. A further challenge would be in developing the case for a combined ADI/APS position during low traffic periods to enable some of the assumed efficiencies in both options. Whilst there is a precedent for this in some other UK airports, our discussions with the CAA suggested that they are likely to require high levels of training, first to validate APP ATCOs to provide APS and then, after sufficient experience, to validate them to provide combined ADI/APS.

The Remote Towers and centralised APS (3) option introduces several new technical and operational challenges due to the relatively recent emergence of Remote Towers. Nevertheless it is expected that most of the broader technical and operational challenges will have already been solved by those who will implement Remote Towers before HIAL, including in Sweden (already operating Remote Towers since 2015) and Norway (due to enter operations in the next few years). In the UK and Channel Islands, many of the challenges in the approval process will have been resolved by London City, Cranfield or Jersey, which have already signed contracts for the equipment and are due to enter operations before HIAL. Other implementations will not however address the unique challenges around communications that exist in the HIAL region. Our interviews with RT suppliers indicated that, whilst various bandwidth options were available, communications links were usually the responsibility of the customer (HIAL) and not the supplier, meaning that HIAL would need to put in place sufficient resilience and integrity to support connectivity between airports and the RTC. Our investigations revealed that the Scottish Wide Area Network (SWAN) [20] infrastructure could provide a promising solution with high bandwidth, highly resilient options available – see Annex Q.

6.4.3 Summary

The APP and CAS (1b) option, where the number and location of CWPs will not change, will not allow HIAL to address ongoing recruitment issues, training issues and insufficient staffing levels. Similarly, in the local (2b) and centralised (2c) APS options, the creation of separate APS positions would increase the recruitment, resulting in an exacerbation of the existing resourcing problems. A move away from APP in these two options would however reduce the reliance that HIAL currently has to place on a single training provider.

The move to Remote Towers (3) would allow HIAL to introduce a full APS and remote ADI service while only increasing the ATS staff pool by 3 due to rostering efficiencies and the introduction of a multi-mode tower service. Consequently, from a long-term sustainability perspective the Remote Towers and centralised APS (3) option is the only way of solving HIAL's recruitment and training issues, thus "future proofing" HIAL's ability to provide required services across the Highlands and Islands.

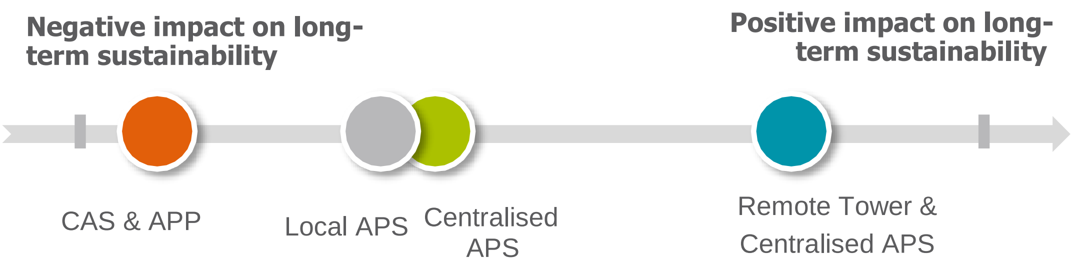

Figure 28 Long Term sustainability assessment

In terms of technical and operational feasibility, the CAS and APP (1b) option would be relatively straightforward with the main challenge being to introduce controlled airspace (which would apply to all options). The other options introduce a significant risk in that they rely on developing a safety case for an APS service not only without primary radar, but also without secondary radar.

In addition to the risks related to the APS service introduction, a remote tower implementation introduces several new technical and operational challenges due to the relatively recent emergence of the RT solution. Nevertheless, it is expected that most of the broader technical and operational challenges will have already been solved by those who will implement RTs before HIAL, but HIAL will be required to address the unique challenges around communications and operating a system on a relatively low frame per second.

On balance, we see the CAS and APP (1b) option carrying the lowest level of technical and operational risk with the Remote Towers and centralised APS (3) option carrying the highest.

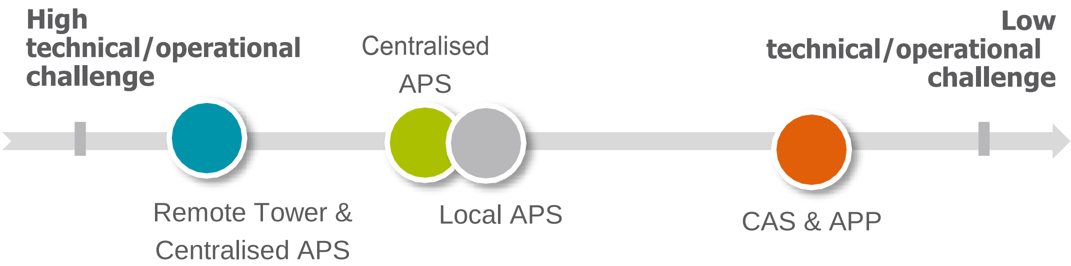

Figure 29 Technical and operational feasibility assessment

6.5 Organisational Capacity

6.5.1 Overview

This section considers the impact of each option from the perspective of HIAL's organisational capacity in terms of the how it impacts staff, the organisational impact of achieving the necessary compliance with regulation and HIAL's ability to handle the overall scale of the change.

6.5.2 Key outcomes

6.5.2.1 Impact on staff

All options will impact on staff to a certain degree, with individual situations and perceptions leading to a variety of responses to the strategy.

The baseline option (APP and CAS, 1b) introduces CAS and, through the ATMs, better situational awareness for ATCOs. ATS staff were generally supportive of this idea and we believe it would largely be welcomed, despite some questioning the need for it. Ultimately the baseline option is unlikely to have a material impact on ATCO job satisfaction, retention or recruitment ability.

Introduction of a local (2b) or centralised (2c) ATS service creates career opportunities for the existing ATCOs through the creation of an APS service. In the local APS (2b) option this growth opportunity would be available locally to the ATCOs (with need for dual ratings) whereas in the centralised APS (2c) option this growth opportunity would only be available in a centralised location. Some staff may not be willing to move to (or able to validate at) this centralised facility and any that do would leave behind vacant ADI positions anyway. Furthermore, in the centralised APS (2c) option the creation of the APS service would mean that ADI ATCOs would no longer be able to provide APP services and this is likely[25] to remove some of the interest and satisfaction in the job. This could impact staff retention, or have the knock-on effect of the ATSA positions being impacted as ADI ATCOs benefit from lower workload and could take over some of the ATSA duties dependent on the airport and traffic levels.

The introduction of Remote Towers (3) creates the largest change to the ATCOs' operational environment:

- In this scenario most ATS staff would be required to relocate. Many are unlikely to want to move and HIAL cannot force it. Staff not prepared to move would need alternative jobs (which may not be available within HIAL) or to be offered severance packages
- The centralised location may be seen as more attractive to potential new staff and would assumedly be located in a location that has a bigger recruitment pool, hence easing the recruitment problems
- This option creates new opportunities to be validated on a new and emerging concept that could translate into higher job satisfaction and retention.

6.5.2.2 Regulatory Approval

Even the baseline option (1b) requires a significant change to HIAL's provision of ANS, namely the introduction of CAS. This change will be brought about through several Airspace Change Proposals (ACPs) each of which will involve a significant degree of effort to prepare, consult on and manage responses to. The ACP for Inverness for example has taken more than five years and involved significant effort being expended. The EU regulatory deadline for implementation by 2020 appears challenging, not only for HIAL but for the UK as a whole. Whilst we would anticipate the CAA allowing some leeway in the deadline, we would also anticipate the implementation across all HIAL ATC airports to be a lengthy and effort-intensive process, that would require more time and effort than for the Inverness ACP, even taking account of the lessons learned in that process. However, as the change is primarily driven from EU and state regulation, a case could perhaps be made for grant funding to support the implementation of the regulation, regardless of which option is taken forwards.

As mentioned in the technical and operational feasibility above, the local (2b) and centralised (2c) ATS options will both require significant additional time and effort as they involve obtaining regulatory approval for a concept that has not yet been achieved anywhere else, namely that of providing an APS service purely using multilateration and ADS-B. Regulatory approval would be further complicated by the aim to provide a combined ADI/APS CWP during low traffic periods for the local APS (2b) option.

The Remote Towers and centralised APS (3) option would involve the most substantial effort of all, requiring all the above and additional effort to approve the concept of RTs, initially in single 1:1 (one airport to one remote module) mode but also, when appropriate, in multiple 2:1 (two airports to one module) mode. As mentioned above, some of the regulatory risk would have been removed by the first movers (particularly NATS, Jersey and Cranfield in the UK) but HIAL's implementation would nevertheless be expected to come under close scrutiny by the CAA, particularly given the high reliance on the relatively limited infrastructure at some of the HIAL airports.

[25] Based on feedback during ATS staff visits

6.5.2.3 Ability to handle scale of change

In order to identify the programmatic risks and change management issues, as well as HIAL's ability and ambitions to deal with them, we held a RAID (Risks Assumptions Issues and Dependencies) workshop with senior HIAL management (See Annex B.8). This resulted in the development of a RAID log as shown below. The outputs of the RAID process are also used later in defining the implementation plan and transition strategy

Note that operational safety risk is covered separately in the operational safety risk assessment mentioned in the previous section on internal process (service quality and sustainability).

6.5.2.3.1 Risks

Table 8 presents the programmatic and strategy elements that could happen in the future which could prevent a successful outcome for the strategy. These risks are within HIAL's control to some extent.

Table 8 RAID log - Programmatic and strategic risks

Programmatic and strategic risks	Mitigation
Lack of management (leadership) capacity	Plan out the phasing of key decisions. Ensure appropriate capacity to communicate throughout organisation and with stakeholders. Be clear on risks from not providing sufficient leadership.
Lack of programme management capacity	Develop a costed resource plan for all aspects of the programme. Implement, including recruiting additional capacity as required.
Lack of procurement capacity	Develop a costed resource plan for all aspects of the programme. Implement, including recruiting additional capacity as required.
Lack of HR capacity	Develop a costed resource plan for all aspects of the programme. Implement, including recruiting additional capacity as required.
Inability to recruit APS ATCOs	Appropriate human resource plan in place for retention, relocation and recruitment. Impact on business case (financials) taken into account and agreed.
Inability to secure sufficient funds for programme	Lay out full costings early on, and secure multi-year agreement if possible. If not possible, implement a phased programme to de-risk future plan delivery as far as practical.

6.5.2.3.2 Assumptions

Table 9 presents the elements which are assumed to remain 100% valid during the project. Stating these explicitly helps identify new risks (where we believe they may change during the lifetime of the strategy).

Table 9 RAID log - assumptions

Assumptions	Any new risks resulting
HIAL maintains the current airport portfolio	Changes to the airport portfolio may lead to further management capacity issues, and may alter the precise business case being examined (particularly CBA).
HIAL maintains the ability to benefit from Scottish Government subsidies	Clear financial risk of lack of funds.
Demand figures remain on trend, and lifeline services continue to be supported for current routes	If demand falls, the requirement for an ATC service may not be present, and an option for HIAL would be available to move the airport to AFIS only.

6.5.2.3.3 Issues

Table 10 presents the elements which exist currently which pose an issue for the successful outcome of the strategy (ie realised risks in the programmatic and strategic areas).

Table 10 RAID log - issues

Issues	Identified mitigations
Potential for relocation of staff causes concern, motivational issues and limited departures	Clear and consistent communication of the need and case for change. Involvement of staff in determining some aspects (where feasible). May need incentives for staff to stay on until the operational change date, even if their intent is not to relocate.
Availability of feasible communications infrastructure	Early identification of possible options, including building on experiences of others globally (eg NavCanada’s use of microwave links). Discussions with the suppliers to negotiate potential terms, particularly with SWAN recognising HIAL’s status as a provider of public services.

6.5.2.3.4 Dependencies

Table 11 presents the elements necessary for the strategy which rely on third parties outside the control of HIAL.

Table 11 RAID log - dependencies

Dependencies for Air Traffic Management 2030 Strategy	Any actions which can be taken by HIAL to mitigate impact of dependencies
Availability of viable APP training until switch-over to APS	[Redacted[2,3]] More detailed investigation of alternative options and costing. Is training in-house really not feasible?
CAA to approve the use of MLAT/ADS-B sole means for Aerodrome Traffic Monitors	Present the CAA with a safety case as early as feasible, to begin the process in detail. It must be driven by HIAL. Identify whether any others in the UK are looking at a similar path, and work together.
CAA to approve the use of secondary surveillance sole means for approach control surveillance (APS)	Present the CAA with a safety case as early as feasible, to begin the process in detail. It must be driven by HIAL. Identify whether any others in the UK are looking at a similar path, and work together. Share data with other States who have achieved approval (eg Norway).
CAA to approve the use of MLAT/ADS-B sole means for APS (as opposed to radar)	Present the CAA with a safety case as early as feasible, with a well designed MLAT/ADS-B system which would clearly meet the surveillance requirements (CAA, EUROCAE, ECTL) for a “radar-like” service. Identify whether any others in the UK are looking at a similar path, and work together.
CAA to approve a combined ADI and APS operation	Present the CAA with a safety case as early as feasible, to begin the process in detail. It must be driven by HIAL. Identify whether any others in the UK are looking at a similar path, and work together.
Public consultations do not lead to undue delay in implementing controlled airspace feasibly	Work with the DfT and CAA on a strategy for implementation of ACPs, recognising this is an external driver on HIAL. Develop consultations as a published phased approach (potentially in parallel?), allowing organisations to respond efficiently. Invest in communications with key organisations in advance, understanding and ideally mitigating any concerns (eg MIL, GA).

6.5.2.3.5 Time & effort to implement

All options will require a significant effort and time to implement. Annexes N and O detail the assumptions, including assumed timelines and phasing for each option. The timelines associated with the key implementation activities are summarised in Figure 30 below.

A more detailed implementation plan is provided for the recommended option in section 7.1.

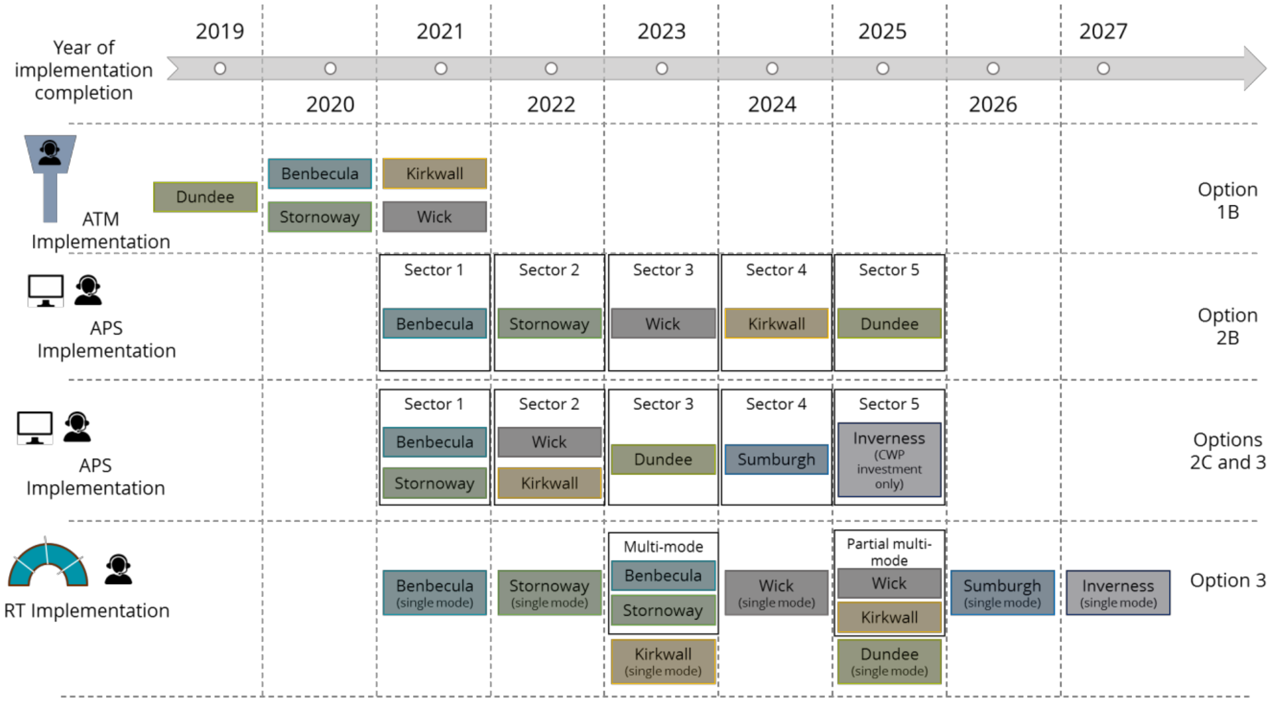

Figure 30: Timelines for key implementation activities in the options

Even the baseline option (1b) involves introducing CAS on a scale not previously undertaken by HIAL. Similarly, all options will require a significant time and effort related to certification and approval.

- CAS and APP (Option 1b): This option is more modest, compared to other options, but still a significant change considering the time taken for the ACP at Inverness. Additional effort will also be required for the introduction of ATMs
- Local APS (Option 2b): much greater effort and resource is required to procure and implement surveillance infrastructure as well as to manage training and transition to APS. Further effort will also be needed to provide evidence for the move to non-PSR APS
- Centralised APS (Option 2c): As for the local APS (2b) option, but with the added complexity of establishing, recruiting, training, and transitioning some staff to a centralised facility
- Remote Towers and centralised APS (Option 3): This option presents a major change on a scale never before attempted by HIAL and will need careful planning and phasing.

6.5.3 Summary

HIAL is not a large organisation and has little spare capacity. The anticipated effort required for this major change programme will test the organisational capacity at all levels.

The baseline option (APP and CAS, 1b) introduces controlled airspace along with ATMs, which ultimately are unlikely to have any real impact on ATCO job satisfaction, retention or recruitment ability.

The local and centralised APS options (2b and 2c) create opportunities for the existing ATCOs through the creation of an APS service. This could be seen as career progression for many ATCOs. In the local APS (2b) option this growth opportunity would be available locally whereas in the centralised APS (2c) option this growth opportunity would only be available in a centralised location, which to some would be a barrier and to others a great opportunity.

The introduction of RTs under option 3 creates the largest change requiring most ATS staff to relocate to a centralised location and also for some to validate on more than one airport.

Overall, we expect the APS options (2c, 2b and 3) to have a varied impact on staff, as all three will be seen as opportunities to some ATS staff and threats to other. Due to the individual nature of the perception of the impact, a clear distinction between the staff impact of the options is difficult to make. The CAS and APP option (1b), which maintains the current status quo, is expected to be the most positively received by staff.

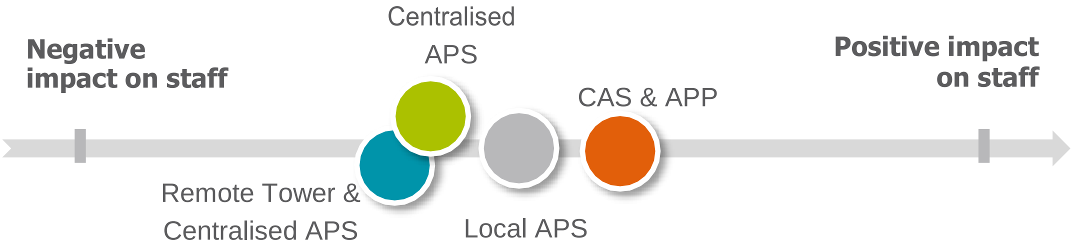

Figure 31 Impact on staff assessment

All options require a significant change to HIAL's provision of ANS, namely the introduction of controlled airspace which will require multiple airspace change proposals and will be associated with a considerable amount of internal effort.

Local (2b) and centralised (2c) APS options will also require obtaining regulatory approval for the provision of an APS service purely using multilateration and ADS-B, which is something not done before.

The Remote Towers and centralised APS (3) Option would involve the most substantial effort of all, as it would require not only the combined effort of options 1 and 2 but also the additional effort to approve the concept of remote towers, initially in single 1:1 (one airport to one remote module) mode but also, when appropriate, in multiple 2:1 (two airports to one module) mode, making it the least favourable option from a regulatory assessment ease perspective.

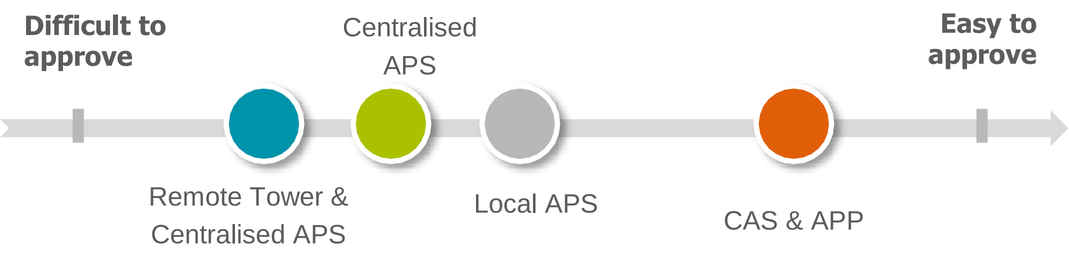

Figure 32 Regulatory approval assessment

The implementation of all options will create a significant strain on the HIAL management and corporate functions, which will rise in line with the pattern observed in the regulatory approval section. The CAS and APP (1b) option will be the simplest, but will still require the implementation of multiple ACPs, local (2b) and centralised (2c) APS options will also require a complex APS approval and on top of that the Remote Towers and centralised APS (3) Option will involve a remote tower approval. All of these processes will require large change management effort, which will be responsible for the collation of safety material, preparation of procurement documentation and support to public consultations. Whilst some of this could be outsourced, the overarching management and responsibility must lie within HIAL.

Additionally, the introduction of a centralised facility (option 2c and 3) would require a significant HR effort to ensure staff buy-in and a smooth transition to a centralised centre, making them the most complex option.

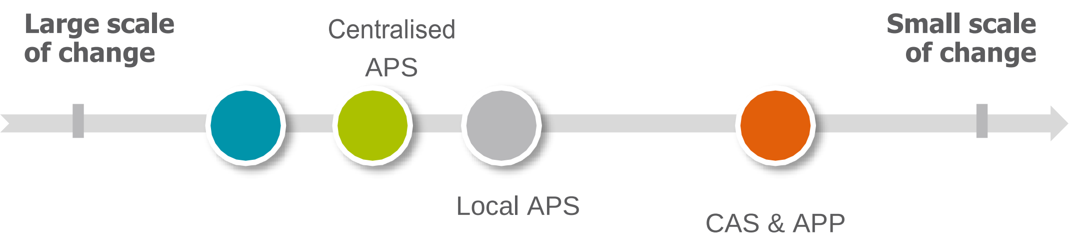

Figure 33 Ability to manage the scale of change assessment

6.6 Overall assessment summary

Combining the results in the previous sections across the four high level categories provides the results shown below.

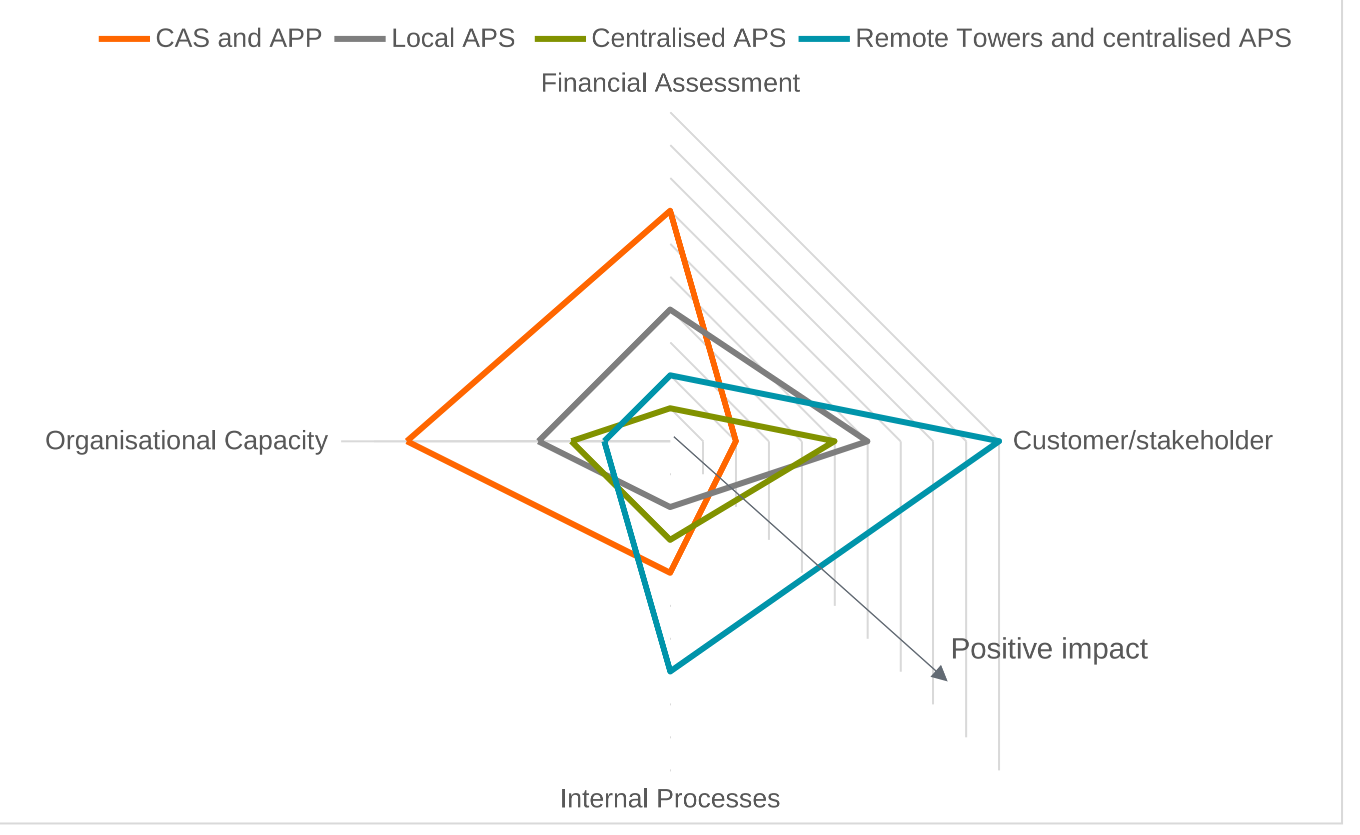

Figure 34 Assessment summary

7 Conclusion and recommendations

Our independent recommendation relies on testing the pros and cons against HIAL's vision, purpose and context. Considering these, we outline our considerations and final recommendations in respect of each option below.

Note that in all options we consider that the current AFIS airports should continue to provide their current services. We see no clear drivers for centralising the AFIS service and no reason why the AFIS airports may not continue to provide an AFIS to commercial aircraft under an exemption from the CAA. A future driver could be that operators into the AFIS airports do not accept the safety implications of that service. This might warrant re-consideration of the AFIS service, but any significant change is likely to be accompanied by an increased cost.

7.1 Conclusions on baseline option (CAS and APP, 1b)

Of the four options the baseline option (CAS and APP, 1b) would be the most straightforward to implement, the lowest cost and would introduce the minimum technical and operational challenge. On the other hand it is likely to offer the least to customers / stakeholders (ATMs won't fundamentally change the service received by the users and controlled airspace is introduced in all options) and it does little to support the long term sustainability or strategic aspirations of HIAL. In particular, it perpetuates the unusual situation of commercial air transport operating in uncontrolled airspace receiving an APP service without the benefit of surveillance. It is an environment in which aircraft can fly in the vicinity of the airport without being required to contact ATC or declare their position. ATCOs cannot guarantee de-confliction and are unable to recover many situations where separation is lost, so pilots will therefore continue to take responsibility for separating themselves from other aircraft. Although this is not intrinsically unsafe, it means that HIAL will remain unable to directly control the risk of airborne conflict and ultimately limits HIAL's ability to further improve safety. The CAS and APP (1b) option will also limit the potential for more efficient flight profiles compared to the other options, for example, where two aircraft arrive and/or depart at the same time, the application of procedural separation will usually lead to one aircraft holding to maintain sufficient separation. The other options all introduce APS which enables the application of a smaller separation standard and allow for more environmental benefits through more direct routing. This could in turn reduce route extensions or holding patterns (and consequent additional fuel burn) related to handling multiple arrivals or departures.

The CAS and APP (1b) option does nothing to address the recruitment challenges HIAL continues to face and that HIAL management have aspired to reduce as part of the Air Traffic Management 2030 Strategy. The option continues to rely on staff changing their working patterns and hours to maintain the service or, as was the case in Stornoway, to 'strategically' close the airport early on numerous occasions. We have not modelled the potential cost of these recruitment challenges, but the evidence clearly shows that recruitment has been hard and that in the past there have been issues in keeping airports open.

Furthermore, the commercial operating environment for ANSPs is beginning to change. Aside from EU regulation that is forcing many ANSPs to reduce costs, a competitive market for ADI and APS services is beginning to emerge. This market is most mature in the UK and Scandinavia where several airports have changed their ANSP recently. To some degree this creates an external driver for HIAL to ensure they are able to compete with neighbours, but it also increases demand for ATCOs . For example the transfer of both Gatwick and Edinburgh from NATS to Air Navigations Solutions has created a shortfall that we understand to have impacted on ATCO salaries (and thus the recruitment market) and also on the demand for APS training (potentially further threatening the less lucrative market for training providers offering APP).

Despite being the easier of the three options to implement and least disruptive change, the CAS and APP (1b) option still implies a significant amount of effort to introduce. For example, it includes an airspace change programme on a far bigger scale than HIAL has attempted in the past together with the implementation of low-cost surveillance infrastructure across the ATC airports. However the introduction of controlled airspace is driven by EU and national regulations which could imply the possibility to fund some or all of it through separate state aid (eg a UK department of transport grant). Furthermore the multilateration surveillance infrastructure trial in Dundee has received funding, so there maybe be similar opportunities to cover the wider deployment of multilateration-based ATMs included in this option.

Whilst CAS and APP (1b) is a credible and viable option today, we believe that it will be an increasingly difficult option to sustain in future as the risks and challenges grow. In essence, the move away from APP control will at some point be inevitable so the question is more of when rather than if. In particular, as the industry is able to introduce surveillance at ever reducing costs, we anticipate the availability of APP ATCOs to diminish and the training costs to increase (HIAL is already dependent on a single private sector training provider in the UK). Outside of locally based airspace users, the familiarity of pilots with APP is likely to continue to be low (and potentially decreasing). It will therefore continue to act as a barrier to traffic growth, as already evidenced in the situations with KLM, who only operate at Inverness under a surveillance service, and a commercial airline operator for whom a lack of surveillance was one of the reasons for withdrawing their routes from Dundee.

7.2 Conclusions on approach surveillance options 2b and 2c

The local (2b) and centralised (2c) APS options perform similarly and, on balance, worse than either of the other two options. They are both relatively costly, risky, difficult to implement and have a negative impact on the long-term sustainability of HIAL by exacerbating recruitment and retention issues. This is because they continue to require the same number of ADI ATCOs at each airport and therefore don't address two of the key challenges to HIAL's sustainability namely: to recruit sufficient staff at the airport locations; and to operate more flexibly.

Furthermore the centralised (2c) APS option (and to a lesser degree local (2b) option) remove one of the more interesting parts of the ADI role (the approach function). While in the local APS (2b) option ATCOs would also be able to hold both ADI and the APS ratings, in the centralised APS (2c) option this change is likely to reduce the appeal of the ADI role (and potentially impact the assistants in case some of their workload is subsumed into the ADI role). In both options this would exacerbate the recruitment challenge because it would create additional positions to be filled at the airports (or centralised facility in the case of options 2c and 3). In the local APS (2b) option, in line with CAP670, we estimate that HIAL would require an additional 11 ATCOs to support the additional working position. In the centralised APS (2c) option, where the APS provision is centralised we have estimated that an additional 25 ATCOs and 4 supervisors would be required. Recruiting individual positions in the centralised APS (2c) option is likely to be easier than in the local APS (2b) option as they will be drawn from a central location, that is likely to be more attractive to candidates and provide a bigger pool to recruit from. The number of new staff required is nevertheless likely to cause issues and may result in delays in implementing the option. Whilst both options do address HIAL's aspiration to move away from APP control and therefore potentially improve safety and offer more environmentally friendly air navigation services this in itself is unlikely to drive increased traffic or generate enough revenue to cover the substantial cost. In particular both options will require the employment of new ATCOs to provide the APS function that has been split out.

Regardless of where the APS is provided from (the airport in the case of 2b or a centralised facility in the case of 2c), it will substantially increase costs as APS ATCOs command higher salaries and require more expensive training. Significant capital costs will also be required to provide the necessary surveillance infrastructure and to provide the arguments and evidence for a non-radar APS to the regulator. It might however offer new benefits such as the possibility for HIAL to provide APS to new locations (such as to Sumburgh or North Sea locations) or a lower airspace service in Scotland, much like the LARS [116] service provide by NATS in the South of England. The introduction of an APS service might also be an opportunity for HIAL to consider recovering approach fees, as already done by most other ANSPs in Europe. For example in Sweden a private company, ACR, provides ADI and APP services at several municipality-owned airports and is able[26] to recover a proportion of the APS from the Swedish en-route cost base (directly from the Eurocontrol Central Route Charges Office - CRCO).

An area, to be considered further is the potential for HIAL to recover approach fees. Although not the focus of this study (it is a possibility in all options) it would impact on the potential for outsourcing which has otherwise been discounted on the basis that: it would not be commercially attractive (landing fees would not cover the costs alone, and there is no fee recovery for approach); economies of scale would be unpicked; boundaries would be complex to define; and because it's unlikely to be attractive to the market. If HIAL were to move to a similar model to Sweden, for example, there might be opportunities to recover some of the approach fees from the enroute cost base or through establishing a terminal charge for the HIAL region.

7.3 Conclusions on remote tower & surveillance centre option 3

The Remote Towers and centralised APS (3) option offers the most positive benefit in terms of impact on customers and ability to sustain HIAL services for the long-term. However, this comes at a price: it is one of the most expensive and certainly the most difficult and risky. To airspace users, a combined ADI and APS service would be considered better value than either: the CAS and APP (1b) option (which offers only ADI and APP services); or than the local (2b) and centralised (2c) APS options (which offer ADI and APS at an increased level of staffing). The saving is due to the eventual introduction of multi-mode remote tower operations where two airports are handled by one ATCO. This would necessarily take time to introduce due to the need to prove and certify the concept. The cost saving is however outweighed by a combination of other costs, including: the increased capital costs needed to procure the remote tower equipment, remote centre and surveillance infrastructure; and the additional managerial, procurement and technical staff effort required during the implementation process.

[26] Swedish regulation stipulates that this is possible beyond 13km from the airport

However, some of the costs in the Remote Towers and centralised APS (3) could potentially be reduced. Whilst we have taken a conservative approach and not modelled any of these potential cost savings, they are nevertheless opportunities that could only be realised in this option. They include:

- The potential to receive UK or EU grant funding to develop the remote centre, considering that HIAL would be an early mover in the technology and in the relatively unique position to be able to apply the technology across a large number of airports that it both operates and provides ANS to (remote tower projects have already received EU funding for example in Sweden, Germany and Hungary for example)
- The possibility to share costs with others, for example in case other airports in Scotland (eg Prestwick) or the surrounding region were to consider connecting to the centre or in case some costs (such as connectivity infrastructure) could be shared with other agencies, such as the Highlands and Islands Enterprise as part of a wider infrastructure improvement programme
- The potential for remote tower infrastructure costs to be reduced by a) procuring them as part of a larger package with the surveillance infrastructure and b) the market maturing such that costs are reduced through natural market forces.

A further consideration, mentioned by some remote tower suppliers, is the possibility to procure the remote tower equipment on a more flexible basis than a purely up-front capital outlay, for example through a leasing arrangement that could spread costs (ie replace capital costs with operational costs). A similar arrangement could apply to the centralised facility through renting rather than constructing a building.

Compared to other options, we believe that the Remote Towers and centralised APS (3) option would, in the longer term, provide more opportunities for HIAL to reduce their reliance on a Scottish Government subsidy. This would be through potential revenue generating opportunities that a remote centre could offer, not only to provide APS services to other regions (as per the local (2b) and centralised (2c) APS options) but also to other airports such as Prestwick (as mentioned above). The introduction of an APS service might also be an opportunity for HIAL to consider recovering approach fees (as described above for the local (2b) and centralised (2c) APS options).

A further opportunity is in the delivery of services out of hours (OOH). In all other options the OOH service would continue to rely on ATS staff commuting in for OOH operations. With the Remote Towers and centralised APS (3) option, there is flexibility to re-consider the provision of OOH from a new perspective, for example potentially offering extended opening hours, permanent ATS cover during OOH or even the ability, in the more distant future, to radically change the way that ATS is provided for example through a flexible ATS service provision that covers flights when required rather than only when the airport is open. This option is therefore the only option to address one of HIAL's highest priority corporate risks, namely that caused by operators using the airport out of hours.

The Remote Towers and centralised APS (3) option is fundamentally the only option to fully tackle the recruitment issues that threaten HIAL's long term sustainability. It is the only option to provide the possibility to recruit outside of the remote locations that HIAL has struggled to recruit from. Firstly, the remote centre could be located in a location with a bigger pool from which to recruit; and secondly as all ATS staff would be working from a single centre, additional efficiencies would be possible for example through optimising rosters, enabling ATCOs to hold multiple licenses and sharing administrative duties across airports.

The Remote Towers and centralised APS (3) option is however the most difficult and risky to implement. Whilst HIAL may not be the first in the world, or even the first in the UK to implement remote towers, HIAL could still be an early mover and the first in the UK to roll it out across a large number of airports. This translates to risk and must be considered carefully. In particular further work is needed to determine the level of communications availability and redundancy that would be needed considering what is possible at each location (see Annex Q). The connection between airport and remote centre provides a point of failure to operations that doesn't exist today. This means new levels of contingency will be required. New procedural and technical mitigations will need to be developed, tested and implemented in order to maintain or improve the overall resilience of the operation. The options might involve different levels of built-in contingency to the remote tower technology and resilient communication services such as those offered by the Scottish Wide Area Network (SWAN). The solutions will be driven by safety and business considerations and will impact cost.

Another key area of risk is the ability of HIAL to handle such a large-scale change. Even if there was widescale buy-in to the concept, centralising the operations would rely on significant resources, time and effort. When also factoring in the social and political impact due to the many staff and local communities that are likely to be impacted by the option, the issue becomes even more acute. HIAL may therefore be constrained in what is realistically achievable, or at least in how quickly it is achieved.

7.4 Our recommendation

Sustaining the provision of APP services will be increasingly difficult in future. The provision of APP services will only become harder as: the availability of APP ATCOs diminishes; as training costs increase; as the competitive market for ANS grows; and as APP continues to act as a barrier to traffic growth, flight efficiency and safety improvement. The question to move away from APP is therefore one of 'when' rather than 'if'.

The APS service in the local (2b) and centralised (2c) APS options would offer improvements in safety and flight efficiency compared to the APP service, and allow HIAL to move away from an APP service. However the centralised (2c) APS option reduces the appeal of the ADI role and both options exacerbate the challenge of recruiting sufficient staff at the airport locations. Whilst some benefits and opportunities could open up, both options also introduce substantial cost, not only of the new APS ATCOs, but also related to the procurement and certification of the necessary surveillance infrastructure. The local (2b) APS option relies on the ability of existing ADI/APP ATCOs to gain the APS rating and both options also rely on CAA approval of a combined ADI/APS position for certain periods of the day. For these reasons we ultimately do not recommend implementing the local (2b) and centralised (2c) APS options.

The CAS and APP (1b) option is a credible and viable option today. It is also the easier and least disruptive of the four options. However, it continues to rely on the flexibility and goodwill of staff to support services during frequent extension requests to opening hours and in situations were available number of staff is below requirements. There is insufficient evidence and no way of costing the tenability of this situation as it depends on the probability of that goodwill to continue and the likelihood of external factors that could increase reliance on it. For example any changes in: the recruitment market (such as the potential for controllers to be attracted to other jobs, or a fall in the number of applicants or pass rate); the likelihood of staff unavailability (eg due to sick leave); or the demand from aircraft operators for changes to the airport opening hours, ATS service or frequency of extensions. It also continues to expose HIAL to the increasingly likely risk of APP training courses increasing in cost or being withdrawn altogether in the UK market. This option also still implies a significant change programme and cost despite generating relatively small benefits compared to all other options.

The Remote Towers and centralised APS (3) option, although one of the costliest options overall, provides ADI at a lower staff cost than any other option. It also offers the potential to reduce costs and generate revenue, for example through grants, sharing costs with others, striking a more innovative deal with suppliers, reducing reliance on NATS, offering new services and even recovering approach fees. Whilst we have taken a conservative approach and not modelled all of these aspects, they present clear opportunities that, in the longer term, could help HIAL to reduce their reliance on a Scottish Government subsidy.

Whilst cost is an important element, there are many unknowns that we have had to make reasonable assumptions on. These assumptions are realistic but also conservative to ensure costing figures that are closer to “worst case” than “best case”. However, the level of uncertainty means that any cost argument must be weighed up against other factors and, in particular, the ability for HIAL to maintain its purpose and objective. Some of the cost assumptions with the most impact and uncertainty include: the additional staff overhead associated with a centralised facility; the communications costs - which could increase where insufficient contingency or diversity is available; staff relocation costs; and the potential efficiencies that could be introduced through multi-mode operations.

The Remote Towers and centralised APS (3) option is also the only option to fully tackle the recruitment issues that threaten HIAL’s long term sustainability and the only option to fundamentally address HIAL’s risk exposure to operators using the airport out of hours. It is however the most difficult and risky to implement so HIAL would need to address the risks identified herein, particularly with regards to service resilience. HIAL would also need to identify and recruit significant resources to handle such a large-scale change, especially when factoring in the social and political impact on the many staff and local communities that are likely to be impacted.

Ultimately, whilst the CAS and APP (1b) option offers the most straightforward option to implement today, it doesn’t sufficiently address the underlying concerns and risks that lie behind HIAL’s Air Traffic Management 2030 Strategy, in particular the risks of not being able to recruit and train controllers. These risks look set to only increase (indeed the risk to the provision of APP training is now the highest category of risk on the corporate risk register) and furthermore could materialise relatively quickly and lead to hurried action needing to be taken, to the disbenefit of HIAL. The Remote Towers and centralised APS (3) introduces substantial risks of its own which must not be underestimated. But it also offers the best answer to HIAL’s strategic aspirations and the best chance of future-proofing operations. By choosing the Remote Towers and centralised APS (3) now, a solution to manage existing risks can be phased in strategically, costs amortised over time, and lessons learnt at each phase to de-risk future operations.

In our capacity as an independent assessor of the options available to HIAL under ATM 2030 Strategy, **we make an overall recommendation that HIAL pursues the Remote Tower and centralised APS option**.

7.5 Implementation plan

There are many open questions in determining an implementation path for The Remote Towers and centralised APS (3) option. A HIAL priority will be to de-risk the change as far as possible, and build in appropriate contingency.

The exact contractual structure with the supplier will also determine implementation details. A Joint Venture or other collaborative vehicle could take longer to set up, but allow for more actions in parallel in the longer term.

Several assumptions were made during the financial assessment, and are carried through to this plan for consistency. These include:

- A decision is made by the HIAL Board on Air Traffic Management 2030 Strategy (option 3) by summer 2018. This includes the resourcing for the programme management and various steps identified, as well as the new capex programme.
- CAS is implemented through a phased process of five ACPs (potentially supported by the UK Government and CAA), aiming to be complete by 2024. At present, they are scheduled in the order of Benbecula, Stornoway, Dundee, Wick then Kirkwall. Inverness is assumed to have implemented CAS prior to the scope of this strategy.
- A combined APS and RTC building is identified by early 2019. It is equipped ready for a phased introduction of individual APS positions and Remote Towers.
- The new surveillance infrastructure (to be used for APS and ATM displays in the tower positions) will be specified by early 2020.
- The necessary communications infrastructure for the surveillance, communications (radio) and RT feeds is specified by the end of 2019. Any new communications infrastructure is then installed and phased according to the operations being moved.
- The implementation of APS (where currently APP) and RT is assumed to be approximately concurrent where possible. In practice, the APS service may move prior to the tower service (eg by 6 months). This path aims to minimise the training and recruitment needs, but needs to be validated against the likely training and validation schedule.
- There may be a discrepancy between the required timing of the airspace changes, in line with regulatory compliance deadlines, and the preferred schedule of introducing changes at each unit. For that reason, we have split out ACPs in the implementation plan. If they are considered separately, they will require their own safety case (and approval) and route design, separate from the introduction of APS.
- Likewise, if the approval for MLAT/ADS-B ‘sole means’ as a source for an APS is delayed, the option exists to continue with APP based at the units, and to alter the order of units moving to the combined APS/RT centre as appropriate.
- Our assumed order of implementation at each unit (which can of course be altered) and is shown below and detailed in Annex O.2. The order in which the implementation will be undertaken may be crucial from a strategic perspective, and should be thoroughly assessed by HIAL management taking into account traffic volume and complexity; ease of transition; communications technical capabilities; and human resource issues.

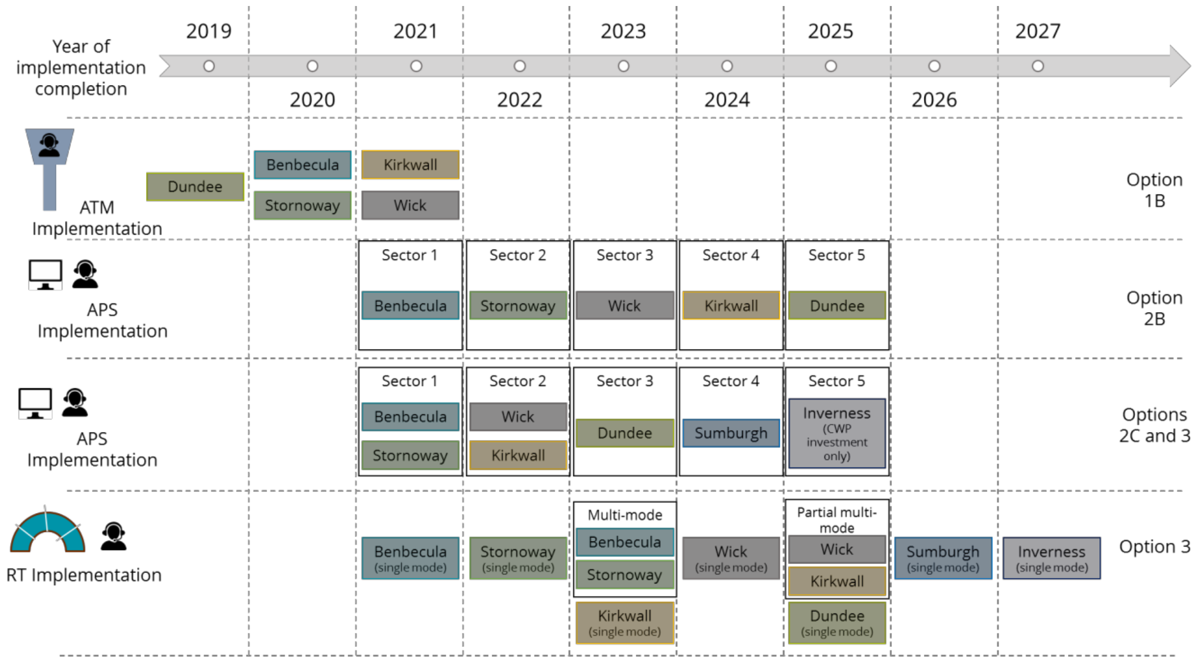

Figure 35: Timelines for key implementation activities in the options

7.5.1 Timeline

Based on the assumptions above, we have outlined an approximate timeline, split into HIAL activities related to government and regulatory (in grey), human resources (in orange) operational service provision (in blue) and technical (in black) domains. The government and regulatory activities relate to effort that HIAL needs to spend on areas involving the regulator or the Department for Transport. Evidently, there are dependencies here, captured in Table 11 above.

There are a set of critical near-term actions to be started in 2018 that will influence the successful achievement of the timescales set out in this high-level implementation plan. We therefore recommend HIAL examines these near-term actions and makes a decision on initiating them as early as possible, to de-risk the overall delivery of the Air Traffic Management 2030 Strategy.

The critical near-term actions, assuming a positive Board decision on the Air Traffic Management 2030 Strategy, are:

a) Determination of UK Government approach for controlled airspace (liaison with Department for Transport), enabling HIAL to scope the development of the ACPs and associated CONOPs.

b) Develop a specification for the MLAT (including ADS-B) solution. Note that an initial draft of the safety case should be developed early on, ensuring safety requirements are taken forwards into the specification and procurement.

c) Proceed discussions on viable communications solutions (enabling the new surveillance sources and remote towers), including with SWAN and with microwave link suppliers.

d) Development of high level CONOPs and strategy for the combined approach (APS) centre, and the Remote Tower centre. This will include functional requirement setting (eg number of positions, toolsets) and an understanding of the content of the new MATS Part II.

e) Analyse options for geographic location of approach centre and remote tower centre. Co-location would obviously bring benefits, but is dependent on the options available.

f) Initial HR consultation started, ensuring planning takes into account staff views in full.

g) Explore the options to reduce costs and generate revenue, for example through grants, sharing costs with others, striking a more innovative deal with suppliers, reducing reliance on NATS, offering new services and investigating the potential for HIAL to recover approach fees.

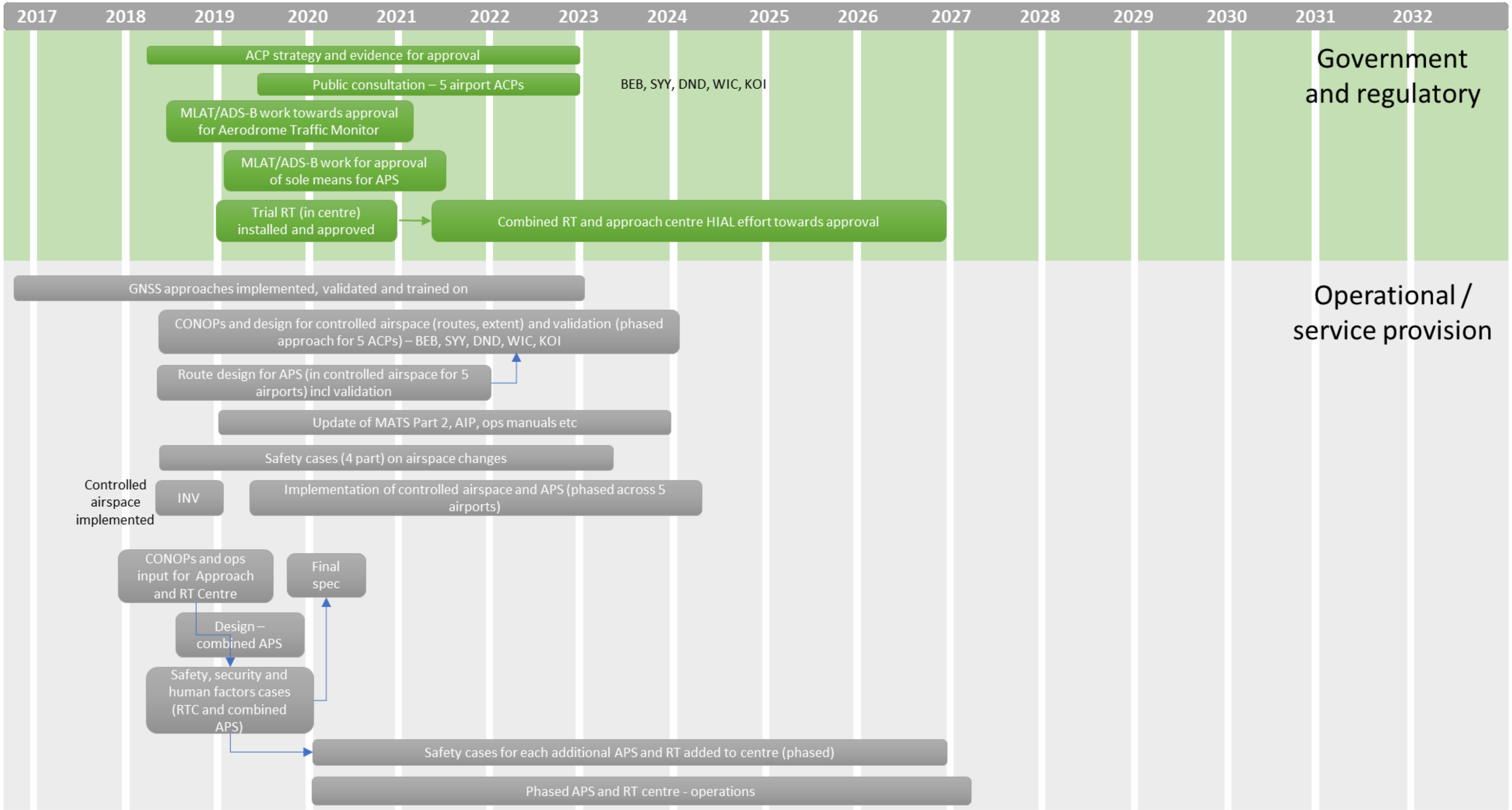

Figure 36 Timeline for government, regulatory and operational/service provision implementation activities

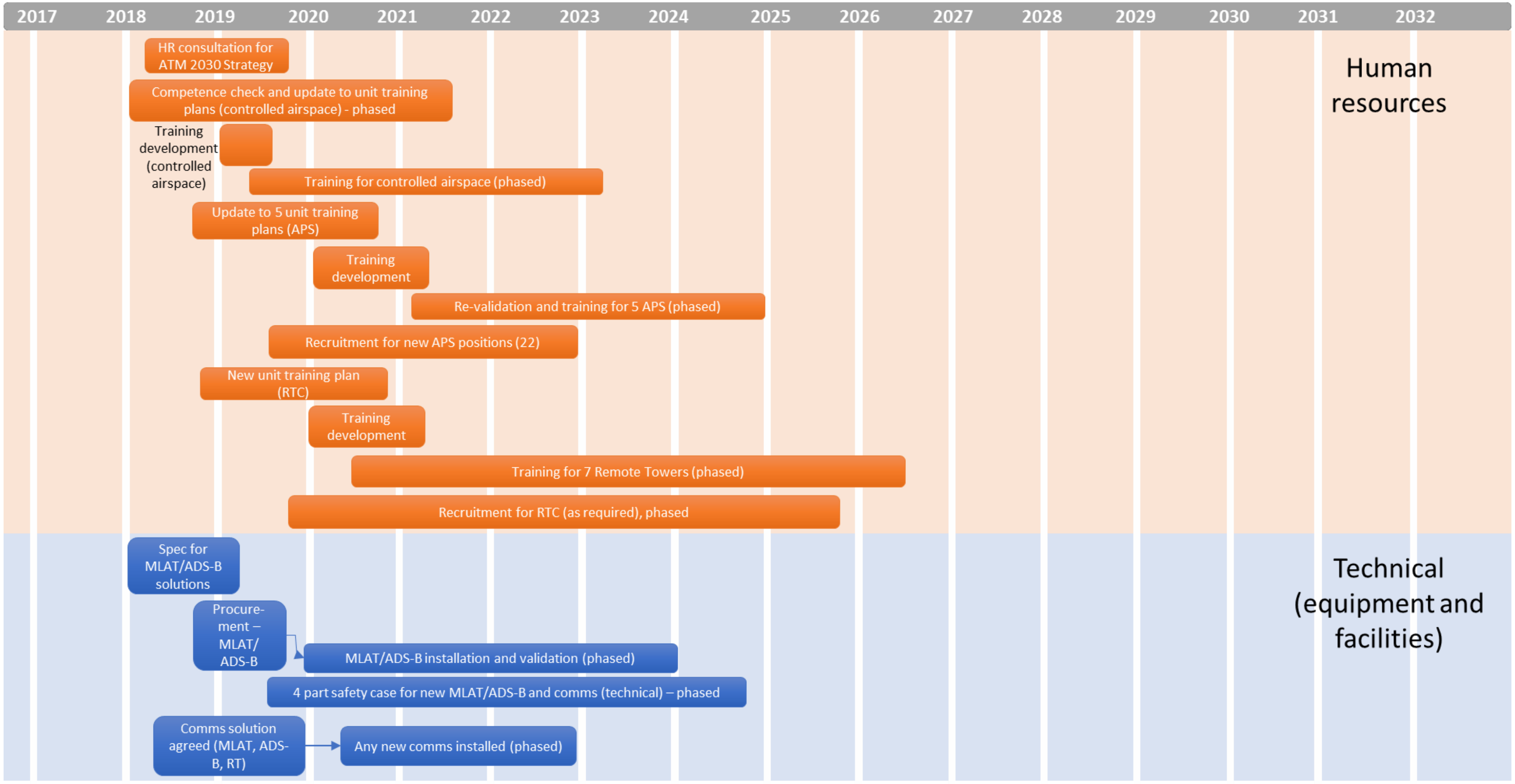

Figure 37 Timeline for human resources and technical (equipment and facilities) implementation activities

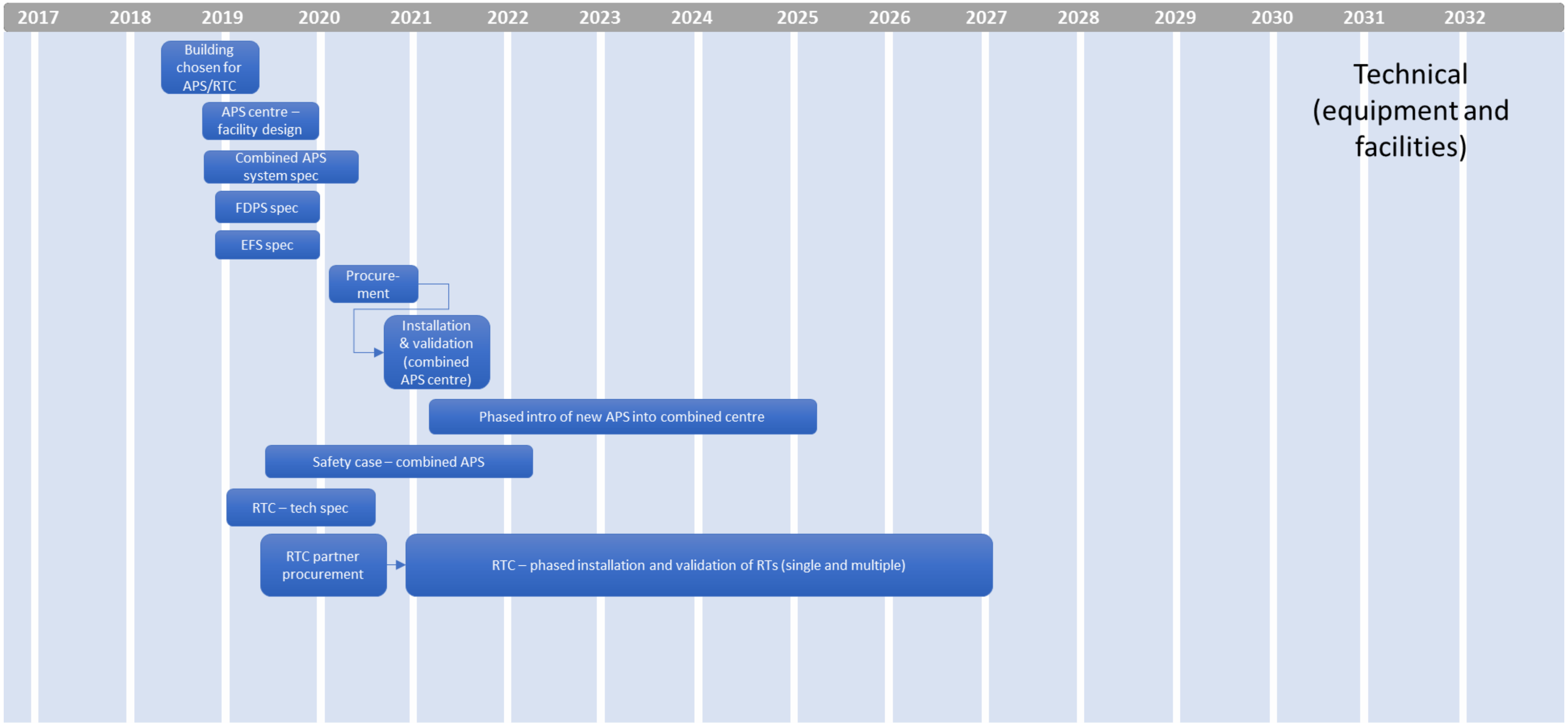

Figure 38 Timeline for technical (equipment and facilities) implementation activities

A References

A.1 Airport Info

[1] Airport response to Helios request for info (received from from Dundee, Kirkwall, Campbeltown, Inverness, Stornoway, Sumburgh and Wick)

[2] HIAL Conditions of Use & Airport charges (Effective 1st April 2017, URL: http://www.hial.co.uk/wp-content/uploads/2017/04/HIAL-Conditions-of-Use-and-Airport-Charges-1-April-2017.pdf)

[3] HIAL Out of Hours Indemnity Application Form (URL: http://www.hial.co.uk/wp-content/uploads/2017/03/20170401-HIAL-OOH-Permit-Application-Form.pdf)

[4] E-mail from [redacted[1]], SATCO, 14th August 2017

[5] E-mail from [redacted[1]], Manager Air Traffic Services Inverness, 22nd August 2017

[6] Email from [redacted[1]], Head of Infrastructure Services regarding cost of building extensions, 14th November 2017

A.2 ATM Strategy 2030 HIAL briefings

[7] ATM Strategy - Outline for Minister v3 (002)

[8] ATM STRATEGY CHART V.3.

[9] ATM2030 + Notes

A.3 CNS

[10] NATS CNS-ATM equipment register (PSS 2016-17 issue 40)

[11] EC Trial Budget forecast. v0.2 May 2017

[12] ATE Replacement Plan September 2016

[13] ATE Costs (e-mail from [redacted[1]], dated 14th June 2017)

[14] Financial information (Excel sheet dated 2nd August 2017) for Turnover & subsidy per year, Kirkwall tower refurbishment quote, Dundee surveillance project and Inverness radar cost

[15] Technical engineering problem reports for all airports (Excel sheets)

[16] GNSS Approach Analysis prepared by Loganair, dated 23 Nov 2017

[17] ATC Asset Costs Rev D

[18] Progress Meeting 4 Meeting Minutes

[19] SWAN Pricing Tool v16

[20] Scottish Wide Area Network (SWAN) (URL: https://www.scottishwan.com/)

A.4 Extensions and closures data

[21] Extension_Analysis_for HELIOS (Excel sheet, dated 2nd August 2017)

[22] Individual airport input (by e-mail) on strategic closures from Benbecula, Kirkwall, Stornoway, Sumburgh and Wick (responding to HIAL GMATS request on 10th August 2017)

A.5 HR & recruitment data

[23] 20170419 - ATS - Age profiles (Excel sheet, dated 27th July 2017)

[24] 20170419 - ATS Staff Data (Excel sheet, dated 2nd August 2017)

[25] 20170718 - ATC - Recruitment data (Excel sheet, dated 2nd August 2017)

[26] 20170727 - Turnover in ATS (Excel sheet, dated 27th July 2017)

[27] NATS Recruitment Information (URL: http://nats.aero/blog/2013/06/infographic-becoming-an-air-traffic-controller/)

[28] ATS Staffing (Excel sheet, dated 14th June 2017)

[29] HIAL and DAL Salaries and Allowances - 01 October 2016

[30] ATS Staffing - ATMS basic structure 031117 (Excel sheet, dated 3rd November 2017)

[31] Mail from [GMATS] dated 3rd November 2017 titled “HIAL Staffing Assumptions”

[32] CANSO ATCO Remuneration and HR Metrics Report 2015 (De-identified)

[33] Mail from [GMATS] date 7th December 2017 titled “RE: Final costing clarifications”

A.6 Inverness Airspace Change Proposal

[34] Inverness ACP details, including: Environmental and Economic Benefits and response from KLM

[35] Mail from [DGMATS] dated 2nd August 2017 entitled “Indicative Cost; Inverness Radar Installation and ACP”

A.7 Procurement details

[36] HIAL Procurement Activity 2016-17 (Jun 16) (Excel sheet dated June 2016)

[37] Jun 2016 board paper providing a summary of the SG procurement assessment process (PCIP), together with results

[38] Nov 2016 – providing overview of legislative requirement to have a Procurement Strategy, together with draft HIAL Strategy for approval

A.8 Regulatory material

[39] 04-AFISO IAP Exemption – 20170106

[40] 20170327-Consolidation of CAA Part-ATS comments for WG

[41] CAP 670 23 May 2014

[42] CAP 774Issue2_3

[43] CAP393Ed5Am1_OCT2016_BOOKMARK

[44] Manual of Air Traffic Services – Part 1 CAP 493

[45] ICAO, DOC 9426 Air Traffic Services Planning Manual 1984, p. V-1-1-5

[46] EUROCONTROL Manual for Aerodrome Flight Information Service (AFIS)

[47] ICAO (2001), PANS-ATM Procedures for Air Navigation Services — Air Traffic Management [Doc 4444] 2001, 14th ed.

[48] CAP 1391 Electronic conspicuity devices

[49] CAA Responses to EASA's Consultation on NPA 2016-09 'Part-ATS'. (URL: https://www.caa.co.uk/uploadedFiles/CAA/Content/Standard_Content/Our_work/Consultations/Responses_to_external_consultations/Files/20170224EASACRTNPA201609PartA.pdf; https://www.caa.co.uk/uploadedFiles/CAA/Content/Standard_Content/Our_work/Consultations/Responses_to_external_consultations/Files/20170227EASACRTNPA201609PartB.pdf)

[50] EASA Notice of Proposed Amendment NPA 2016-09(A) and (B) (URL: https://www.easa.europa.eu/system/files/dfu/NPA%202016-09%28A%29.pdf)

[51] EASA Opinion on Performance-based navigation implementation in the European air traffic management network (URL: https://www.easa.europa.eu/document-library/opinions/opinion-102016)

[52] CAP 1430 UK Air Traffic Management Vocabulary

[53] COMMISSION REGULATION (EU) 2015/340 of 20 February 2015 laying down technical requirements and administrative procedures relating to air traffic controllers' licences and certificates pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council, amending Commission Implementing Regulation (EU) No 923/2012 and repealing Commission Regulation (EU) No 805/2011

[54] UK CAA website, “How is UK airspace structured” (URL: https://www.caa.co.uk/Consumers/Guide-to-aviation/Airspace/How-is-UK-airspace-structured-/)

[55] UK Government “Holiday entitlement” (URL: https://www.gov.uk/holiday-entitlement-rights)

[56] UK Government “Bank holidays” (URL: https://www.gov.uk/bank-holidays)

[57] UK Civil Aviation Authority (CAA) press release dated 16th August 2017 confirming that ADS-B is its preferred national system to improve electronic conspicuity for general aviation

[58] UK Government “The Green Book” (URL: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent)

[59] ICAO Annex 13

A.9 Safety data

[60] Individual incident reports (x24) covering the period between April 2012 and March 2017 inclusive

[61] Operational Risk Assessment Hazard Log, v1.0 July 2017

[62] HIAL ATS Risk register

A.10 Traffic data

[63] Movements (1217 MAR 17 Main Stats) (pdf file)

A.11 Training data

[64] Scanned pdf of Global ATC Costs for training Courses (2016-2017)

[65] Email to [GMATS] from [redacted[1]], College & Courses Manager, Global ATS

[66] Entry Point North "Remote Tower Operation Training" (URL: https://www.entrypointnorth.com/training/remote-tower-operation/?filter=other-atc&tab=atc-training)

[67] Email from [GMATS] dated 08/08/2017 titled HIAL - ATMS-ATS and MET Training Costs

A.12 Remote Tower references

[68] Air Traffic Management article "Singapore eyes Remote Tower tech for Changi" (13 April 2016) (URL: http://www.airtrafficmanagement.net/2016/04/singapore-eyes-remote-tower-tech-for-changi/)

[69] LFV press release "Sweden first in the world with remotely operated air traffic management" (21 April 2015) (URL: http://www.lfv.se/en/news/news-2015/sweden-first-in-the-world-with-remotely-operated-air-traffic-management)

[70] Future Airport "Remote control: the Remote Tower concept" (URL: http://www.futureairport.com/features/featureremote-control-the-remote-tower-concept-4157951/featureremote-control-the-remote-tower-concept-4157951-1.html)

[71] FlightGlobal "Remote Tower technology receives final approval" (03 November 2014) (URL: https://www.flightglobal.com/news/articles/remote-tower-technology-receives-final-approval-405562/)

[72] Fly (29 October 2015) (URL: www.dfly.no/svenske-lfv-etablerer-seg-i-norge/)

[73] Aviation International News "Sweden's LFV Inaugurates First 'Remote Tower' Operations" (21 April 2015) (URL: www.ainonline.com/aviation-news/air-transport/2015-04-21/swedens-lfv-inaugurates-first-remote-tower-operations)

[74] Avinor "Experience from Værøy (& Røst" (URL: http://www.entrypointnorth.com/wp-content/uploads/sites/3/Remote-tower-in-Norway1.pdf)

[75] Aviation International News "Norway's ATM Agency Signs Up for Remote Tower Service" (26 August 2015) (URL: http://www.ainonline.com/aviation-news/air-transport/2015-08-26/norways-atm-agency-signs-remote-tower-service)

[76] Photo courtesy of Kongberg & Indra

[77] SAAB press release "SAAB's Remote Tower: A new paradigm in air traffic control systems" (14 March 2014) (URL: http://saab.com/sv/region/singapore/about-saab/stories/saab-singapore-stories/2014/saabs-remote-tower-a-new-paradigm-in-air-traffic-control-systems/)

[78] HIS Airport 360 "World ATM Congress 2016: DSNA chooses Searidge Remote Tower solution for overseas territory" (URL:

http://www.ihsairport360.com/article/7541/world-atm-congress-2016-dsna-chooses-searidge-remote-tower-solution-for-overseas-territory?from_rss=1)

[79] Air Traffic Management "Remote Tower tech puts Jersey in vanguard" (URL: http://www.airtrafficmanagement.net/2017/03/remote-tower-tech-puts-jersey-in-vanguard/)

[80] NATS press release "London City Airport and NATS to introduce the UK's first digital air traffic control tower" (19 May 2017) (URL: http://www.nats.aero/news/london-city-airport-and-nats-to-introduce-the-uks-first-digital-air-traffic-control-tower/)

[81] NATS press release "World's first approved remote ATC contingency facility unveiled" (17 August 2009) (http://www.nats.aero/news/worlds-first-approved-remote-atc-contingency-facility-unveiled/)

[82] Photo courtesy of HungaroControl

[83] Air Traffic Management "Searidge wins Budapest Remote Tower work" (27 April 2015) (URL: http://www.airtrafficmanagement.net/2015/04/searidge-wins-budapest-remote-tower-work/)

[84] Photo courtesy of the IAA

[85] ENAV press release "ENAV prepares for Remote Tower trial" (15 March 2015) (URL: http://www.enav.it/ec5/enav/en/comunication/press_office/press_review/ihsairport.pdf)

[86] DFS press release "DFS selects Remote Tower technology from Frequentis" (03 June 2015) (URL: https://www.dfs.de/dfs_homepage/en/Press/Press%20releases/2015/03.06.2015.-%20DFS%20selects%20remote%20tower%20technology%20from%20Frequentis/)

[87] Rheinmetall Defence "Innovative "smartVision" - system replaces view from tower" (URL: http://www.rheinmetall-defence.com/en/rheinmetall_defence/public_relations/themen_im_fokus/flugsicherung/index.php)

[88] Air Traffic Management "Down Under Vision" (01 November 2012) (URL: http://www.airtrafficmanagement.net/2012/11/down-under-vision/)

[89] Photo courtesy of SAAB

[90] SAAB press release "Saab, VSATS and Leesburg Executive Airport Partner to Demonstrate and Evaluate Remote Tower Technology" (01 March 2015) (URL: http://www.leesburgva.gov/home/showdocument?id=14513)

[91] Coloradoan "Virtual tower could lure airlines to Fort Collins airport" (URL: http://www.coloradoan.com/story/money/business/2017/07/26/virtual-tower-ready-take-flight-regional-airport/511966001/)

[92] HungaroControl press release "HungaroControl has contributed to the concept of Dubai contingency Remote Tower" (URL: http://en.hungarocontrol.hu/press-room/news/hungarocontrol-contributes-to-dubai-contingency-tower)

[93] 2015 ADV statistics (URL: http://adv.aero/verkehrszahlen/archiv/)

[94] 2015 AENA statistics (URL: http://www.aena.es/csee/ccurl/483/1011/Copia%20de%2012.Estadisticas_Diciembre_2015.pdf)

[95] EASA Notice of Proposed Amendment 2015-04 “Technical and operational requirements for Remote Tower operations” (23 March 2015) (URL: https://easa.europa.eu/system/files/dfu/NPA%202015-04.pdf)

[96] Ninth USA/Europe ATM Research and Development Seminar (14-17 June 2011) (URL: http://www.atmseminar.org/seminarContent/seminar9/papers/133-Moehlenbrink-Final-4-15-11.pdf)

[97] LFV press release “LFV and Swedavia investigates the conditions for Remote Towers Services” (11 April 2016) (http://www.lfv.se/en/news/news-2016/lfv-and-swedavia-investigates-the-conditions-for-remote-towers-services)

[98] SESAR Solution Regulatory Overview, Single Airport Remote Tower (07 February 2014) (URL: http://www.sesarju.eu/sites/default/files/solutions/2_Single_Airport_Remote_Tower_Regulatory_Overview.pdf?issuusl=ignore)

[99] EASA “Guidance Material on the implementation of the Remote Tower concept for single mode of operation” (03 July 2015) (https://www.easa.europa.eu/system/files/dfu/Annex%20to%20ED%20Decision%202015-014-R.pdf)

[100] Economist “Airports switch to virtual control towers” (25 May 2017) (URL: https://www.economist.com/news/science-and-technology/21722618-remote-centres-using-video-replace-airfield-edifices-airports-switch-virtual)

[101] Albatros statistics (URL: https://www.airport-information.com/data/)

[102] AGS (13.10.2017) (URL: http://www.ags-airlinegroundservices.com/single-post/2017/10/13/Worlds-first-NINOX-remote-air-traffic-control-tower-installed-at-Norway-airport)

[103] Transition To Remote Tower Operations And The Human Element (October 2017) (URL: https://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=14&ved=0ahUKEwiGif6M2frXAhUnKcAKHe92AqMQFgh1MA0&url=https%3A%2F%2Fwww.sintef.no%2Fglobalassets%2Fproject%2Fhfc%2Fdocuments%2F7-duestad-hf-in-rtc-181017.pdf&usg=AOvVaw3Hu0a72Jp7aHg3O_0bUdFc)

[104] Cranfield University (10 October 2017) (URL: https://www.cranfield.ac.uk/press/news-2017/saab-to-supply-cranfield-airport-with-digital-control-tower)

[105] “Green Light for Remote Control Tower Operations at Budapest Airport “(21 November 2017) (URL: http://www.airport-world.com/news/general-news/6433-green-light-for-remote-control-tower-operations-at-budapest-airport.html?utm_content=buffer4b958&utm_medium=social&utm_source=linkedin.com&utm_campaign=buffer)

[106] Hungarocontrol “Remote Tower” (URL: http://en.hungarocontrol.hu/knowledge-center/remote-tower)

[107] “Budapest becomes largest remote tower site” (21 November 2017) (URL: http://www.janesairport360.com/article/9770/budapest-becomes-largest-remote-tower-site)

[108] CANSO Press release 7th November 2017, (URL: https://www.canso.org/air-traffic-management-industry-must-take-advantage-new-technologies-improve-safety)

A.13 Miscellaneous

[109] Office for National Statistics "Inflation" (10 September 2017) (URL: https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l55o/mm23)

[110] Eurocontrol "Standard Inputs for EUROCONTROL Cost-Benefit Analyses" v7.0 (November 2015) (URL: https://www.eurocontrol.int/sites/default/files/publication/files/standard-input-for-eurocontrol-cost-benefit-analyses-2015.pdf)

[111] ATM Cost-Effectiveness (ACE) "2015 Benchmarking Report with 2016-2020 outlook" (URL: https://www.eurocontrol.int/publications/atm-cost-effectiveness-ace-2015-benchmarking-report-2016-2020-outlook)

[112] Oanda Currency Converter (18 September 2017) (URL: https://www.oanda.com/currency/converter/)

[113] PANSA Public Procurement website (10 September 2017) (URL: http://bip.pansa.pl/zamowienia-publiczne/10003-revision-v1-2/)

[114] About the Balanced Scorecard (20 September 2017) (URL: http://www.balancedscorecard.org/BSC-Basics/About-the-Balanced-Scorecard)

[115] JLL, "Service Charge Analysis for Offices", 2013 (URL: http://www.jll.co.uk/united-kingdom/en-gb/Documents/OSCAR/Office/jll-uk-OSCAR-Office-2013.pdf)

[116] NATS, "What is a Lower Airspace Radar Service?" (URL: https://nats.aero/blog/2017/06/lower-airspace-radar-service/)

B Stakeholder consultation log

The following tables shows the stakeholders consulted in the course of this study up to and including 21st August 2017.

B.1 Site visits to airports & ATS staff

As part of the Air Traffic Management 2030 Strategy scoping study, Helios visited all 11 HIAL airports to independently gather information about the local operating environment of each airport and more importantly, for ATS staff to air thoughts and concerns around the Air Traffic Management 2030 Strategy study.

The following table provides a record of consultations held by Helios:

Table 12 Airport Consultation Schedule

Stakeholder group	Date	Attendees
BARRA ATS staff	6th July 2017	**[Redacted[1]]**
BENBECULA ATS staff	4th July 2017	**[Redacted[1]]**
CAMPBELTOWN ATS staff	4th July 2017	**[Redacted[1]]**
DUNDEE ATS staff	28th June 2017	**[Redacted[1]]**
INVERNESS ATS staff	19-20th June 2017	**[Redacted[1]]**

Stakeholder group	Date	Attendees
ISLAY ATS staff	3rd July 2017	**[Redacted[1]]**
KIRKWALL ATS staff	22nd June 2017	**[Redacted[1]]**
STORNOWAY ATS staff	23rd June 2017	**[Redacted[1]]**
SUMBURGH ATS staff	21st June 2017	**[Redacted[1]]**
TIREE ATS staff	5th July 2017	**[Redacted[1]]**
WICK ATS staff	26th June 2017	**[Redacted[1]]**

B.2 Hazard Identification workshop

The following attended the hazard identification workshop held on 27th June 2017, Inverness

Table 13 Hazard ID workshop attendance

Name	Organisation	Role
[Redacted[1]]	HIAL	SATCO, Sumburgh
[Redacted[1]]	HIAL	SATCO, Kirkwall Airport
[Redacted[1]]	HIAL	SATCO, Wick
[Redacted[1]]	HIAL	Deputy General Manager ATS
[Redacted[1]]	HIAL	Technical Administrator ATS
[Redacted[1]]	HIAL	AFIS/Met Advisor, Campbeltown Airport
[Redacted[1]]	HIAL	ATCO, Benbecula
[Redacted[1]]	HIAL	Director of Airports
[Redacted[1]]	HIAL	Director of Operational Support
[Redacted[1]]	HIAL	ATCO (radar controller), Inverness
[Redacted[1]]	HIAL	SATCO, Stornoway Airport
[Redacted[1]]	HIAL	SATCO, Dundee
[Redacted[1]]	HIAL	Manager ATS, Inverness Airport
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

B.3 Options Definition Workshop

The following attended the options definition workshop held 25th July 2017:

Table 14 Options Definition Workshop attendance

Name	Organisation	Role
[Redacted[1]]	HIAL	Director of Operational Support
[Redacted[1]]	HIAL	Deputy General Manager ATS
[Redacted[1]]	HIAL	Manager ATS, Inverness Airport
[Redacted[1]]	HIAL	SATCO, Kirkwall Airport
[Redacted[1]]	HIAL	SATCO, Stornoway Airport
[Redacted[1]]	HIAL	SAO AFISO, Barra Airport
[Redacted[1]]	HIAL	Deputy SATCO, Dundee Airport
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

B.4 HIAL managers

The following HIAL managers attended the dedicated HR, Finance and Procurement meetings held on 26th July, Inverness:

Table 15 HIAL Manager meetings

Name	Organisation	Role
[Redacted[1]]	HIAL	Director of Operational Support
[Redacted[1]]	HIAL	Deputy General Manager ATS
[Redacted[1]]	HIAL	Finance Manager
[Redacted[1]]	HIAL	HR manager
[Redacted[1]]	HIAL	Head of procurement
[Redacted[1]]	HIAL	Head of business development
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

B.5 Remote Tower Suppliers

The following meetings were held between Helios **[Redacted]** and RT suppliers:

Table 16 RT Supplier consultations

Stakeholder group	Date	Attendees
Saab digital ATS	2nd August 2017	**[Redacted[1]]**
Frequentis	7th August 2017	**[Redacted[1]]**
Searidge	8th August 2017	**[Redacted[1]]**

Note: Avinor and Kongsberg both declined to participate

B.6 Union

The following attended a meeting with the union held on 9th August, Glasgow:

Table 17 Union meeting attendance

Name	Organisation	Role
[Redacted[1]]	Prospect	Prospect representative
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

B.7 Civil Aviation Authority

The following attended a meeting with the CAA, held 8th August 2017, Stirling:

Table 18 CAA meeting attendance

Name	Organisation	Role
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	CAA	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

B.8 Risk Assumptions Issues and Dependencies (RAID) workshop

The following attended the RAID workshop held 9th August 2017, Inverness:

Table 19 Risk Assumptions Issues and Dependencies (RAID) workshop attendance

Name	Organisation	Role
[Redacted[1]]	HIAL	Managing Director
[Redacted[1]]	HIAL	Head of Business Development
[Redacted[1]]	HIAL	Head of Finance
[Redacted[1]]	HIAL	Interim Senior HR Manager
[Redacted[1]]	HIAL	Director of Operational Support
[Redacted[1]]	HIAL	General Manager ATS
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

B.9 Aircraft operators

The following attended the aircraft operators workshop held 10th August 2017, Glasgow:

Table 20 Aircraft Operators meeting attendance

Name	Organisation	Role
[Redacted[1]]	AirTask	[Redacted[1]]
[Redacted[1]]	Bristow	[Redacted[1]]
[Redacted[1]]	Eastern Airways	[Redacted[1]]
[Redacted[1]]	Gama	[Redacted[1]]
[Redacted[1]]	Loganair	[Redacted[1]]
[Redacted[1]]	Loganair	[Redacted[1]]
[Redacted[1]]	Loganair	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

B.10 Airport managers

The following attended the Airport Managers workshop held 17th August 2017, Inverness:

Table 21 Airport Manager meeting attendance

Name	Organisation	Role
[Redacted[1]]	HIAL	Sumburgh airport manager
[Redacted[1]]	HIAL	Kirkwall airport manager
[Redacted[1]]	HIAL	Stornoway airport manager
[Redacted[1]]	HIAL	Wick station manager
[Redacted[1]]	HIAL	Inverness airport manager
[Redacted[1]]	HIAL	Dundee airport manager
[Redacted[1]]	HIAL	Station manager for AFIS airports
[Redacted[1]]	HIAL	Interim Senior HR Manager
[Redacted[1]]	Helios	[Redacted[1]]

B.11 Other

The following additional meetings were held:

Table 22 Other meeting attendance

Stakeholder group	Date	Attendees
NATS (engineering)	2nd August 2017 (Inverness)	**[Redacted[1]]**
NATS (Remote Towers)	11th September 2017 (Swanwick)	**[Redacted[1]]**
University of the Highlands and Islands	28th July 2017 (by phone)	**[Redacted[1]]**
HIAL Project team	22nd May 2017 20th June 2017 25th July 2017 17th August 2017 22nd September 2017 (all in Inverness)	**[Redacted[1]]**
Dundee County Council	27th September 2017, Dundee	**[Redacted[1]]**
Scottish Wide Area Network (SWAN) experts	26th September 2017 (by phone)	**[Redacted[1]]**
RAF	20th October 2017	**[Redacted[1]]**

C Overview of HIAL ATC Towers

This annex provides a summary of services provided from each ATC tower, together with photos taken during site visits.

C.1 Summary of ATS provision

Table 23 ATS Provision at HIAL

<table>
<tr><th>Airport</th><th>ATS</th><th>ATS (out-of-hrs)</th><th>Approach service</th><th>Airspace (class)</th></tr>
<tr><td>Inverness</td><td>ATC</td><td>No, but still have SAR</td><td>Radar (SSR/PSR)</td><td>Uncontrolled (G), but applying to become Class D in 2018 (+Class E + TMZ)</td></tr>
<tr><td>Sumburgh</td><td>ATC</td><td>AFIS on call</td><td>Radar</td><td>Controlled, class D</td></tr>
<tr><td>Benbecula</td><td>ATC</td><td>AFIS on call</td><td rowspan="5">Combined (with ADI) APP (eg 30-40 NM from airport).</td><td>Uncontrolled (G)</td></tr>
<tr><td>Dundee</td><td>ATC</td><td>No OOH</td><td>Uncontrolled (G)</td></tr>
<tr><td>Kirkwall</td><td>ATC</td><td rowspan="7">AFIS on call; Not applicable to Barra</td><td>Uncontrolled (G)</td></tr>
<tr><td>Stornoway</td><td>ATC</td><td>Uncontrolled (G)</td></tr>
<tr><td>Wick</td><td>ATC</td><td>Uncontrolled (G)</td></tr>
<tr><td>Barra</td><td>AFIS</td><td>N/A</td><td>Uncontrolled (G)</td></tr>
<tr><td>Islay</td><td>AFIS</td><td>N/A</td><td>Uncontrolled (G)</td></tr>
<tr><td>Campbeltown</td><td>AFIS</td><td>N/A</td><td>Uncontrolled (G)</td></tr>
<tr><td>Tiree</td><td>AFIS</td><td>N/A</td><td>Uncontrolled (G)</td></tr>
</table>

C.2 Barra

[Image redacted[4]]

Figure 39 Barra tower (internal, 1)

[Image redacted[4]]

Figure 40 Barra Tower (internal, 2)

C.3 Benbecula

Figure 41 Benbecula Tower (External)

[Image redacted[4]]

Figure 42 Benbecula Tower (Internal, 1)

[Image redacted[4]]

Figure 43 Benbecula Tower (Internal, 2)

C.4 Campbeltown

Figure 44 Campbeltown Tower (External)

C.5 Dundee

[Image redacted[4]]

Figure 45 Dundee Tower (Internal, 1)

[Image redacted[4]]

Figure 46 Dundee Tower (Internal, 2)

C.6 Inverness

Figure 47 Inverness Tower (External)

C.7 Islay

[Image redacted[4]]

Figure 48 Islay Tower (External)

[Image redacted[4]]

Figure 49 Islay Tower (Internal)

C.8 Kirkwall

Figure 50 Kirkwall Tower (External)

[Image redacted[4]]

Figure 51 Kirkwall Tower (Internal)

C.9 Stornoway

Figure 52 Stornoway Tower (External)

[Image redacted[4]]

Figure 53 Stornoway Tower (Internal)

C.10 Sumburgh

Figure 54 Sumburgh Tower (External

[Image redacted[4]]

Figure 55 Sumburgh Tower (Internal, equipment)

[Image redacted[4]]

Figure 56 Sumburgh Tower (Internal, Aerodrome Traffic Monitor

C.11 Tiree

Figure 57 Tiree Tower (External)

C.12 Wick

[Image redacted[4]]

Figure 58 Wick Tower (Internal, 1)

[Image redacted[4]]

Figure 59 Wick Tower (Internal, 2)

D Surveillance coverage

This annex outlines radar coverage associated with Stornoway, Kirkwall, Wick, Dundee and Benbecula Airports. Screen shots are utilised from the NATS NODE Adaptation Visualiser Tool with a radar coverage height set at either 3000ft or 4000ft. Please note that some radar sensors only provide partial coverage at the above mentioned heights.

The theoretical coverage predictions of NATS En-Route plc surveillance systems are indicative of the available radar coverage; however it is important to note that the biggest influence on coverage are environmental factors which vary from day to day and any assessment of specific operational requirements would require verification against actual radar performance.

D.1 Overview of Coverage

Table 24 Radar coverage across HIAL sites

Airport	Primary	Secondary	Primary Radar Sensors Contributing	Secondary Radar Sensors Contributing
Stornoway	Tiree**	Stornoway 1 (Sandwick) Stornoway 2 (Sandwick) Tiree**	1**	3
Kirkwall	No Primary Cover	Sumburgh (Fitfull Head) Allanshill	0	2
Wick	Allanshill*	Sumburgh (Fitfull Head) Allanshill	1*	2
Dundee	Lowther Aberdeen (Perwinnes)* Kincardine**	GDF (Great Dun Fell)** Aberdeen (Perwinnes)** Lowther Allanshill**	3	4
Benbecula	Tiree	Tiree Stornoway 1 (Sandwick)** Stornoway 2 (Sandwick)**	1	3

*Limited Coverage

**Extremely Limited Coverage

D.2 Primary Only - MRT. Base of Radar Cover 4000 ft

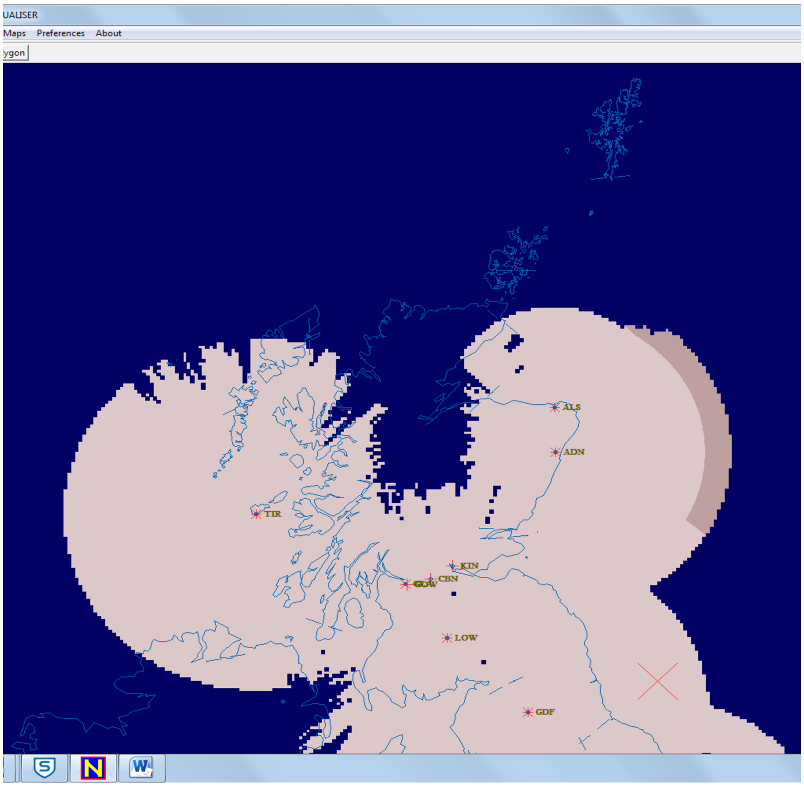

Figure 60 Base of Primary Radar Cover 4000 ft

D.3 Primary Only - MRT. Base of Radar Cover 3000 ft

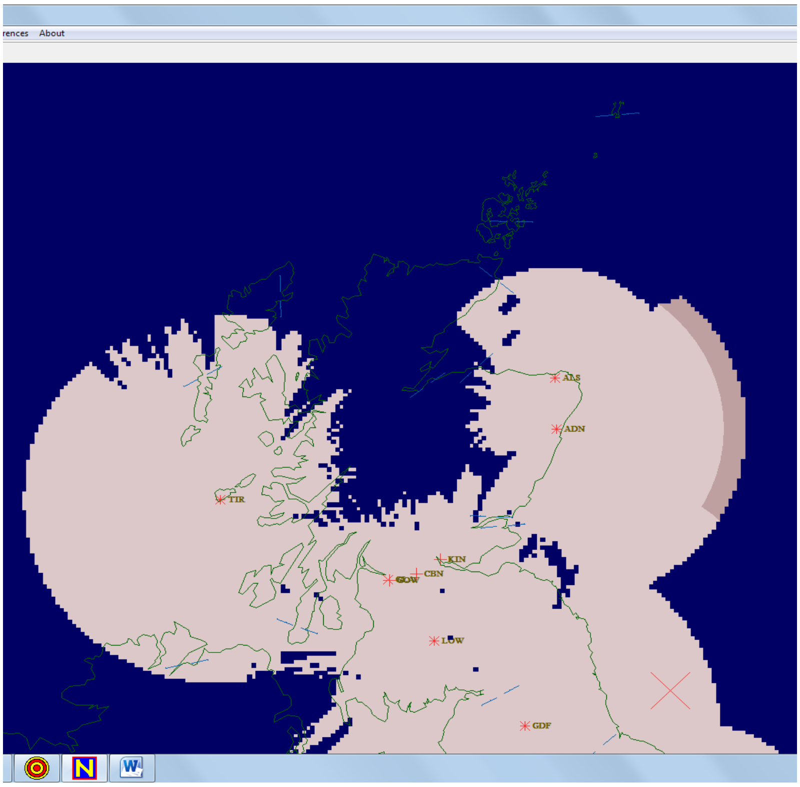

Figure 61 Base of Primary Radar Cover 3000 ft

D.4 Secondary Only – MRT. Base of Radar Cover 4000 ft

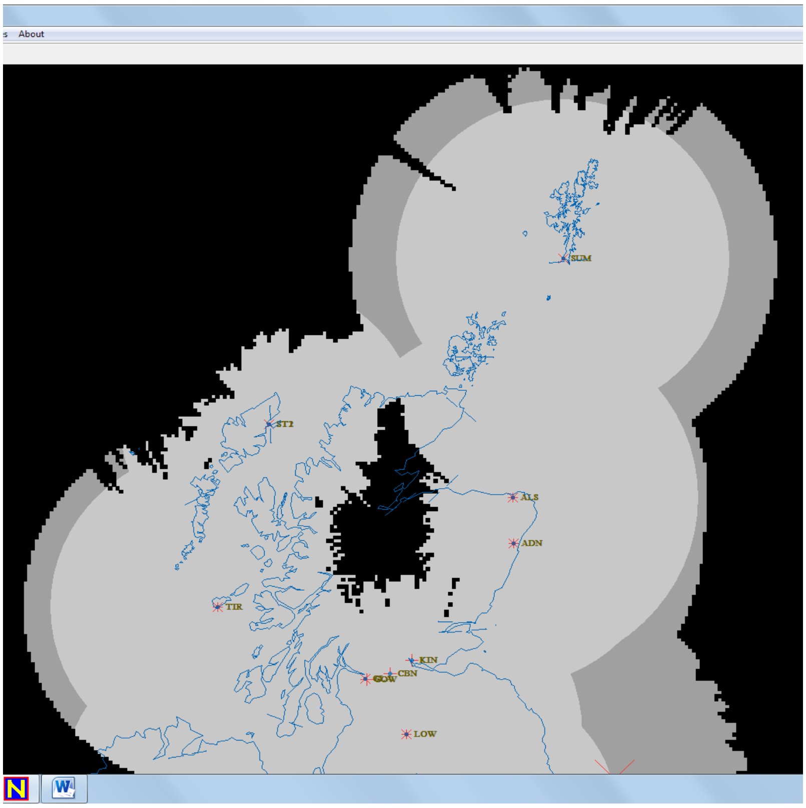

Figure 62 Base of Secondary Radar Cover 4000 ft

D.5 Secondary Only – MRT. Base of Radar Cover 3000 ft

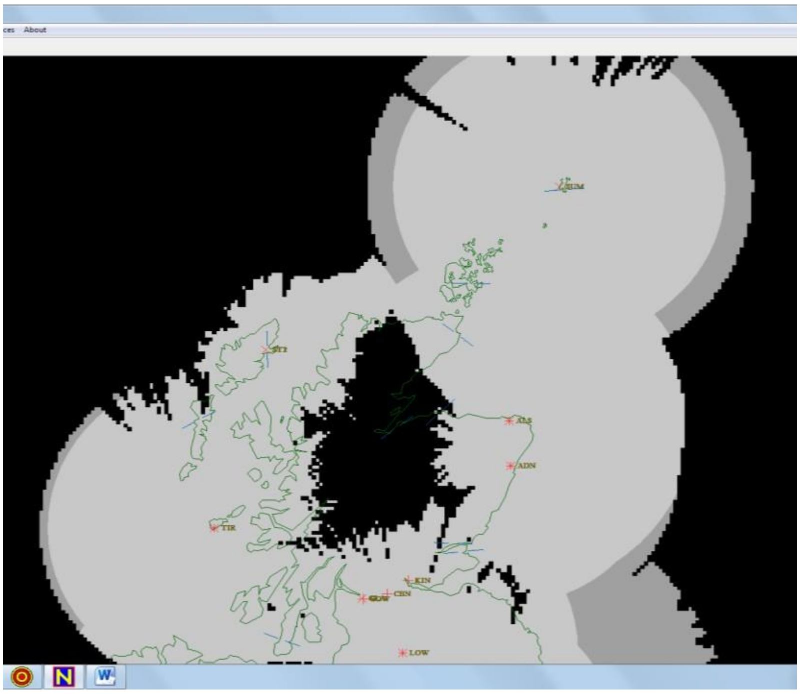

Figure 63 Base of Secondary Radar Cover 3000 ft

E Agenda and topics for airport site visit consultation

Below follows the site visit agenda distributed to each airport on the 14th of June 2017, in advance of the site visits.

E.1 HIAL Scoping Study Site Visits

- As part of the Air Traffic Management 2030 Strategy scoping study, Helios will visit all 11 HIAL airports to capture views and input on the local situation and perspective. This document provides:
  - An agenda and topics to be covered at each site-visit
  - a list of questions/inputs that would ideally be answered and returned to Helios in advance of Helios' visit
  - The schedule of visits

E.1.1 Site-visit agenda

Each site-visit may differ slightly, for example to factor in the airport complexity, location, meeting duration, number of attendees etc but the overall agenda will aim to cover at least the following:

- Tour of site and ATS/CNS facilities (1hr – either at the start or end of meeting)
- Discussion on the current situation (1-2hrs)
- General airport operations (hrs, situation, typical day)
- Airspace environment (classification, boundaries, military areas, wildlife etc)
- ATS Practices & Procedures
- Use of Air Traffic Monitors
- Resourcing (rostering, resilience, training, supervisory processes)
- ADI and APS
- Arrival, departure procedures (eg RNAV, CCO/CDO)
- Airport procedures (eg taxi, circuits, low vis etc)
- Out of hours services (eg SAR)
- Traffic characteristics (volume, type, daily activity etc)
- ATM/CNS audit (validation of equipment in place, current performance, contracts, monitoring & maintenance etc)
- Communication
- Navigation (eg navaids in place)
- Surveillance
- Flight Progress strips
- Lighting, meteorology etc
- Future opportunities (2hrs)
- Do you agree with the drivers for ATM Strategy 2030 as presented by HIAL management?

- General views on where improvements might be needed
- Views on the likely impact of the proposed projects (centralised surveillance, controlled airspace and Remote Towers) on:
- People (eg task, hours, rosters etc)
- Procedures
- Equipment (eg CNS)
- Environment (eg airspace)
- Views on potential regulatory changes (eg through FAS or EASA Part ATS)
- Any other risks or concerns (and mitigations)?

E.1.2 Inputs requested in advance

In order to ensure that the site-visits can be as effective as possible, we would be grateful if each airport could provide Helios with the following in advance of our visit:

- A list of anticipated HIAL attendees at the meeting (and their positions)
- MATS part 2
- Information about traffic mix and flight data (type of aircraft, number of movements, peak times of the day/year, etc)
- Roster for:
  - a typical summer week of operations
  - a typical winter week of operations
- High level summary / diagram of applicable airport equipment (lighting, MET, COMMS, navaids, surveillance, etc)
- Map of airfield showing equipment location (eg CNS)

E.1.3 Schedule

Helios will be visiting the airports according to the following schedule, as distributed by GMATS on the 4th of June 2017.

	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul		05-Jul		06-Jul
08:00				0815-0855: LSI-KOI					Drive to INV?						0820-0950: LHR-GLA		0800-0845: GLA-CAL	0800-0845: GLA-TRE		
09:00									CNS familiatrisation											
10:00	0945-1125: LHR-INV	Meet INV (cont...)			Meet Stornaway			0945-1125: LHR-INV		0900-1035: STN-DND						1015-1110: GLA-BEB				
11:00			1035-1120: INV-KOI																	
12:00			1140-1220: KOI-LSI	Meet Kirkwall				Drive to Wick (2.5hr from INV)	Hazard ID workshop						1210-1250: GLA-ILY		Meet Campbeltown			1150-1300: BRR-GLA
13:00	Familiarisation with HIAL & Pat															Meet Benbecula			1300-1415: GLA-BRR	
14:00		3wk F2F progress meeting with project team								Meet Dundee								Meet Tiree		1405-1535: GLA-LHR
15:00			Meet Sumburgh						1500-1640: INV-LGW						Meet Islay					
16:00	Meet INV			1600-1645: KOI-INV				Meet Wick								1600-1655: BEB-GLA			Meet Barra	
17:00		Meet with Sumburgh SATCO (course)		1820-1905: INV-SYY	1700-1755: SYY-GLA					1650-1830: DND-STN							1730-1810: CAL-GLA	1755-1850: TRE-GLA		
18:00															1825-1900: ILY-GLA					
19:00								Drive to INV (or stay in Wick)												
20:00					2025-2145: GLA-LHR															
21:00																				
	Overnight Inverness	Overnight Inverness	Overnight Sumburgh	Overnight Stornaway				Overnight Inverness or Wick							Overnight Glasgow	Overnight Glasgow		Overnight Glasgow	Overnight Barra	
Planned Helios attendance	James, Joe	James, Joe	James, Joe	Ben, James, Joe	Ben, James, Joe			James, Joe	James, Joe	James, Joe	Office day	James on leave (out of UK)			James & Joe	James	Joe	Joe	James	

Figure 64 Airport Visit Schedule

F Summary of site visits staff inputs

As part of the Air Traffic Management 2030 Strategy scoping study, Helios visited all 11 HIAL airports to capture views and input on the local situation and perspective. This annex provides a summary of the key outcomes of those visits, categorised by topic areas.

F.1 Overall ATMS2030 strategy

- There was some distrust of management regarding the strategy, for example a view that management were 'not being upfront' about the reasons. Several staff were unaware of and some were unconvinced by the drivers (redacted[1])
- Many felt that trying to be "ahead of the game" or an "industry leader" in a largely unproven concept like RTs was beyond the scope of a government owned organisation whose primary objective is to provide lifeline services
- There was a common view amongst staff that the reality of HIAL's abilities compared to its ambitions were some distance apart. Most staff were unable to provide examples of infrastructure projects that had been a major success in terms of project management and implementation.
- Whilst the need for surveillance to support CAS was generally recognised, many did not see the logic for or benefit of RTs and believed there was neither a safety nor a business case
- Nearly all staff questioned where the money would come from to implement the strategy

F.2 Jobs & personal situations

- A range of views were expressed about re-location, which varied according to each individual's situation, for example considering their location, age, aspirations and role. Some were keen to move from Island locations whilst others were far more attached to the Island than they were to HIAL.
- Some had career aspirations to move, eg from AFISO or ATSA to ATCO or if already an ATCO to get a APS license
- The view was expressed that it is particularly expensive to leave some islands due to the added transport costs – particularly when relocation packages were not typically offered – this was a barrier even now, for those who already wanted to re-locate
- Although mostly anecdotal, it was recognised that recruitment challenges and training failure rates varied from one place to another. We routinely heard that the recruitment policy had undermined the willingness of people to move as it had deliberately targeted local islanders who were committed to staying on the islands
- The future role of ATSAs was a concern for some, particularly in any move towards centralisation, with ATSAs often very busy in high traffic or poor weather situations, particularly considering the various roles that ATSAs had in some airports (such as customs and immigration responsibilities)

F.3 Controlled Airspace

- Some units did not necessarily see the benefits of introducing CAS, and questioned the difference it would make to safety – particularly with no target level of safety for class G airspace
- Concerns were about the impact on nearby GA airfields as well as GA aircraft that routinely landed at HIAL airfields. [Redacted[1]].
- Out of hours AFISOs raised concerns about how they would maintain competency if there was only CAS (that they were not permitted to provide services in) during daytime hours
- Many aircraft were not using GNSS approaches, either because of lack of equipage or due to routes not being published, there were also some issues due to the go-around procedures typically relying on existing navigation aids.
- They offer little benefit as currently rely on legacy infrastructure (NDB, VOR etc)

F.4 Surveillance

- There was generally strong support for the implementation of Aerodrome Traffic Monitors (ATMs), with many units already familiar with similar technology for situation awareness (eg flight radar 24)
- Some staff were concerned about the idea to move approach control to a centralised location as the ADI (at the tower and without approach) would be less stimulating. Others were content with this and confirmed they would be happy to continue providing ADI only services.
- No hard evidence was given, but some units expressed the view that most incidents were between transponder equipped aircraft
- Staff generally recognised that pilots didn't always know they couldn't be seen by ATC.
- It was also recognised that APP service was increasingly unknown or unusual to pilots and that fewer and fewer colleges were providing training in APP ATC.

F.5 Remote Towers

- Generally a lot of scepticism about connectivity and reliability to support RT operations with connectivity to most airports described as poor and stories of failures routinely given. However, it was also noted that there is cable diversity in some places (eg Shetlands) and supposedly no single point of failure with BT having learned the lessons of past failures.
- Many were concerned about the safety and feasibility of multiple mode operations, in which two airports would be controlled at once
- Some concerns were expressed about the loss of relationship with local airport staff due to the additional trust placed in those known to staff. For example through informal chats to resolve issues about airfield operations (such as with fire crew about marshalling decisions or runway inspections).

- Some staff had heard very little about RT technology and were interested by some of the technical capabilities such as infra-red technology, aircraft tracking and wildlife management (most airports had issues with bird strikes, and one even had permanent patrols) etc. Others felt these capabilities were unnecessary novelties that didn't provide any real benefit.
- Lots of concerns were raised about the ability of the technology to cope with weather (hurricanes, salt spray etc) and to measure weather conditions, particularly as several staff had particular MET expertise (having previously been employed by UK MET office) and routinely had to override the sensing systems that provided inaccurate data
- Another concern was raised about the implied single person operations of a RT given the typical reliance on a second pair of eyes (eg ATSA)
- Some doubt as to how it would work for some operations, [redacted[1]]. Other worries were about the ability to provide the same feeling of reality through a camera, for example to detect kite surfers, birds or weather or to even feel the tower shaking in certain conditions.
- [Redacted[1]].

F.6 Infrastructure

- Our site visits and tour of facilities also showed that many ATC towers were typically built in the 80s/90s, with some in more need for attention/repair than others
- Infrastructure was frequently described as outdated and in need of repair/investment, with NDB frequently a cause of failure, and several complaints about the quality of VHF equipment (perhaps more so with Rhode & Schwarz vs Schmidt)

G Overview of Remote Towers

Driven largely by the requirement to increase flexibility and lower cost, Remote Towers have recently started gaining traction as a possible alternative to visual control towers. A particular driver for many applications is the potential to share costs between multiple airports by providing ADI services from a single, centralised location. Larger airports have also shown interest in Remote Towers, principally as a means of providing a contingency service.

This annex provides an overview of Remote Towers including the following:

- What is a Remote Tower?
- Current status of deployment
- Remote Tower case studies (Sweden, Norway, France, UK, Hungary, Ireland, Italy, Germany, Australia, United States of America, United Arab Emirates)
- Projected development of Remote Towers (SESAR research and Deployment)
- Technology evolution
- Impact of Remote Towers on human factors (Workload and Fatigue, Physiological Issues, Situational Awareness, Environmental Awareness, Sound)

G.1 What is a Remote Tower?

A Remote Tower enables Air Traffic Control services to be provided at an airport from a remote location (potentially off-airport), instead of from a conventional airport-based ATC tower. This enables the costs of the conventional tower to be replaced by the potentially lower costs of a remotely based centre. The remote location can deliver economies of scale and cost sharing since the remote centre can be designed to provide services to more than one airport (Figure 65).

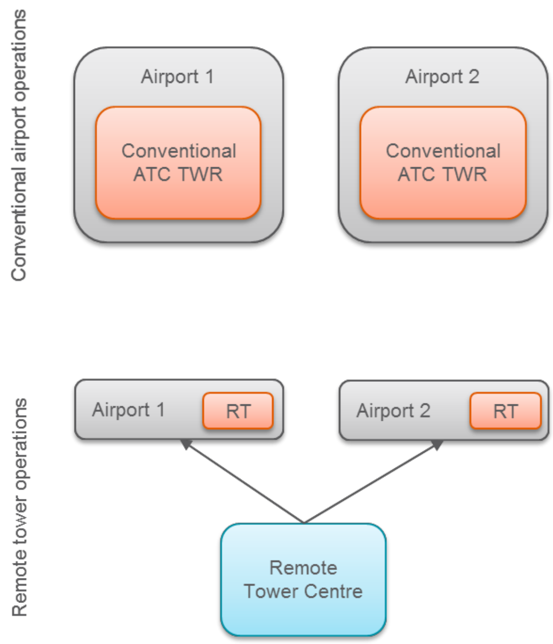

Figure 65 Logic of Remote Towers

The services are provided using innovative technology. High resolution cameras, masts, microphones, sensors and a local processing system are installed at an airport and linked to a Remote Tower Centre (RTC) via a high bandwidth link. The RTC is fitted with screens and hardware controls to enable the ATCO to provide an ADI service, as if seated in the conventional tower.

Remote Tower technology is a change for the way operators deliver ATS, and several new operational concepts have arisen in response to specific local needs. Implementations of Remote Towers are focussed in specific operating environments, and reliant on specific technical solutions from a limited number of manufacturers.

ANSPs are currently developing the following applications throughout the world:

- **Single mode of operation,** in which a single airport is operated by operators in a Remote Tower module. Even if numerous modules may be placed in a single RTC (therefore consolidating many 'towers' into a single location), ATS will not be delivered to more than one airport at a time concurrently.
- **Multiple mode of operation,** in which operators deliver ATS to more than one airport at a time concurrently. This concept is being trialled for low density operations to allow these airports to operate based on demand rather than fixed operational hours.

These modes need to be studied with respect to the way ATS will be delivered by operators:

- **Sequentially:** this way of operating is based on setting timeframes for ATS delivery at given airports. This enables ATS delivery to tactically switch between the aerodromes based on their traffic patterns, enabling efficiencies in ATCO rostering. This approach can be used with both the multi-mode and single-mode concepts. One operator is in charge of one aerodrome at a time meaning controllers are not interrupted by switching from one airport to another reducing any impact related to high workload or confusion.

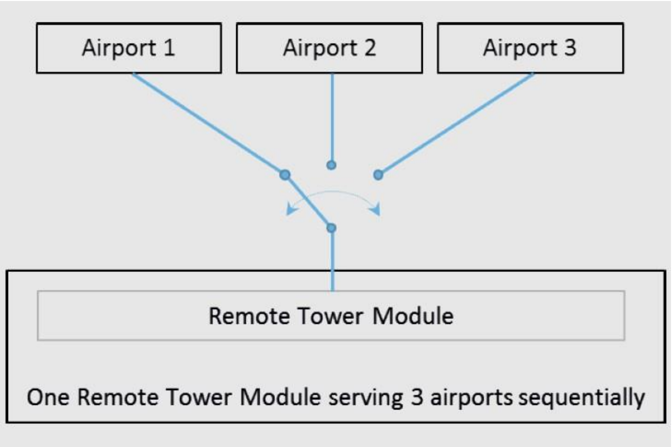

Figure 66 Multiple sequential configuration

- **Simultaneously:** ATS is delivered to more than one airport at a time (concurrently), and is only defined for multi-mode operations. At present, this concept is being trialled at aerodromes with very low traffic density.

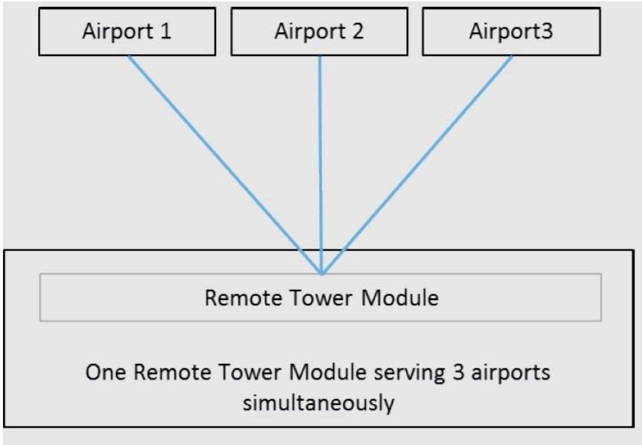

Figure 67 Multiple sequential configuration

By divorcing the ATCO from the airport location, a wide variety of different operational concepts become possible. Airports and ANSPs are becoming increasing interested in Remote Towers for a number of reasons:

- **Cost saving:** Remote Towers can potentially reduce upfront costs compared to a visual control tower and reduce overheads by consolidating views of multiple dispersed aprons, taxiways and runway thresholds into one operator display. The potential to consolidate staff for several airports into one location can also open up possibilities to realise efficiencies in staff rosters.
- **Flexibility:** Portable camera masts offer the ability to accommodate airport expansion and operational changes, allowing a Remote Tower to supplement operations from a visual control tower with a view of airport areas which may not be visible.
- **Contingency:** Cameras and working positions are easily replicated, and a remote facility can be located off-site, offering improvements in service continuity.
- **Enhanced safety and security:** Remote Towers can integrate infra-red cameras and motion tracking, particularly in low visibility when it can be difficult to protect the movement area. This enables improved foreign object detection, increased situational awareness.

Indeed, CANSO the Civil Air Navigation Services Organisation, who's Members support over 85% of world air traffic, recently stated that *"Remote and digital towers improve safety through improved observation via enhanced imaging and infrared for low visibility; and simplification by having all relevant information, such as weather, flight information, and other key data displayed directly on the screen. This reduces controller workload and enhances safety" [108].*

G.2 Current status of deployment

Digital Towers have been certified for use in two locations to-date: Sundsvall and Budapest.

The Remote Digital Tower Centre in Sundsvall was the first fully certified and operational Digital Tower in the world, serving a handful of movements per day to small regional airports (Örnsköldsvik and Sunsvall-Timrå).

In November 2017, Budapest Airport (100,000 annual movements) became the second airport to become certified to conduct live operations from a digital tower. This is also the first dual-runway airport to be managed through a digital ATC service.

The Singaporean ANSP, CAAS, recently announced plans to explore using a Remote Tower to provide ATC to a third runway and new terminal at Changi airport (350 000 annual commercial movements), due to be completed in the early 2020s [68].

There is extensive research and development activity in Remote Towers. Research to date has focussed on Remote Towers at low density airports, and is now switching to validating the multimode concept.

Technology is progressing fast and next generation functionality and systems will soon be available. Whereas current solutions tend to be offered as a package, in the future manufacturer offerings will become more modular as solutions are adapted to the needs of service providers. Further details on the projected development of Remote Towers can be found in Annex G.4.

G.3 Remote Tower case studies

A number of Remote Towers have been implemented worldwide in recent years. The various European implementations including operational and technical characteristics are presented in the map below.

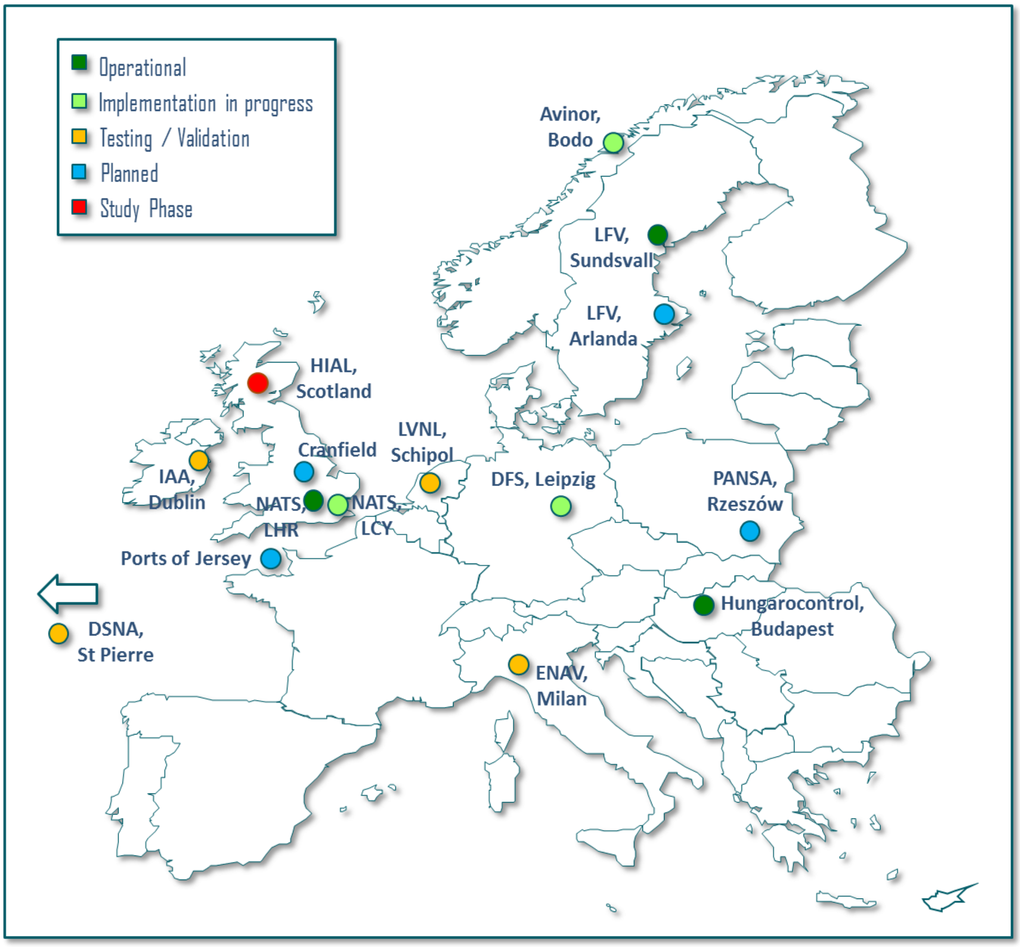

Figure 68 Map of Digital Tower Implementations in Europe

G.3.1 Sweden

The Remote Tower Centre in Sundsvall is currently the only fully certified and operational Remote Tower in the world. ATCOs located in Sundsvall provide air traffic control services to traffic operating to and from Örnsköldsvik, which is located approximately 90 miles away [69]. In 2016, the Sundsvall centre also began monitoring flights at its local airport, Sunsvall-Timrå, and plans to expand again in 2018 to provide ATC to Linkoping City Airport in southern Sweden [100].

The Remote Tower has been implemented primarily to save costs at a low traffic airport; Örnsköldsvik airport is a single runway airport serving only around 2,000 movements per year. Despite this, the tower would have to be manned throughout the opening hours of the airport (5:00 to 23:00). For a single airport the business case is marginal and so to enable further economies of scale and therefore cost savings LFV is working to gain approval for a multi-tower configuration, which would allow the same ATCO to manage the traffic at two airports at the same time. These are ambitious plans, and it is not known when and if the Sweden's Transport Agency will approve multi-tower operations. Although Örnsköldsvik and Sundsvall-Timrå airports are now managed from the same centre, they are operated from different Remote Tower modules.

Figure 69 Remote Tower in Sundsvall [70]

With regards to the process of implementation and certification our understanding is that the regulator was particularly supportive of the project from the start. Together, LFV and Saab wanted to be market leaders and innovators, and recognised the importance of a simplified, step-by-step approvals process. The approvals basis was to therefore treat the RT like any other functional change and to certify it on the basis of existing standards and regulations that would apply to the conventional tower.

The Remote Tower module has been installed since late 2012/early 2013 and passed the site acceptance test in February 2013 [70]. The approval process was initiated in January 2013 and the operational approval was initially expected by July 2013. However, the process took significantly longer than anticipated and operational certification was only obtained in November 2014 [71], nearly 2 years after the module was installed. A further period was necessary to finalise training and the facility became fully operational only in April 2015.

Figure 70 Remote Tower at Sundsvall [72]

The Remote Tower module in Sundsvall is operated by two ATCOs and consists of 15 42 inch screens, which display an 'out of the window' view, provided by 14 high definition cameras. ATCOs see a 360-degree view on screens that span around 200 degrees (image is compressed). The ATCOs have the ability to have a closer look at an area at the airport using pan and tilt cameras, and can operate runway lights, alarms, communication systems etc. Furthermore, the Remote Tower is equipped with metrological sensors and directional microphones [73].

Table 25 Sundsvall Remote Tower key characteristics

Characteristic	Description
Location	RTC located in Sundsvall providing ADI service to Örnsköldsvik and Sundsvall-Timrå
Main reason for construction	Cost saving
Airport operational environment	2,000 movements per annum; one runway; open from 5:00 to 23:00; IFR and VFR traffic. Sundsvall-Timrå: 9,000 movements per annum; one runway. [101]
Technical	'Out of the window' view, made up of 15 large screens arranged in a half-circle.
Operational	The Remote Tower is operated by two ATCOs and is supported by meteorological sensors and directional microphones.
Regulatory Approval	The Remote Tower in Sundsvall became operational in April 2015 after obtaining approval from the Swedish Transport Agency in November 2014. The facility passed its Site Acceptance Test in February 2013.
Provider	SAAB

In addition to the RTC at Sundsvall, and recognising the opportunities afforded by Remote Tower technology, LFV and Swedavia have also signed a Letter of Intent to investigate the potential to establish Remote Towers at five Swedish Airports (which operate at

Malmö, Visby, Östersund, Umeå and Kiruna). The earliest implementation would be in 2018/2019 [97]

G.3.2 Norway

Similarly to LFV in Sweden, Avinor (the Norwegian ANSP and Airport operator) became interested in Remote Towers in order to cut the cost of ADI provision to small and infrequently used airports, which are unable to cover the costs of their ADI service without subsidy. In collaboration with SAAB a trial was initiated in 2012 and a Remote Tower facility was created in Bodø, Norway. The aim of the trial was to prove the operational concept by providing Aerodrome Flight Information Service (AFIS) to the Værøy heliport and in the future to Roest Airport as well [74]. The objective was to prove that Remote Towers can withstand rough weather conditions and to demonstrate more advance infrared technology.

Figure 71 SAAB trial solution at Bodø

The trials began in June 2012 and the facility passed the site acceptance test in April 2013. The trial conclusions were published as part of SESAR work and led to a decision by Avinor to invest further in the technology. In 2015 Avinor signed a NOK 400 million (€43 million) contract with Kongsberg Defence Systems and Indra Navia for the provision of equipment needed to provide Remote Tower services to 15 low traffic density airports from the one Remote Tower located in Bodø[75]. Early in 2016 it was announced that the first airport to be equipped with the Kongsberg & Indra Navia RT Solution is Roest Airport (installation planned towards the end of 2016) with Roros, Hasvik, Berlevag and Menamn airports to follow. The NINOX Remote Towers ATC system has now been installed at Røst Airport (Oct 2017) [102] is planned to be operational by Q3 2018.

Initial operation will be as a Contingency Digital Tower with 5 workstations and a supervisor. Parallel construction of a Main Digital Tower with 16 workstations is planned to be complete in 2019 [103].

Figure 72 Kongsberg & Indra Navia RT Solution [76]

The system includes airfield lighting, flight data processing, electronic flight strips and meteorological sensors as well as information augmentation on the out of the window view [77].

The current plan is that by 2017 the RT in Bodø will be ready to be connected to the Roest Airport equipment; however, we believe this to be an optimistic deadline. Despite being actively involved in Remote Tower developments for 4 years now, as of today Avinor has not yet obtained approval or certification from the regulator to operate a remote solution at any airport.

Table 26 Bodø Remote Tower key characteristics

Characteristic	Description
Location	RTC located in Bodø providing AFIS service to Værøy heliport
Main reason for construction	Cost saving
Airport operational environment	The heliport serves approximately 4 movements a day. Roest Airport has a single runway and serves approximately 1,500 flights a year.
Technical	The SAAB Remote Tower solution has an 'out of the window' view, made up of 10 large screens arranged in a half-circle. Despite the screens being arranged in a half circle the image presented covers 360 degrees.
Operational	The Remote Tower provides aerodrome flight information service (AFIS). It is operated by one ATCOs and is supported by infra-red technology and 2 microphones.
Regulatory Approval	2012: preparation for single aerodrome trials (SAAB) Værøy passed its sat acceptance test in April 2013 (SAAB). Kongsberg and Indra Navia systems will start being installed in 2016.
Provider	SAAB (trial); Kongsberg & Indra Navia (full system)

G.3.3 France

DSNA has selected Searidge to deploy a Remote Tower solution comprising high definition, day/night, visible, thermal and pan-tilt-zoom cameras at Miquelon Airport, on an island near Canada. The system will be operated from the neighbouring island of St Pierre and includes a bespoke HMI [78].

G.3.4 UK and Channel Islands

In March 2017 Jersey Airport announced plans to implement a Remote Tower service to increase its capability of continuing to provide air traffic services in the event of a catastrophic technical failure of equipment or the need to evacuate the main air traffic control facility at Jersey Airport [79]. The system will provide the ATCOs with a 220 degree view and will be used for contingency purposes.

In May 2017 NATS announced that London City would implement a Remote Tower which is due to become operational in 2019. It will be located in the NATS centre in Swanwick and will be utilising state-of-the-art 360° HD cameras and sensors on a newly constructed tower. London City will be the first UK airport to introduce and operate a Remote Tower [80].

In October 2017, Cranfield airport announced delivery of a new Digital Control Tower supplied by Saab. The new system will allow controllers to zoom in on aircraft, improving visibility, and provide them with a 360-degree view of the airfield [104].

Since 2009 NATS has operated a windowless remote ATC facility, which has been established to provide a contingency service for Heathrow. The facility uses low visibility procedures to enable Heathrow to provide a service to 70% demand [81], if the primary visual control tower is unable to operate. The equipment in the room is an exact replica of the visual control tower, meaning that ATCOs would already be familiar with the environment. This implementation is certified for use, but does not actually involve the use of cameras, screens or out-the-window view at all. It is therefore considered to be a somewhat different concept to the Remote Towers mentioned above and not strictly comparable.

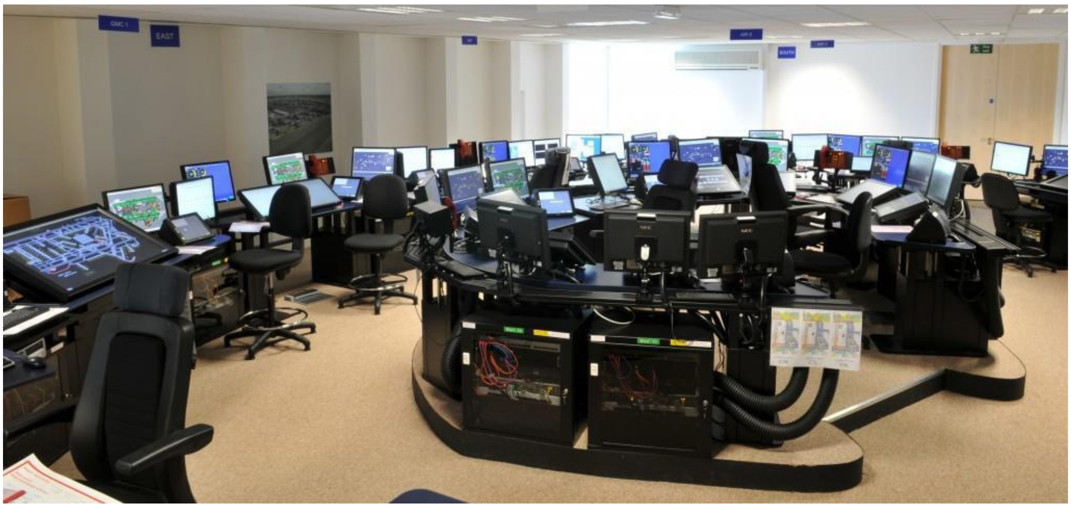

Figure 73 Heathrow's windowless remote contingency facility

G.3.5 Hungary

In April 2015, HungaroControl signed a €4.9 milling contract with Searidge to develop and deploy an integrated Digital Tower with the aim to provide ATC services while the main tower undergoes renovation.

In November 2017, HungaroControl's integrated Digital Tower at Budapest Airport was certified for live operations, without restrictions [105]. This follows the successful completion of the live trials at the end of 2016, where close to 600 movements were managed, without any limitation or constraints with the scheduled traffic [106].

The solution has to provide ATC at a dual runway airport handling around 100,000 movements a year, and is the earliest demonstration of the DT concept in a busy traffic environment. For the time being, the newly certified Digital Tower will be used by HungaroControl for contingency, training, and backup operations. Ultimately, the ANSP aims to operate a full Digital Tower solution at Budapest by 2018 [107].

Figure 74 Visualisation of the Remote Tower in Budapest [82]

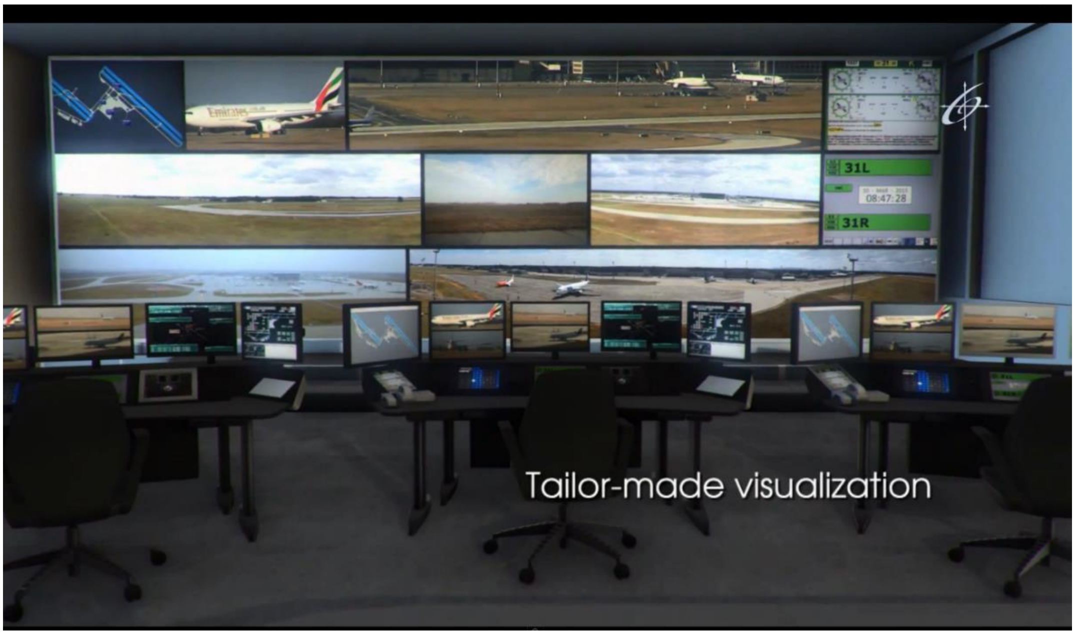

Figure 75 Visualisation of the Remote Tower in Budapest [82]

The visual system will comprise a panoramic video wall with a ‘stitched’ view of various parts of the airport including runways and the manoeuvring area. This wall will incorporate a tailored human-machine interface and relevant data overlays. HungaroControl aim to be able to provide a full capacity service regardless of the weather conditions [83].

Table 27 Budapest Remote Tower key characteristics

Characteristic	Description
Location	RTC located in Budapest
Main reason for construction	Contingency
Airport operational environment	Two runways, 24h operation, IFR traffic only, 100,000 movements a year
Technical	The Remote Tower has a screen wall displaying a number of images of the airport.
Operational	The Remote Tower provides ADI service. It is operated by multiple ATCOs and is supported by infra-red technology.
Regulatory Approval	April 2015: System commissioned March 2016: System to be fully implemented 2016: Live trial certification as SESAR demonstration 2017: System certified for live operations, without restrictions Mid-2018: system to be certified for full operations
Provider	Searidge

G.3.6 Ireland

The IAA is performing a trial of Remote Tower technology in partnership with the DAA, SJU and SAAB. Systems were installed in 2015, and the trial will shadow ADI services at night at Shannon and Cork in a multimode configuration. Results will be provided to the SJU and there are no current plans to receive regulatory approval for providing remote-tower-only services at Cork or Shannon.

Figure 76 Test module of the Cork and Shannon RT [84]

Both Shannon and Cork have relatively low levels of traffic (approx.18,000 movements per year) and hence are more comparable to the Avinor and LFV examples of remote technology being used in low traffic density scenarios.

Table 28 Cork and Shannon Remote Tower key characteristics

Characteristic	Description
Location	RTC located in Dublin providing ADI to Cork and Shannon Airport
Main reason for construction	Trial and night service provision to investigate possibility of delivering services at night to both airports from a single position
Airport operational environment	Each airport is open for 24 hours a day, serves approximately 18,000 movements per year and handles both VFR and IFR traffic.
Technical	The Remote Tower has an 'out of the window' view, made up of 15 large screens arranged in a half-circle (220 degree arc). Despite the screens being arranged in a half circle the image presented covers 360 degrees.
Operational	The Remote Tower provides ADI service. Each module is operated by 2 ATCOs
Regulatory Approval	2015: system commissioned 2017: trial to be completed and results available
Provider	SAAB

G.3.7 Italy

In 2015 ENAV launched the Remote Airport Concept of Operation (RACOON) project, which is one of 15 large-scale demonstration projects under the Single European Sky ATM Research Joint Undertaking (SESAR JU). The aim of the research project is to test the feasibility of providing night time ADI services at Milan Linate Airport, from Milan Malpensa Airport [85]. Trials will also cover the possibility of providing air traffic control services for multiple airports from a single module. The project is being carried out with support from Searidge, who will provide ENAV with a tailored Remote Tower system, which integrates their existing ATC systems.

G.3.8 Germany

DFS is working closely with Frequentis to provide ADI services to three low density airports: Saarbrucken, Erfurt and Dresden. Their Remote Tower centre will be located in

Leipzig and DFS expects to begin operations in 2017. It will be equipped with an out of the window view along with pan-tilt-zoom cameras, movement tracking software and infrared cameras [86]. Compared with deployed SAAB systems, the Frequentis solution uses individual Remote Tower positions, with each ATCO having his own set of screens (Figure 77). The ATCO working position consists of an augmented panoramic view of the runway and manoeuvring areas (1), pan and tilt camera tracking view (2), integrated control panel (3) and finally an additional surveillance display (4). Frequentis also uses IR cameras as part of their tracking algorithm to improve motion detection of targets.

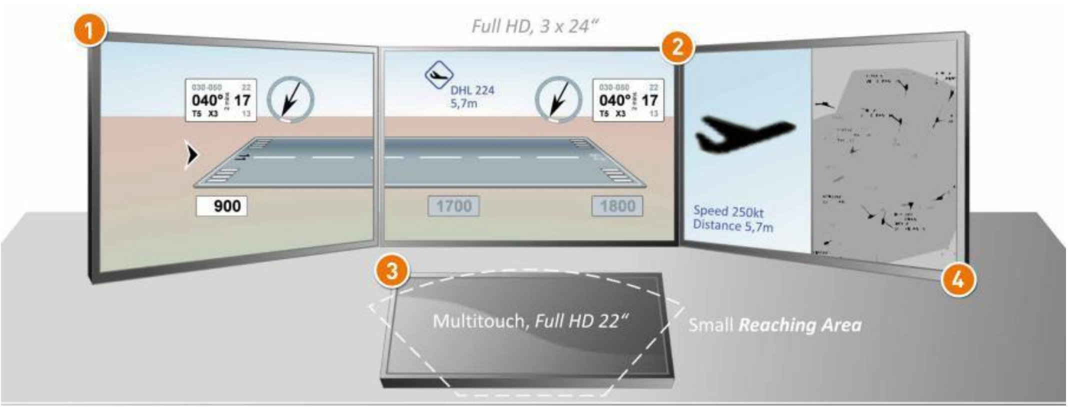

Figure 77 Frequentis' Working Position Concept [87]

Figure 78 Frequentis' infra-red tracking solution [87]

In November 2016 Friedrichshafen Airport has also published a request for information on the available Remote Tower solutions and implementations. It is unclear whether they have engaged in a detailed negotiation with a supplier and Ig they will be proceeding with a Remote Tower implementation.

G.3.9 Australia

In 2010 Airservices Australia launched a trial Remote Tower implementation project, which aimed to investigate the provision of ADI services to Alice Springs from a Remote Tower module located 930 miles away, in Adelaide. The airport serves approximately 65 movements per day, and is open to both VFR and IFR traffic. In Alice Springs it is common for ATCOs to visually separate flights within the circuit, if weather conditions permit [88]. As a result, it was key for the project to gain ATCOs approval of the camera system. SAAB was chosen to provide the Remote Tower equipment, and was required to adapt the system to the hot and dry weather conditions present in Alice Springs. Despite the project having launched 6 years ago, there is little information about its progress. The facility has not been certified for operations nor is there any information about it passing a site acceptance test. It is our understanding that the trials were successful, but that subsequent resistance has stopped the project going to a full implementation phase.

G.3.10 Poland

In 2015 PANSA published a tender detailing their plans to create a Remote Tower Centre in Łódź providing ATC service to Zielona Góra Airport. The initial tender was of limited scope and following an initial exchange with the suppliers it was altered to also include investment in Electronic Flight Strips and Local Flight Data Processing Systems. PANSA's plans have also been revised and the location of the planned RTC was moved to Rzeszów, with the first airport receiving a remote tower service being Lublin [1]. The tender also established an option to expand the scope to include Zielona Góra airport.

The deadline for the tender responses were due in March 2016, but the scope change had an impact on the initially allocated budget, hence the project was halted while the budget was re-visited and replanned. The most recent information (2016 Annual Report published in September 2017 [2]) suggests that PANSA is also re-assessing the local needs to ensure that the investment is fit for purpose.

G.3.11 United States of America

Figure 79 SAAB Remote Tower system at Leesburg Airport, Virginia [89]

A SAAB Remote Tower solution is also being trialled in the US at Leesburg Executive Airport in Virginia. The Remote Tower module is located at the airport and is supported with an out of the window view displayed on 14 55 inch screens, pan-tilt-zoom cameras, signal light guns and microphones [90]. Similarly to the module in Sundsvall it is operated by two ATCOs and the main aim of the project is to gain regulatory approval.

The FAA has also been testing a Remote Tower facility at Fort Collins-Loveland Airport in Colorado. Searidge has been chosen to develop an appropriate solution in order to improve safety and the commercial attractability of the airport [91].

G.3.12 United Arab Emirates

In 2015 Dubai Air Navigation services (DANS) announced that they will be issuing a tender for a Remote Tower solution which would provide contingency services to Dubai International Airport (70M+ passengers). This particular development is currently in the stage of defining the concept of operations and for this DANS has been in close partnership with HungaroControl, building on the experience gained in Budapest [92]. The project also involves conducting a feasibility study assessing whether it would be possible to maintain a 100% service level when using Remote Towers. We understand that procurement is going ahead, but will be limited to a trial operation initially.

G.4 Projected development of Remote Towers

There is extensive research and development activity in Remote Towers. This section presents information on the expected evolution of the technology over the coming years and provides an overview of current research.

G.4.1 SESAR research

SESAR has performed a series of trials and validations to date (see case studies above). The trials largely focussed on validating the single airport concept for medium traffic volumes (Saarbrucken, 0.5 million annual passengers [93]) or for contingency (Girona, 1.8 million annual passengers [94]) using shadow mode exercises to evaluate the capacity which could be provided.

Meanwhile the focus in SESAR is on multi-airport operations. Previous validation activities have partially covered parallel mode operations, and the next phase of SESAR (SESAR 2020) aims to build upon these results to validate the concept in several environments and to demonstrate which type of and how many airports at varying traffic levels can be controlled.

SESAR 2020 also aims to deliver a Remote Towers solution to improve access to secondary airports in low visibility conditions.

G.4.2 Regulatory and Standardisation activities

SESAR JU carries out development and validation activities in support of Remote Tower operations. These activities support the standardisation and regulation work. SESAR JU has published several documents, including an Operational Services and Environment Description (OSED), a Safety Assessment and Human Performance Report for single mode operations, and a Safety Assessment and Validation Report on multiple mode operations. Several validation activities have taken place through SESAR, firstly under SESAR 1 WP 6.9.3, and work is now developing under PJ05 of SESAR 2020.

The table below summarises the key bodies involved in regulation and standardisation, and their current initiatives:

Organisation	Summary of activity
Eurocae	EUROCAE Working Group 100 is responsible for developing European standards for Digital Remote and Virtual Towers. Its first task was to develop Minimum Aviation System Performance Standards (MASPS) for the visual optical sensors element of a Remote Tower, the final version of which was published in September 2016 as ED-240. The next task for the Working Group will be to extend its analysis to develop standards for Digital Tower optical sensor tracking facilities. ED-240A, an extension to the existing MASPS including target tracking technologies, is in development and is due Q2 2018.
ICAO	Based on recommendations from ITF (International Transport Workers´ Federation), the ICAO Air Traffic Management Operations Panel (ATMOPSP) reviewed the ICAO provisions in Annex 11 and PANS-ATM (Doc 4444) with a view to examine the provisions in order to identify shortcomings, if any, and develop new provisions as necessary to accommodate remotely provided aerodrome ATS. Their proposal to amend PANS-ATM is included in ICAO State Letter AN 7/63.1.1-17/23. The update has been approved by the Air Navigation Commission (ANC) and is planned to enter into force in November 2018.
European Commission	Regulation and guidance material exists on several topics related to the human dimension, including: • Annex I to Decision 2015/010/R1 'AMC and GM to Part ATCO' Amendment. This deals with Digital Towers related training elaborated by EASA. • Guidance material related to IR 2015/340 ATCO.D.060. EASA issued Requirements on Air Traffic Controller licensing regarding Digital Tower operations **Error! Reference source not found.**, an amendment to Acceptable Means of Compliance and Guidance Material of Commission Regulation (EU) 2015/340, in 2015 which focusses on the establishment of high-level guidance on training and qualification of ATCOs.
EASA	• Phase 1 of EASA's Technical Requirements for Digital Tower operations (RMT.0624) focussed on single mode operations, resulting in an NPA (2015-04 Technical and operational requirements) and Guidance Material on the implementation within the current regulatory framework. The guidance material has a key focus on Human Performance (HP) assessment in the frame of safety assessment. • Phase 2 of RMT.0624 was launched in 2016, to expand into 'multiple and more complex mode of operations', and will reference industry standards as produced by EUROCAE WG-100 (ED-240). Further to RMG meetings, a new public consultation or NPA is scheduled to be published in 2017.

Table 29 Remote Towers Standardisation and Regulatory Activities

G.4.3 SESAR Deployment

As a result of validation in SJU, the European ATM Master Plan (2015 Edition) foresees the use of Remote Towers to enable efficient and flexible operations, primarily delivering improved ADI services for low and medium traffic airports. Deployment is expected between 2017 and 2021.

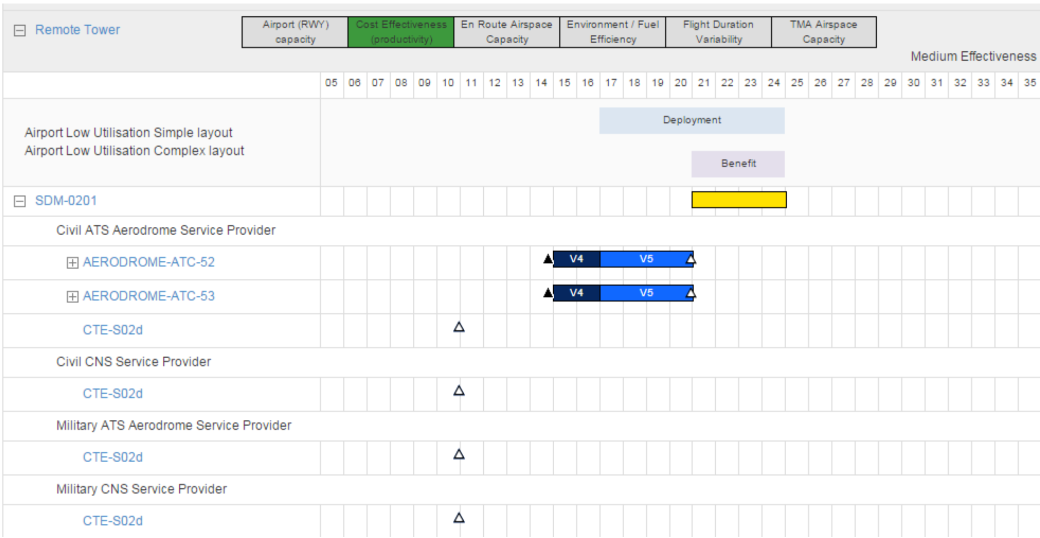

Figure 80 Extract from European ATM Master Plan (Edition 2015) showing deployment timescales for Remote Towers at low density airports

EASA has also published a Notice of Proposed Amendment (NPA2015-04 [95]) stating that "*the results of the validation exercises available so far show that the single mode of operation for the remote provision of ATS may be applied to low-density airports"*.

G.5 Technology evolution

EUROCAE WG-100 is tasked with developing standards for Remote Towers which can be used as reference material including minimum requirements on technical systems and the related components.

However, technology is progressing faster than standards can be developed. Current Remote Tower solutions tend to be offered by manufacturers as a package. SAAB for example offers a package of fixed cameras linked to heads up screens, which replicate the 360 degree out of the window view, complemented by ATCO tools such as data link and electronic flight strips. In the future, manufacturer offerings will become more modular as solutions are adapted to the needs of service providers.

- **Cameras:** Fixed, static cameras are currently used to provide an 'out the window' view at the Remote Tower centre. In the future, there will be a shift towards processed images – for example, multiple high dynamic range cameras can be used to build a more complete picture of the airport (eg on apron areas), with images 'stitched' together.
- **Tracking:** Frame by frame comparisons are used to provide a tracking capability; however, in the future, infrared sensors will be integrated to provide a more sophisticated tracking service. This enables safety nets to be used in areas with limited surveillance (eg on the apron). Eventually, labelling of aircraft will be possible.
- **ATCO working position:** the Human Machine Interface will initially replicate existing ATCO working positions. As ATCOs become comfortable with the Remote Towers set up, heads down information and tools can gradually be moved onto the heads up display, increasing 'heads up time' for ATCOs. For example, ADS-B and A-SMGCS data can be overlaid on the heads up display to increase an ATCO's situational awareness.

- **Communications links:** SESAR is looking to improve network quality of service requirements, and other resilience and redundancy related issues, which are important in gaining regulatory approvals. It is also possible that SWIM will be used in the future to transmit data from airports to the Remote Tower centres. Cyber-security will be key.

G.6 Impact of Remote Towers on human factors

G.6.1 Workload and Fatigue

Workload is a key factor to be considered when evaluating a ADI working position [96]. A too high level of workload may increase the propensity of a ATCO making a mistake as well as driving fatigue. It is likely that the process of assessing the workload associated with a Remote Tower ATCO working position will be significantly longer than that of a VCT position, due to the complexity of the additional systems that the ATCO would have to interact with.

G.6.2 Physiological Issues

In a visual control tower, it is well established that the ATCO works for up to 2 hours and then has a rest period of minimum 30 mins. There would be no change to the current break arrangements.

In the SESAR Remote Tower trials some ATCOs reported that looking at screens instead out looking out the windows strained their eyes and caused dryness [98].

G.6.3 Situational Awareness

In a visual control tower, the window view means it is easy for the ATCO to maintain a good situational awareness. In the Remote Tower environment, the 360° view is commonly compressed into a 220° view. This results in either the entire view being distorted, or the view in the most outer screens being distorted. Alternatively, the RT could reproduce a full 360-degree view. In all cases, the impact on how the ATCO builds his understanding of the operational environment must be assessed. SESAR trials [98] showed that ATCOs had a relatively high situational awareness for low density traffic environments.

G.6.4 Environmental Awareness

In a visual control tower the ATCO can easily see and assess the environmental conditions at the airport. In a Remote Tower it is more difficult for the ATCO to visually assess the intensity of rain, strength of wind, identify hail etc. This can negatively affect the ATCOs’ perception of airport conditions. However, there is less impact when the Remote Tower is located at the airport.

G.6.5 Sound

ATCOs often rely not just on visual cues but also on sound in order to further develop the situational and environmental awareness. In a visual control tower, sound can be partially muted by the windows, but is not fully blocked. EASA recommends that airport sound reproduction should be available *if the outcomes of the safety assessment and the human performance assessment require so [99]*, and LFV’s Remote Tower centre at Sundsvall is equipped with directional sound, to closely simulate conditions in a conventional tower.

H Agenda and topics for Remote Tower supplier consultation

This annex provides a list of questions that were provided and responded to by the following Remote Tower suppliers:

- SAAB Digital ATS
- Searidge
- Frequentis
- NATS (part-owner of Searidge)

Avinor/Kongsberg declined to provide input.

H.1 Introduction

Helios has been contracted by Highlands and Islands Airports Ltd (HIAL) to conduct a scoping study for their 'Strategy 2030' vision, investigating the introduction of four strategic projects as follows:

- Centralised Surveillance service
- CAS (at 7 ATC airports)
- Remote Towers
- Out of Hours AFIS service

Given that Remote Towers are new and fast evolving technological solution, Helios wishes to engage with Remote Tower suppliers on behalf of HIAL to assess potential Remote Tower solutions and their feasibility (projects 3 & 4 above) in the context of HIAL's unique operating environment.

The particular topics Helios would like to cover are discussed below and we would be very grateful if you would take the time to consider the 7 questions presented.

Any responses you can provide by e-mail (to [redacted]) would be very welcome as we would then like to discuss your inputs over a phone call at a mutually convenient time (preferably between 26th July and 8th August). It would be helpful if you could indicate in your response several 1-2hrs slots in this period that you can be available for a call.

Any information provided will be used purely for the benefit of the scoping study as this document is not a call for interest or invitation to tender. Also note that the scoping study may be subject to a freedom of information request[27], so any confidential/proprietary responses should be marked as such.

H.2 Topics & questions

Whilst a number of variants of the concept exist, the remote centre may need to be able to provide:

- a centralised surveillance service (suitable for traffic and de-confliction services under UK FIS[28]) to anything up to all 11 airports

[27] http://www.gov.scot/About/Information/FOI
[28] https://publicapps.caa.co.uk/docs/33/CAP%20774Issue2_3.pdf

- a Remote Tower ADI ATC service (to the 7 ATC airports)
- a remote AFIS, during opening hours[29] to at least 4 airports; and
- a remote AFIS, during out of hours, to anything up to all 11 HIAL airports:

Q1) From a technical perspective, which of the above services could be combined and approximately how many controller working positions would be required for a) 1:1 operations and b) 1:2 operations?[30]

Q2) In case of single person operations, what aids are available to compensate for not having a second operator (such as an assistant)?

Q3) Several operating and financing models are being considered, including the possibility for outsourcing the operation (incl. ATS) of the remote centre. What models of purchase and operation (eg build-operate-transfer etc) are possible and what do you consider to be the pro's and con's for each?

Q4) Several HIAL airports are located in regions with poor connectivity (Shetlands, Orkney Islands etc) necessitating a clear solution for a) a sudden loss in connectivity and b) low bandwidth normal operations. What options (and which performance levels) are available for the above a) and b) situations?

Q5) Several options are under analysis for the location of a single Remote Tower Centre including on or off an airport and on or off the mainland (eg several Island locations are possible). How might your potential solution differ, if at all, depending on each location option?

Q6) A significant amount of time is expected from operational concept to deployment. How long would you expect it to take from contract signature to a) final acceptance and b) initial operations considering the cases of: i) just one airport; and ii) deployment at all 11 airports?

Q7) A cost-benefit analysis forms part of the scoping study. Whilst we understand that costs cannot at this stage be specified in any detail, is there anything you can provide us that may help us to avoid over or under-estimating costs for the different models you are able to deliver in Q3) at the 7 ATC airports or 4 AFIS airports?

[29] http://www.hial.co.uk/hial/about-us/charges-opening-hours-and-pilots-information/
[30] 1:2 means one operator (ATCO or AFISO), two airports

I Agenda and topics for CAA consultation

This annex provides a copy of the detailed agenda and questions asked at Helios' meeting with eth CAA on 8th August 2017.

I.1 Agenda

ATM Strategy scoping study: CAA Meeting

Agenda

8th August 2017, CAA offices Stirling

The aim of the meeting is to cover questions around FAS, the implementation (likelihood, timescales) of EASA part-ATS, the future of ATS in class G and the regulatory views on Remote Towers.

A more specific, though flexible, agenda is provided below, with some of the key questions we hope to cover during the session.

1300-1315: Reminder of HIAL Air Traffic Management 2030 Strategy:

- How do you foresee ATSOCAS continuing into the future?
- What evidence is there for the safety of procedural control in uncontrolled airspace?
- How will the UK CAA regulations (eg SES, EASA) change after Brexit?
- How does HIAL Air Traffic Management 2030 Strategy align with Future Airspace Strategy?

1315:1415: EASA Part ATS:

- Where and when will EASA part ATS be implemented in UK aerodromes?
- Does part ATS imply controlled airspace for all HIAL airports?
- Will AFIS airports with commercial IFR traffic have to become ATC aerodromes?
- Does the introduction of controlled airspace necessitate surveillance (or an approach control service)?
- Under what conditions could an approach control service be provided from the tower?

1415-1500: Surveillance & Controlled airspace:

- Could MLAT only be used to provide an approach control service?
- What is the separation minima for a de-confliction service under a GNSS approach?
- If all 11 airports were to introduce some form of controlled airspace (eg due to part ATS) what would this be possible as a single airspace change proposal?

1500-1600: Remote Towers:

- What would be the process and timescales for approving a Remote Tower for i) a single aerodrome operations (1:1) and ii) multiple aerodrome operations (1:2)
- Will the CAA use existing safety documentation/guidance (eg from Sweden) or develop it's own?
- What additional mitigations do you foresee to compensate for removing ATS staff from the airport (eg in terms of MET observations etc)

J Agenda and topics for airline consultation

This annex provides a copy of the invitation and agenda send in advance of Helios' consultation with airlines on 10th August 2017.

J.1 Invitation

To: Airline operators using HIAL airports

Our ref: P2423C003jah

11th July, 2017

Dear Sir or Madam

Re Invitation to consultation event on 10th August for HIAL Strategy 2030 scoping study.

Helios, a UK-based Aviation consultancy, has been contracted by Highlands and Islands Airports Ltd (HIAL) to conduct an independent scoping study to assess HIAL's 'Air Traffic Management 2030 Strategy'. The strategy aims to deliver enhanced levels of safety, flexibility and sustainability to HIAL customers, reducing delays and cancellations whilst ensuring more environmentally friendly air navigation services.

The proposed strategy is comprised of the following four projects to meet this aim:

- Centralised surveillance centre to provide improved situational awareness to controllers and separation services (eg deconfliction) to aircraft
- Controlled airspace at ATC airports
- Remote Towers at some or all HIAL airports
- Out of Hours (OOH) AFIS Service, provided from a Remote Tower centre

As part of the scoping study, Helios is conducting consultations with relevant stakeholders to understand a wide range of viewpoints on each of the proposed projects, and the Strategy as a whole. To that end, we would like to invite you to a Consultation workshop for airline operators from 1300 - 1630 on 10th August, at the Holiday Inn at Glasgow airport.

The meeting will cover airline operator's experiences of the current Air Navigation Service provided by HIAL, and the benefits or concerns which arise from the suggested changes through the four above projects. This will feed into the scoping study assessment.

Based on the agenda and topics provided below, I would be grateful if you could please forward this invitation on to the relevant representatives within your organisation and ask them to confirm their attendance to the Helios project manager, [redacted], giving names and contact details of those attending.

J.2 Agenda

The agenda for the day is flexible and will be tailored to those airline operators attending, but we plan to step through the following topics and questions:

- Overview of HIAL's Strategy 2030 (Helios to provide a short presentation of the project and the drivers for change)

- Future Growth Plans (Helios to ask attendees questions such as, what are the desired/planned changes to traffic routes in Highlands and Islands?)
- Risks to operations (to discuss questions such as whether there are safety and commercial concerns in HIAL airspace?)
- Views on APP as a service (to capture views and opinions from the audience on operating in APP control)
- Differences per airport (To get airline operator views on the differences between airports, particularly regarding services – eg how AFIS differs from one AFIS location to another, how ATC services differ between ATC airports and how OOH differs)
- Specific views on each proposed project (i.e. to cover audience views on Centralised Surveillance, Controlled Airspace, Remote Towers, Out of Hours Service)
- Improvements to airspace and routes (To discuss airline operator preferences on airspace routes and procedures eg GNSS, procedural, visual approaches etc)
- General views of HIAL (To capture any additional thoughts from airline operators on how HIAL could improve operations?)

K Summary of Airline Meeting

As part of the Air Traffic Management 2030 Strategy scoping study, Helios met with representatives of 5 aircraft operators: AirTask, Bristow, Eastern Airways, Gama and Loganair on 10th August 2017. This annex provides a summary of the key outcomes of this meeting.

K.1 Attendance

Table 30 Airline meeting attendees

Company	Attendee	Role/Position
AirTask	[Redacted[1]]	[Redacted[1]]
Bristow	[Redacted[1]]	[Redacted[1]]
Eastern Airways	[Redacted[1]]	[Redacted[1]]
Gama	[Redacted[1]]	[Redacted[1]]
Loganair	[Redacted[1]]	[Redacted[1]]
Loganair	[Redacted[1]]	[Redacted[1]]
Loganair	[Redacted[1]]	[Redacted[1]]
Helios	[Redacted[1]]	[Redacted[1]]
Helios	[Redacted[1]]	[Redacted[1]]
Helios	[Redacted[1]]	[Redacted[1]]

K.2 Future Growth Plans

- With the exception that Air Ambulance demand was increasing due to an ageing population, there was a general consensus that very little passenger growth or more demand was foreseen for commercial flights to HIAL airports. Anecdotal evidence included references to BMI Regional being unable to fill aircraft even when offering passengers on the Stornoway-Edinburgh route seats for ~13GBP one way. Similarly, an attempt was made to connect Sumburgh with Stansted, but the demand did not materialise.
- A large number of the connections (the PSO routes) are highly dependent on subsidy and would not be able to continue without it.
- The only exception to this would be the areas in which demand is driven by the oil rigs, where an increase in demand may occur, but is difficult to predict.
- There could be a potential for Dundee to become a competitor to Edinburgh, but is currently too expensive and the runway is not long enough.

K.3 Reflections on the proposed projects (controlled airspace, surveillance and Remote Towers)

- The meeting highlighted that CAS would be welcomed, if it led to more efficient routes though current traffic density does not necessarily warrant the introduction of controlled airspace.
- Helicopter operators sought assurances that their special operations would not be affected by the introduction of CAS.

- Loganair recommended the introduction of an RMZ to ensure that all users are heard on the same frequency.
- The participants agreed that many non-regional pilots are not familiar with the rules of procedural control in uncontrolled airspace and are often not trained appropriately to operate in it. In uncontrolled airspace, you need to have a different mind-set of being more pro-active and listening to what is being said over the radio. The lack of familiarity of some pilots with this environment commonly results in confusion which may lead to mistakes.
- Insurance premiums did not seem to be a factor in the discussion on CAS and surveillance.
- The meeting participants were receptive to the idea of Remote Towers, but were concerned with the resilience of the infrastructure (especially communications and power) as well as the ability to, for example, notice runway infringements of operating vehicles. It was noted that appropriate contingency arrangements would be required.
- There was a long discussion on GNSS and the willingness to adopt it. Airlines believe that the majority of aircraft frames will be appropriately equipped by 2020 and that it would be worth investing in the technology given how many benefits may be generated by it.
- It was noted however, that GNSS jamming remains an issue and needs to be addressed by the CAA or the DfT. Similarly, some issues relating to intersecting GNSS routes at different airfields were raised.

K.4 Other views

- There was a general view that HIAL passenger charges were high (eg ~17GBP compared to ~11GBP in Glasgow Airport).
- Some attendees had a view that the procedural deconfliction eg at Wick was somewhat inefficient causing unreasonable additional flying time.
- A note was made that nearly all operators are equipped with Mode S/ADS-B and there was encouragement for HIAL to making use of this.
- There was a feeling that in some cases HIAL was too risk averse, for example aircraft being certified to land in 4mm of snow, but the runway being shut for clearing with just 1mm of snow. The meeting also discussed concerns as to why the Inverness ILS was turned off at night.

L Summary of RAF Meeting

As part of the Air Traffic Management 2030 Strategy scoping study, Helios spoke with RAF representatives on 20th October 2017. This annex provides a summary of the key outcomes of this meeting.

L.1 Attendance

Table 31: RAF meeting attendees

Company	Attendee	Role/Position
RAF	[Redacted[1]]	[Redacted[1]]
RAF	[Redacted[1]]	[Redacted[1]]
RAF	[Redacted[1]]	[Redacted[1]]
Helios	[Redacted[1]]	[Redacted[1]]
Helios	[Redacted[1]]	[Redacted[1]]
Helios	[Redacted[1]]	[Redacted[1]]

L.2 Opinions regarding the key strategy components

L.2.1 Controlled airspace

The RAF is aware of the upcoming EASA Part-ATS changes, but has not been involved in any discussions with the CAA yet. Most importantly, they have not heard anything with regards to the timelines, but do not believe 2020 is a feasible deadline for the introduction of CAS. Mid-2020 is seen as a more realistic deadline.

RAF expects part-ATS to result in the creation of class D airspace (potentially E in the close vicinity to the aerodrome) and expects the DfT to be involved in supporting the change process.

The RAF have also pointed out that currently Wick does not have a defined airspace boundary which my result in the Wick controllers being unaware of traffic in the vicinity of the procedural approach path. A creation of CAS at Wick would solve this issue and protect the approach path, but may also result in a channelling of traffic along the airspace boundary, creating a safety hazard there.

The RAF agrees with the opinion that a proportion of foreign crew is often unfamiliar with the specificities of operations within the UK airspace.

L.2.2 Surveillance infrastructure

The RAF expressed a concern that the level of surveillance will not be sufficient for the service provided (i.e. that the lack of a primary radar may be problematic).

L.2.3 Remote Towers

No concerns or comments were raised with regards to remote towers.

L.2.4 Out of Hours

The RAF expressed a concern that controlled airspace would be established but a sufficient workforce would not be available to keep this airspace open.

On the other hand, the RAF would welcome a full OOH service enabling them to use Inverness as the diversion airfield. Currently, the Leuchars airbase is used as the diversion airfield at night, but an airfield in a closer proximity to Lossiemouth would be preferred from an operational point of view.

L.3 Other upcoming changes

L.3.1 New aircraft

The RAF is also waiting for the delivery of the new P8 aircraft, which will be based in Lossiemouth. These aircraft will result in a significant amount of training within the RAF, as their operations are significantly different to that carried out by the existing aircraft. This may also affect HIAL, as the new aircraft will also operate in their airspace.

The RAF also expects the traffic density to increase in the coming years.

L.3.2 Wind farms

A large windfarm is being built between Lossiemouth and Wick, which will result in significant radar interference problems. As a result, the RAF is carrying out a radar upgrade, but will also be implementing a TMZ in the area.

During the radar upgrade the RAF will be using the radar feed from Inverness.

L.4 Supplementary information

- The controllers based in Lossiemouth do not have sufficient coverage to see a full traffic situation at Wick, but a good working relationship is in place to ensure safe operations.
- A good working relationship is also established with Inverness.
- RAF is currently implementing Project Marshall- centralising approach service, and enabling one controller to manage approach to multiple aerodromes are the same time.
- RAF would like to be involved in the change process.

M High level Operational Risk Assessment

M.1 Introduction

M.1.1 Purpose and overview

This high-level Operational Risk Assessment forms part of Helios' Scoping Study for Highland and Islands Airports Ltd. (HIAL) ATM Strategy 2030.

Risk Assessment is one of three streams of work in the scoping study, intended to identify operational and business risk which may arise from the four proposed projects under the strategy, namely:

- Controlled airspace
- Surveillance centre
- Remote Towers
- Centralised out of hours (OOH) AFISO service - The OOH service is considered within this analysis as part of the Remote Tower project.

This annex represents the outputs of the risk assessment. It focuses on **operational** safety risk, arising from the provision of the Air Traffic Services to airspace users. Business, programmatic and transition risks are considered separately, though where issues were identified during operational discussions they have also been reflected at the end of this annex. The document takes the form of a high level, operational hazard log. Conclusions from the analysis presented in this document have been integrated into the final report of the scoping study. Where assumptions have been made, these have been identified.

This document is only a high level consideration of the safety impact of the various elements of the Air Traffic Management 2030 Strategy and not a detailed consideration of the change or the impact on individual airports or operations. It is certainly not a regulatory hazard log or safety case for the changes, per CAA CAP 760. It is solely used as an input to the scoping study.

M.1.2 Methodology

The methodology employed is fully aligned with HIAL's Safety Management System (SMS)[31], in particular using the severity/consequences and likelihood definitions and the risk matrices and risk ratings as per pages 46-55 of the SMS.

An operational hazard identification meeting (HAZID) session was held in Inverness on 27th June 2017, including both HIAL management and operational staff from a representative spread of HIAL airports (for detailed participation, see below). The aim of the workshop was to discuss the operational changes which arise from the proposed Strategy 2030 projects, and consider safety benefits and risks for each of the four projects.

The safety benefits section of the workshop identified current risks which are mitigated by the introduction of centralised surveillance, controlled airspace and Remote Towers (ie the Air Traffic Management 2030 Strategy). These benefits are summarised in section M.2.1. The perceived benefits derived from the workshop are then compared to previous

[31] CORP001 – HIAL Group Safety Management System Safety Manual

incidents, to consider whether Strategy 2030 would have mitigated their occurrence, presented in section M.2.4.

New or evolving hazards (and associated risks) arising from the potential ATM Strategy 2030 changes are captured in the Hazard log in section M.3. This was populated during the workshop, with substantial edits made through a review process, and identified the following areas:

1. **Scenario** – An operational or technical situation which is affected by the change
2. **Hazard** – A hazardous event which could result from the scenario
3. **Mitigation** – The barriers which are in place to mitigate the effect of the hazard
4. **Operational Consequence** – The worst credible operational consequence of the hazard
5. **Severity** – assign a severity to the hazard, based on HIAL’s risk classification scheme
6. **Likelihood** – An estimate of how likely the hazard would occur

The severity and likelihood are analysed through HIAL’s Risk Matrix to define the Risk Rating for each Hazard, through a traffic light system from low (green), medium (amber) and high (red).

Scenarios were identified considering the services provided within the scope of each project, ie:

1. Surveillance Centre
   a) Radar (surveillance) approach service
   b) Traffic, de-confliction service
   c) Procedural approach service (as backup)
   d) Aerodrome/tower service

2. Controlled Airspace
   a) Procedural approach service
   b) Radar (surveillance) approach service
   c) Aerodrome/tower service

3. Remote Tower
   a) Aerodrome/tower service
   b) AFIS (Including out of hours)

M.1.3 HAZID Agenda

The agenda of the hazard identification meeting was as follows:

1100: Introductions and Overview

1130: Description of the change for each project:

- Define what we're certain about
- Define what might change as the projects develop

1200: Current risks mitigated by each project in ATM Strategy 2030

1230: Risks introduced by each project in ATM Strategy 2030

1300: Lunch

1400: Continuation of risk assessment

1500: Differences per option

1600: Conclusions and close

M.1.4 Participation

Participation in the meeting is presented in Table 32.

Table 32 Strategy 2030 HAZID participation

Name	Organisation	Role
[Redacted[1]]	HIAL	SATCO, Sumburgh
[Redacted[1]]	HIAL	SATCO, Kirkwall Airport
[Redacted[1]]	HIAL	SATCO, Wick
[Redacted[1]]	HIAL	Deputy General Manager ATS
[Redacted[1]]	HIAL	AFIS/Met Advisor, Campbeltown Airport
[Redacted[1]]	HIAL	ATCO, Benbecula
[Redacted[1]]	HIAL	ATCO (radar controller), Inverness
[Redacted[1]]	HIAL	SATCO, Stornoway Airport
[Redacted[1]]	HIAL	SATCO, Dundee
[Redacted[1]]	HIAL	Manager ATS, Inverness Airport
[Redacted[1]]	Helios	[Redacted[1]]
[Redacted[1]]	Helios	[Redacted[1]]

M.2 Safety Benefits of Strategy 2030 projects

M.2.1 Brainstorm: Current risks mitigated by a Surveillance Centre

Table 33 Current risks mitigated with surveillance centre

[Redacted[4]]

M.2.2 Brainstorm: Current risks mitigated by Controlled Airspace

Table 34 Current risks mitigated with controlled airspace

[Redacted[4]]

M.2.3 Brainstorm: Current risks mitigated by Remote Towers (and OOH Service)

Table 35 Current risks mitigated with Remote Towers and OOH service

[Redacted[4]]

M.2.4 Impact of Air Traffic Management 2030 Strategy on causal factors of previous incidents

The projects of Centralised Surveillance and Controlled Airspace, when considered together, will increase the situational awareness of the ATCO and ensure a known environment, giving clear safety benefits. Considering the incidents which have been reported over the past 5 years (since 2012), and the benefits presented in section M.2.1, the ATM Strategy 2030 would provide significant mitigation to prevent similar incidents in future. Full explanation of the incidents is provided in the individual incident reports and only summaries are reflected below in Table 36.

Many of these incidents could have been mitigated by the introduction of Surveillance and Controlled Airspace. The introduction of surveillance and controlled airspace could therefore potentially improve safety. Highlighted in green are those incidents that are likely to have been mitigated by the ATM 2030 strategic projects. Those that are not green would be unaffected or the potential to mitigate cannot be determined.

Table 36 Future mitigation of Strategy 2030 projects based on past incidents

[Redacted[4]]

M.3 Operational Hazard Log

M.3.1 Brainstorm: risks introduced by a Surveillance Centre

Note: the worst credible consequence (and thus severity and likelihood) presented, are with the barriers in place, ie post-mitigation.

Table 37 Risks Introduced through surveillance centre

[Redacted[4]]

M.3.2 Brainstorm: risks introduced by Controlled Airspace

Table 38 Risks introduced through controlled airspace

[Redacted[4]]

M.3.3 Brainstorm: risks introduced by Remote Towers (and OOH Service)

Note: assumption taken that remote surveillance centre and CAS have been implemented and RTs have EFPS

Table 39 Risks introduced through Remote Towers

[Redacted[4]]

M.4 Brainstorm: other (non-operational) risks introduced

The risks below represent ***some*** of the non-operational risks (eg business continuity risks) that were identified during the operational assessment. These were not dealt with in any detail during the workshop (in order to instead focus on the operational risks) and so no credibility or likelihood has been assigned, but the hazard and barrier has been captured below for the record.

These hazards would generally be known about well before any operational impact and are more likely to impact on the business.

Table 40 Some of the non-operational risks of Air Traffic Management 2030 Strategy, as identified during the operational workshop

Scenario	Hazard	Barriers	Worst Credible Consequence
Service outsourced (eg APS)	Losing staff prior to successful changeover.	Change Management Strategy, Incentive schemes, Communication, HR Policies,	Airport Closures
	Losing staff prior to successful changeover.	Change Management Strategy. Incentives scheme, Communication	Airport Closures
Combined ADI/APS (single controller)	Failure to gain approval (eg lack of regulation, or enough staff validating on APS)	Change Management Strategy. Training, licensing and competence schemes.	Airport Closures
Splitting ADI/APP (ADI/APS colocation in tower)	Insufficient staffing or transition plan	Change Management Strategy. Training, licensing and competence schemes.	Airport Closures
Introduction of CTR and CTA	More prohibitive MET conditions for GA under CAP 493 MATS Part 1.	Exceptions for emergency services	Reduced business opportunity

N Modelling the cost and benefits

Costs and benefits of each option have been determined through a Cost Benefit Analysis (CBA), as described below.

N.1 Approach

We followed a best practice approach to building the CBA model that involved:

- Establishing the scope of the model: what it does and does not do; the outputs of the model;
- Developing and recording all the model assumptions and key functional relationships;
- Following a logical model flow, separating areas of data entry, calculations and outputs;
- Identifying and communicate data input requirements, their sources and timescales for delivery;
- Building the model and populating it with data;
- Validating the logical flow of the model and data;
- Testing and implementing required changes.

This approach enabled us to deliver a model that has the flexibility to generate the required outputs, carry out testing of 'what-ifs', and is robust with reduced risk of errors.

N.2 Scope of the Analysis

The aim of the CBA is to account for cost changes resulting from the implementation of each of the options (described in section 4). All costs are compared against the baseline: the analysis does not capture the entire HIAL cost base, it only captures the relative differences between the possible options. We assume that all other conditions remain constant, hence an analysis of the differences between the options is sufficient to make an informed decision on which option is most preferable from a financial point of view.

As under all options no changes are expected in the AFIS units, the costs related to the running of those units has been excluded from the analysis.

The structure of the HIAL CBA model below (Figure 81) breaks down the costs and benefits that have been captured. Please note, not all cost streams are relevant to each of the options. The model is inclusive of building, system and staff costs such as employment, training and relocation costs.

It should also be noted that there are a number of important benefits in the decision making process which cannot be monetised therefore not quantifiably captured in the model. These benefits include increased safety, future proofing and increased staff satisfaction and are captured qualitatively in section 6.

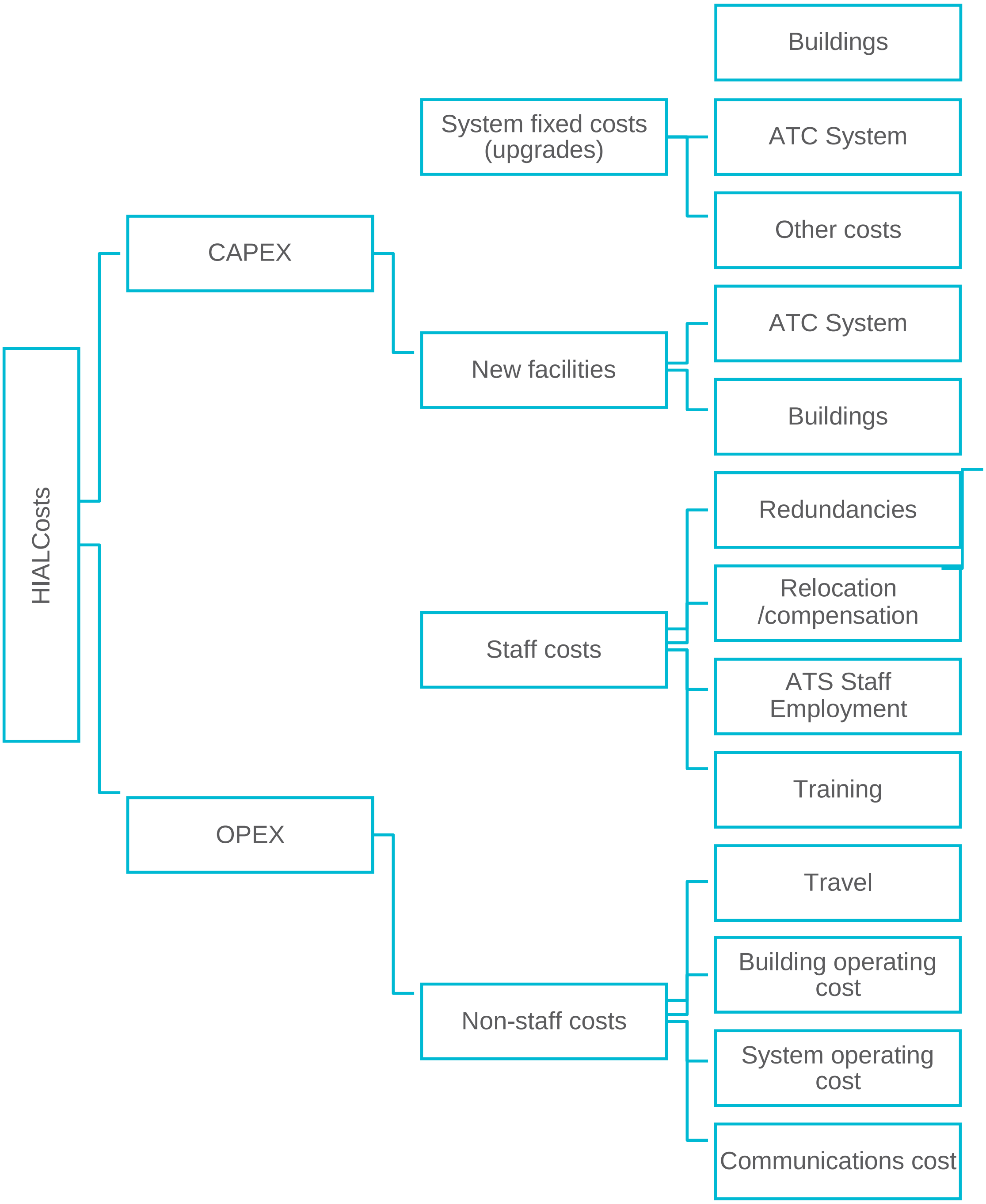

Figure 81 Diagram showing the breakdown of the HIAL CBA Model

We exclude items which we expect will remain unchanged across options. This includes, but is not limited to: airport infrastructure such as radars, ILS', VORs.

N.2.1 Sensitivity Analysis

As the model was based on a number of assumptions and forecasts, there was value in assessing by how much the indicators would change as a result of a change in the inputs. To accommodate this, we carried out a range of sensitivity analyses, which included the assessment of the impact of a change in the following elements on the output of the CBA:

- Discount rate used;
- CBA timespan.

N.3 Outputs of the CBA

The investment appraisal constitutes an assessment of the investment required by HIAL in each option under analysis. A range of investment indicators have been used to provide HIAL with the most robust overview of the upgrade options as possible.

For all defined options, we will provide the following indicators, which will allow HIAL to make an informed investment decision:

- The net present value of cost:
  - This uses the relevant net cash flows generated by an upgrade option as a way to capture the net cost of a particular option (in comparison to the cost of the baseline option).
  - The present value of cost takes into account the time value of money and hence future cash flows will be discounted to reflect the investment return expected by HIAL's shareholders.
- Internal Rate of Return:
  - This technique calculates the interest rate at which the net present value of all the cash flows from a project or investment equal zero. This will provide an additional way in which to evaluate the attractiveness of an option.
  - Payback period & breakeven year: This indicator captures the length of time it takes for a given investment portfolio in the chosen option to be paid back and provides an indication in which year the benefit starts to be accrued.

O Assumptions

This annex provides an overview an explanation of all the assumptions and information used when creating the CBA model. This annex presents the assumptions in the following order:

- Key parameters,
- Airport order of implementation;
- Building costs;
- ATE Contract;
- Surveillance infrastructure costs;
- Remote Tower costs;
- ATS Staffing requirements.

O.1 Key parameters

Table 41 Key CBA model parameters

Parameter	Area
CBA Overall Timeline	The modelling captures the relevant expenditure that applies to each option in years 2018 – 2032 (15 years).
Capital Expenditure Payments over years	The CBA Model accounts for the fact that the payments for capex expenditures are spread out over a period of time. It has been assumed that all capital expenditure is paid for over a course of three or four years, depending on the investment size. In each case, the total payment is split equally across the given number of years.
Currency and exchange rate	The modelling has been conducted in British pounds. When cost estimates have been provided in Euros (eg from system suppliers), an exchange rate of 1.13 EUR per GBP was assumed [112].
Inflation	In line with the average inflation observed by Scotland in the past 5 years forecasts we have applied a 1.5% inflation to all of the expenditure [109].
Discount rate	The discount rate used in the model is a nominal discount rate, it accounts for time value of money, risk premium, and inflation. In line with the recommendation put forward by Eurocontrol [110], we have assumed a real discount rate of 4%, supplemented by an inflation correction of 1.5%. We have used the discount rate to correctly account for the opportunity cost related to the investment.
Capital Expenditure Overarching Assumptions	The following key assumptions have been made: • All capital costs are inclusive of all installation costs; • Building costs are assumed to include the furniture and fittings cost, but not equipment costs.
Operating expenditure overarching assumptions	In rare cases where we have been unable to estimate more accurate operating costs of ATS infrastructure, we have assumed that the operating cost are ~12% of the upfront capital expenditure. This is derived from ACE 2014 data which shows that, across Europe, the (non-staff) operating costs of capital assets for Terminal ATS are ~12% of their initial value. It assumes that the costs reported by all European ANSPs in 2014 are representative of an “average year” and that on average these assets are depreciated over a 15 year period.

O.2 Airport order of Implementation

The development of a detailed and accurate implementation plan is an important activity to undertake once a decision is taken by HIAL on the way forward following this feasibility and scoping study. We have nevertheless proposed in section 7.5 an initial and high-level implementation plan, using reasonable assumptions and based on information available at the time. Below we present the order of implementation of each option at each airport on which the implementation plan in section 7.5 is based.

Changing the proposed order in which the changes at each airport are implemented may not necessarily impact significantly on the financial case but it could be crucial from a strategic perspective, recognising the following influencing factors:

- Information obtained directly from the units (see annex B.1), for example the likely procurement lifecycle at each facility;
- Ease of transition;
- Communications technical challenge for each location;
- Human resource management issues;
- Traffic volume (see Figure 82) and complexity. The lower the traffic and complexity, the simpler the operational transition and lower the risk.

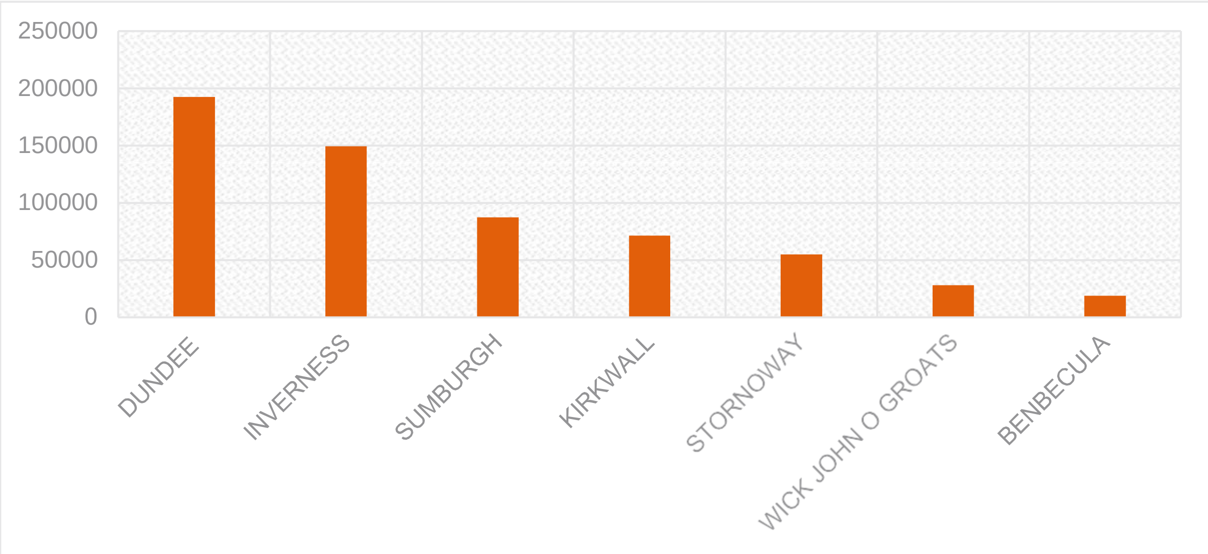

Figure 82 Total number of movements (2012-2016)

O.2.1 MLAT "Lite" Implementation Plan (Option 1b only)

In option 1b we have assumed that the procurement of the ATM and MLAT systems will commence in Dundee, building on the experience with the current trial system (due to be returned to the vendor in April 2018). We have assumed that only one airport would be equipped in the first year, to allow for the additional managerial and procurement effort that will be required.

The implementation would then be followed by Benbecula, where the traffic is lowest, giving the most straightforward path for HIAL to develop a safety and regulatory case for the use of an "MLAT Lite" system for the purpose of an ATM. In the same year, Stornoway would be equipped with the system, as it is in close geographical proximity which may allow for coverage efficiencies to be gained. We believe that following the first implementation in Dundee, HIAL would have the managerial capability to procure and implement the system at two airports in one year. In the following year Wick and Kirkwall are assumed to be equipped.

Sumburgh and Inverness already have appropriate surveillance information, hence no investment in MLAT "Lite" equipment is expected at these airports in option 1B.

Allowing for the time for specification and procurement, we have assumed that the first implementation will take place by the end of 2019, with all airports being equipped by the end of 2021. There could be some slippage in the date of initial operations if HIAL were to decide on a single procurement for the five airports (to account for a longer time for specification and procurement) but we would expect a more efficient installation timeframe in this case and for the 2021 date to remain valid.

The assumed implementation timeline for option 1b is presented below in Figure 83.

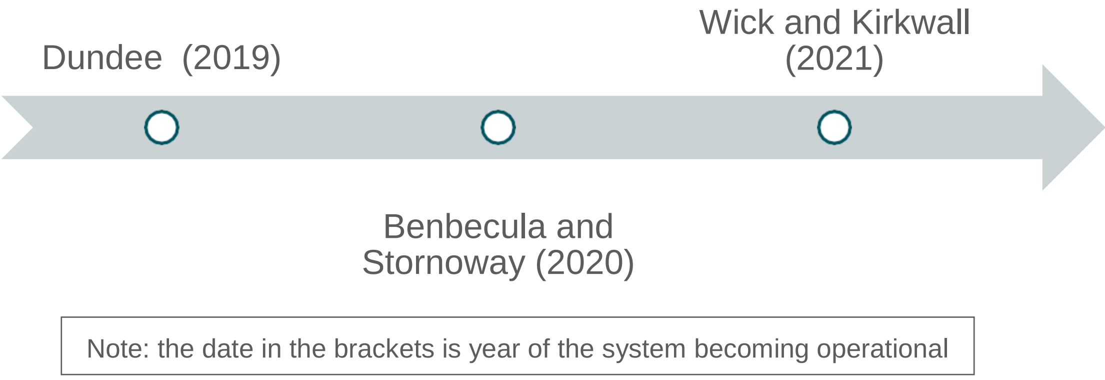

Figure 83 Option 1b ATM implementation plan

O.2.2 WAM System Implementation Plan (option 2b, 2c and 3)

In options 2b, 2c and 3 WAM surveillance has been assumed to be implemented across HIAL ATC airports in the following order:

1. Benbecula first, due to the low traffic levels and simple traffic flows, allowing for a more straightforward implementation and safety case development. This would allow the Project Team to gain experience before proceeding with implementations in more complex operational environments.
2. Stornoway, due to the physical proximity to Benbecula, which allows for coverage efficiencies to be made and the potential to combine the approach sector with Benbecula.
3. Wick, due to a low traffic level, that will make the implementation, safety case and regulatory approval more straightforward.
4. Kirkwall, as it has higher traffic than the preceding airports and therefore may be more complex to implement and will benefit from the lessons learned in the prior implementations.
5. Dundee is a more complex and challenging environment, for both surveillance and CAS implementation than some earlier airports and therefore is suggested to come later in the order. However we also recognise that commercial airline interests and prior experience with the MLAT-lite implementation could make this a good candidate for tackling it earlier in the implementation order.
6. Sumburgh will not be equipped with WAM in option 2b, as we assume the existing surveillance arrangements are sufficient. In options 2c and 3 however, we assume that it would be beneficial to centralise the Sumburgh APS provision, hence in these options an investment in MLAT is assumed with a corresponding termination of the current radar feed and APS contract with NATS.
7. Inverness is the only airport with surveillance infrastructure owned and operated by HIAL, hence an investment in MLAT need only be considered when existing surveillance infrastructure (PSR and SSR) reaches end of life. In option 2b the

existing arrangements will remain, but in options 2c and 3 it is assumed that by 2025 the CWPs will be moved to the central facility to allow for rostering efficiencies. The PSR and SSR radar is expected to undergo a hardware upgrade around 2020 and could subsequently be replaced by an MLAT system (eg 2035), subject to an impact assessment (eg on military operations). *Please note that the Inverness SSR/PSR/MLAT investment is not accounted for as it is outside of the scope of the analysis and independent of the options. We have only accounted for the centralisation of the controller working positions, which is a differentiating factor between the options.*

In all WAM implementation options (option 2b, 2c and 3) we expect the first implementation will be completed in 2021 allowing for sufficient time for procurement and safety approval. We are assuming that one sector will be equipped per year. The assumed implementation timelines are presented below in:

- Figure 84 for the WAM implementation in the de-centralised option 2b, and;
- Figure 85 for the WAM implementation in the centralised facility for options 2c and 3.

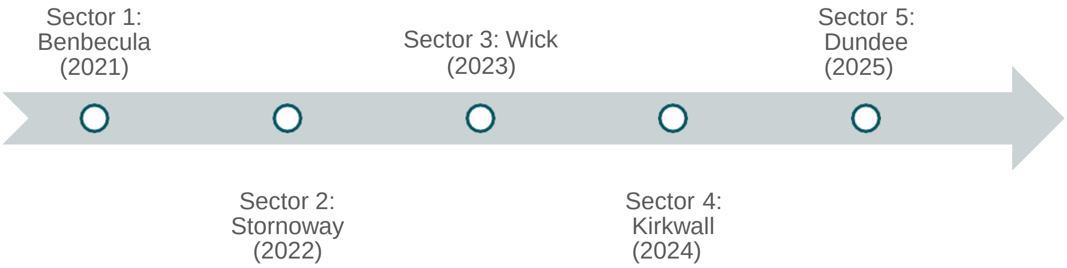

Figure 84 Option 2b surveillance implementation plan

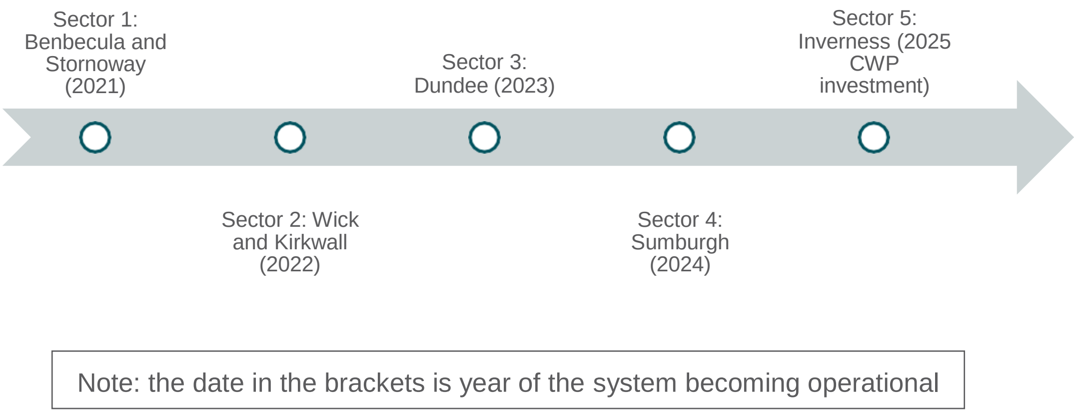

Figure 85 Option 2c and 3 surveillance implementation plan

O.2.3 Remote Tower Implementation Plan (Option 3 only)

Airports with low traffic volume are assumed to be operated in a multi-mode configuration (2 airports operated by one ATCO). Whilst work in the industry is ongoing to prove and demonstrate the feasibility of such a concept, we believe this is a reasonable assumption considering the relatively low traffic volumes and sufficient time to implement. More details of the multi-mode concept are provided in Annex G.1. Whilst a full analysis of scheduling and operational impact should be undertaken to determine the best combination on each multi-mode concept, we have assumed that Benbecula and Stornoway could be operated from one position and Wick and Kirkwall from another for certain low traffic periods of the day. These airports have been clustered into pairs due to a geographical proximity and also on the basis of combining one airport with very low movements (Wick, Benbecula) with an airport with slightly more movements (Stornoway, Kirkwall). The same sectorisation as with the APS will also ensure that the APS ATCO can ensure that traffic is adequately sequenced to be managed by an ADI ATCO in a multi-mode configuration.

Due to a high volume of traffic and high operational complexity we have conservatively assumed that in the coming 15 years Sumburgh, Inverness and Dundee will still be operated in single mode only (one airport operated by one ATCO).

The order in which the implementation is expected to be undertaken is identical as in the case of WAM implementation (see O.2.2 for more information on the reasoning). We have assumed that the first implementation will take place in 2021 (allowing 3-4 years for planning, procurement and implementation activities). Benbecula, Stornoway, Wick and Kirkwall will first be implemented in single-mode and then moved to a multi-mode operation. We have conservatively assumed that Benbecula and Stornoway will operate in multi-mode full time, but Wick and Kirkwall will only operate in multi-mode in off-peak hours only (weekends, mornings and evenings, dependent on the schedule).

The detailed assumed implementation schedule is presented in Figure 86.

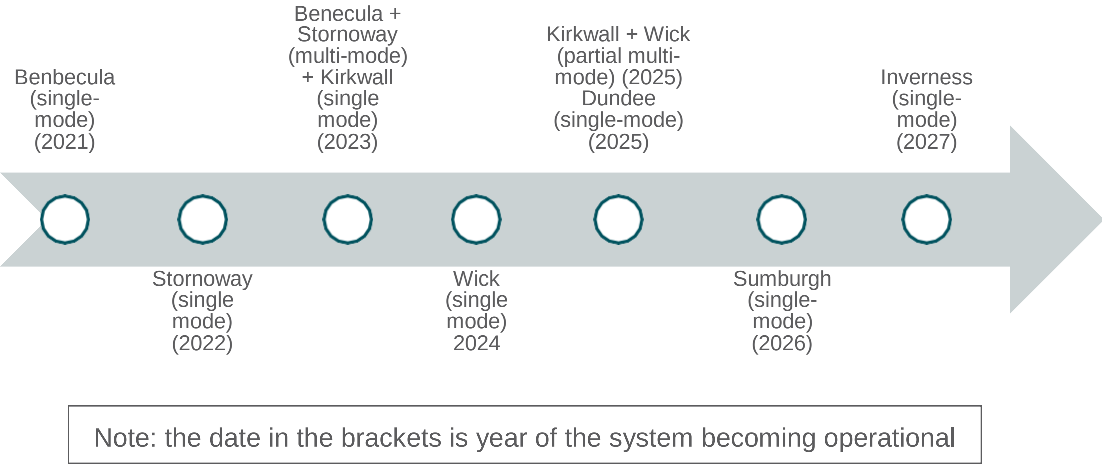

Figure 86 Option 3 Remote Tower implementation plan

O.3 Buildings

The expected rough-order-of- magnitude assumptions relating to building costs of each options are presented in the table below. These include:

- Direct costs, for example to construct or replace assets. Note that we have provided construction costs, but – particularly in the case of a new centralised facility, renting may also be an option to look into that may introduce cost savings (or at the very least spread costs)
- Costs related to management, procurement etc. Note that maintenance and refurbishment of existing towers is mostly assumed to be absorbed within the capacity of HIAL's existing staff. Effort related to larger projects such as procurement of towers or building construction has however been identified as additional resource. We expect this effort to be undertaken by Head Office staff, potentially supported by external consultancies, depending on the number of parallel projects being undertaken.

Table 42 Building refurbishment and redecoration costs

	1b	2b	2c	3	Item	Year	Cost estimate	Management and Procurement support required	Source
Benbecula Tower	✓	✓	✓		Refurbishment	2019-2022	- UPS (£22K) - AGL control desk (£15K) Total: £37K	0.25 FTE for 2 years	HIAL input, inclusive of the optimism bias factor and extrapolated from 2030 to cover all years up to 2032 [17].
					Redecoration	2020, 2025 and 2030	£23K	N/A	
					Reconstruction	around 2030	£2,737K	3.0 FTE for 3 years (large investment complexity)	
					Maintenance	Annual	£155K	N/A	
		✓			Building extension	As per O.2.1	£80K	1 FTE for 1 year	Helios' market research shows that at the time of writing office space in the Highlands and Islands can be purchased for approximately £3K per sqm. HIAL [6] notes that the costs observed during the construction of Inverness tower were approximately £5.4K per sqm. In the analysis as a mid-point we have assumed that a building extension would cost £4k per sqm. This extension is assumed to be approx. 20sqm.

	1b	2b	2c	3	Item	Year	Cost estimate	Management and Procurement support required	Source
Dundee Tower	✓	✓	✓		Refurbishment	2020-2024	- Recladding (£734K) - VCR glazing (£76K) - Electrical distribution (£68K) - Foul drainage (£15K) - HVAC (£21K) - UPS (£10K) - AGL control desk (£15K) Total: £939K	0.5 FTE for 2 years (large investment complexity)	HIAL input inclusive of the optimism bias factor and extrapolated from 2030 to cover all years up to 2032 [17].
					Redecoration	2020, 2025 and 2030	£19K	N/A	
					Maintenance	Annual	£82K	N/A	
		✓			Building extension	As per O.2.1	£80K	1 FTE for 1 year	Helios' market research shows that at the time of writing office space in the Highlands and Islands can be purchased for approximately £3K per sqm. HIAL [6] notes that the costs observed during the construction of Inverness tower were approximately £5.4K per sqm. In the analysis as a mid-point we have assumed that a building extension would cost £4k per sqm. This extension is assumed to be approx. 20sqm.

	1b	2b	2c	3	Item	Year	Cost estimate	Management and Procurement support required	Source
Inverness Tower	✓	✓	✓		Refurbishment	2020-2024	- Recladding (£1,592K) - VCR glazing (£151K) - Electrical distribution (£76K) - UPS (£38K) - AGL control desk (£18K) Total: £1,874K	0.5 FTE for 2 years (large investment complexity)	HIAL input inclusive of the optimism bias factor and extrapolated from 2030 to cover all years up to 2032 [17].
						2029	HVAC (£21K)	0.25 FTE for 2 years	
					Redecoration	2020, 2025 and 2030	£23K	N/A	
					Maintenance	Annual	£178K	N/A	

	1b	2b	2c	3	Item	Year	Cost estimate	Management and Procurement support required	Source
Kirkwall Tower	✓	✓	✓		Refurbishment	2020-2024	- Electrical distribution (£60K) - Foul drainage (£15K) - HVAC (£21K) - UPS (£22K) - AGL control desk (£15K) Total: £134K	0.25 FTE for 2 years	HIAL input inclusive of the optimism bias factor and extrapolated from 2030 to cover all years up to 2032 [17].
						2028	Recladding (£626K)	0.5 FTE for 2 years (large investment complexity)	
					Redecoration	years 2023, 2028 and 2033	£12K	N/A	
					Maintenance	Annual	£127K	N/A	
		✓			Building extension	As per O.2.1	£80K	1 FTE for 1 year	Helios' market research shows that at the time of writing office space in the Highlands and Islands can be purchased for approximately £3K per sqm. HIAL [6] notes that the costs observed during the construction of Inverness tower were approximately £5.4K per sqm. In the analysis as a mid-point we have assumed that a building extension would cost £4k per sqm. This extension is assumed to be approx. 20sqm.

	1b	2b	2c	3	Item	Year	-	Cost estimate	Management and Procurement support required	Source
Stornoway Tower	✓	✓	✓		Refurbishment	2020-2024		- Recladding (£174K) - VCR glazing (£76K) - Electrical distribution (£60K) - Foul drainage (£15K) - HVAC (£21K) - UPS (£23K) - AGL control desk (£15K) Total: £384K	0.25 FTE for 2 years	HIAL input inclusive of the optimism bias factor and extrapolated from 2030 to cover all years up to 2032 [17].
					Redecoration	2020, 2025 and 2030	£15K		N/A	
					Maintenance	Annual	£140K			
		✓			Building extension	As per O.2.1	£80K		1 FTE for 1 year	Helios' market research shows that at the time of writing office space in the Highlands and Islands can be purchased for approximately £3K per sqm. HIAL [6] notes that the costs observed during the construction of Inverness tower were approximately £5.4K per sqm. In the analysis as a mid-point we have assumed that a building extension would cost £4k per sqm. This extension is assumed to be approx. 20sqm.

	1b	2b	2c	3	Item	Year	Cost estimate	Management and Procurement support required	Source
Sumburgh Tower	✓	✓	✓		Refurbishment	2025-2027	- Recladding (£174K) - UPS (£23K) Total: £197K	0.25 FTE for 2 years	HIAL input inclusive of the optimism bias factor and extrapolated from 2030 to cover all years up to 2032 [17].
					Redecoration	2020, 2025 and 2030	£7K	N/A	
					Maintenance	Annual	£47K	N/A	

	1b	2b	2c	3	Item	Year	- Cost estimate	Management and Procurement support required	Source
Wick Tower	✓	✓	✓		Refurbishment	2019-2023	- Recladding (£44K) - VCR glazing (£76K) - Electrical distribution (£60K) - HVAC (£21K) - UPS (£23K) - AGL control desk (£15K) Total: £239K	0.25 FTE for 2 years	HIAL input inclusive of the optimism bias factor and extrapolated from 2030 to cover all years up to 2032 [17].
					Redecoration	2020, 2025 and 2030	£2K	N/A	
					Maintenance	Annual	£11K		
		✓			Building extension	As per O.2.1	£80K	1 FTE for 1 year	Helios' market research shows that at the time of writing office space in the Highlands and Islands can be purchased for approximately £3K per sqm. HIAL [6] notes that the costs observed during the construction of Inverness tower were approximately £5.4K per sqm. In the analysis as a mid-point we have assumed that a building extension would cost £4k per sqm. This extension is assumed to be approx. 20sqm.

	1b	2b	2c	3	Item	Year	Cost estimate	Management and Procurement support required	Source
Centralised Facility Location			✓		“Small” Centralised Facility (For APS only) construction	As per O.2.2	£1,600K	2.5 FTE for 3 years (due to large investment and complexity size)	Helios’ market research shows that at the time of writing office space in the Highlands and Islands can be purchased for approximately £3K per sqm – this aligns with the costs of remote centres in Sweden. HIAL [6] notes that the costs observed during the construction of Inverness tower were approximately £5.4K per sqm. In the analysis as a mid-point we have assumed that a new building would cost £4k per sqm. A “small” centralised facility is assumed to require: - 100 sq m for the APS ops room - 200 sq m for break rooms, kitchens offices and training facilities - 100 sq for the equipment room 400 sq m in total
			✓		“Small” Centralised Facility running cost		£389K per annum	N/A	In line with a market research carried out by JLL [115], we have assumed that the average cost of running a building is equal to £7.3 per sq ft.

1b	2b	2c	3	Item	Year	Cost estimate	Management and Procurement support required	Source
			✓	"Large" Centralised Facility (For APS and RT) construction	As per O.2.3	£3,000K	3.0 FTE for 3 years (due to large investment and complexity size)	Helios' market research shows that at the time of writing office space in the Highlands and Islands can be purchased for approximately £3K per sqm. HIAL [6] notes that the costs observed during the construction of Inverness tower were approximately £5.4K per sqm. In the analysis as a mid-point we have assumed that a new building would cost £4k per sqm. A "large" centralised facility is assumed to require: - 300 sq m for the APS ops room - 300 sq m for break rooms, kitchens offices and training facilities - 150 sq for ancillary: reception, toilets etc. 750 sq m in total
			✓	"Large" Centralised Facility running cost		£59K	N/A	In line with a market research carried out by JLL [115], we have assumed that the average cost of running a building is equal to £7.3 per sq ft.

O.4 ATE Contract

NATS, through a direct contract with HIAL, is responsible for Air Traffic Engineering (ATE) i.e. the maintenance of a wide range of ATC equipment for HIAL. This maintenance contract covers a number of systems which will not be affected by the implementation of the options in questions. This includes high-cost infrastructure such as VORs, DMEs, systems and ILS'.

An analysis of the planned ATE upgrades (Based on document ATE Replacement Plan September 2016) showed that between 2016 and 2022:

- The total ATE replacement cost (excluding hardware) will be equal to £9,591K
- Of this, we have determined that only approximately £401K (4.2%) is related to systems and infrastructure that will be affected by the options.

In line with the analysis above, we have assumed that the implementation of option 3 (where local towers are no longer required for ADI) results in a 4.2% decrease in the ATE cost.

O.5 Surveillance infrastructure

Element group	Option/Airport	Element	Cost	Cost recurrence	Management and Procurement effort required [32]	Cost Source/ Notes
"MLAT Lite"	**Applicable to Benbecula, Kirkwall, Stornoway and Wick in option 1b only.** No investment is expected in Inverness and Sumburgh, as a surveillance solution is already in place at each of these airports (radar is in place in Inverness and radar data is supplied from NATS in Sumburgh). Implementation timeline as per section O.2.1	MLAT Sensors	£130K	15 years	0.5 FTE for 1 year per airport	Based on costs observed in Dundee. Inclusive of sensors, radio stations, receivers and sim cards [11].
		Data processing Aerodrome Traffic Monitors (interface)	£110K	15 years	0.5 FTE for 1 year per airport	Based on the Sumburgh implementation which included the data processing and user interfaces, but excluded the data provision (a feed from NATS is used) [18].
		Network Infrastructure/ communications	£20K per airport	Annual	N/A	Based on information obtained from Capita [19] assuming that on average there will be 4 sensors at each airport each no further than 5km from the airport. A full surveillance coverage analysis and communications assessment would be needed to determine this more precisely.
			£37K per airport	15 years	N/A	
		Annual operating cost	£29K	annual	N/A	Will depend on system specification, but as a ball-park figure and in line with analysis of ACE 2014 data, we have assumed operating cost of 12% of the initial capital expenditure (see section O.1 for more explanation).

[32] Helios estimate. Note that HIAL may outsource some of this rather than employ additional staff

Element group	Option/ Airport	Element	Cost	Cost recurrence	Management and Procurement effort required[33]	Cost Source/ Notes
WAM System	Applicable to options 2b, 2c and 3. In option 2b investment is expected at **to Benbecula, Kirkwall, Stornoway and Wick only.** In option 2c and 3 the investment will take place at **all ATC airports** with the exception of Inverness, which is expected to be moved to the new centralised facility, but without the installation of a new MLAT system. Implementation timeline as per section O.2.2.	Central Processing System Network of Remote Units	£700K per airport	15 years	2 FTE for a period of 3 years per airport	Based on industry input we estimate a potential HIAL WAM system to be in the order of 650K EUR (£575K). This is exclusive of the installation cost, which we have assumed to be in the range of £100-£125K. This estimate is consistent with information on WAM equipage contained in the ACE reports.
		Network Infrastructure/ communications	£20K per airport	Annual	N/A	Based on information obtained from Capita [19] assuming that on average there will be 4 sensors at each airport each no further than 5km from the airport. A full surveillance coverage analysis and communications assessment would be needed to determine this more precisely.
			£37K per airport	15 years	N/A	
		Central Processing System and remote units Annual Running Cost	£44K per airport	Annual	N/A	Supplier quote
		Surveillance and Flight Plan Data Processing System (incl. of EFS)	£500K per airport in option 2b £2M in option 2c and 3	15 years		

3 FTE for a period of 2 years per airport/location	£500K as observed in Inverness [35]. In option 2c and 3 fewer, but more resilient, data processing systems will be required.

Element group	Option/ Airport	Element	Cost	Cost recurrence	Management and Procurement effort required[33]	Cost Source/ Notes
		APS CWP	£40K per airport in option 2b £280K in options 2c and 3 (centralised)			Supplier quote plus assumption that the centralised APS room will consist of 7 modules (5 operational, 2 for supervisory, training and contingency purposes. See section O.7.3 for more details)
		Voice Communications System	£50K per airport £500K per centre (for both the APS and ADI RT)			Helios estimate based on internal knowledge and information obtained from HIAL.
		Radar Data Processing System and Controller Working Position operating cost	£65K per airport in option 2b £214K in options 2c and 3	Annual	N/A	Will depend on system specification, but as a ball-park figure and in line with analysis of ACE 2014 data, we have assumed operating cost of 12% of the initial capital expenditure (see section O.1 for more explanation).
NATS Contract	2c and 3	NATS APS/Radar feed contract	-£783K	Annual	N/A	In option 2c and 3 it is assumed that HIAL will introduce and MLAT system at Sumburgh and will move away from relying on NATS to provide an APS. This would provide an annual saving.

[33] Helios estimate. Part of this effort may be undertaken by an external consultancy

O.6 Remote Tower costs

Remote tower related costs are associated only with option 3 and relate to all 7 ATC airports. The year of investment is specified in O.2.3

Element group	Element	Cost	Cost recurrence	Management and Procurement effort required[34]	Cost Source/ Notes
Airport RT infrastructure	Mast cameras pan-tilt-zoom cameras data processing servers	£800K per airport	10 years	1 FTE for 2 years per airport	Supplier consultation
Airport RT infrastructure	Annual running cost	£18K per airport	Annual	N/A	Supplier consultation (exclusive of the costs of VHF maintenance, which has been excluded from the analysis, as is not option-dependent.)
Remote Tower Centre	Voice Communications System	No additional cost to that required for the establishment of an APS centralised facility			See section O.5 for more details.
	Screens E-strips Radar Data Processing System	£400K per module, £3,200K total		1 FTE for 2 years per airport	Supplier consultation plus assumption that the remote tower centre will consist of 8 modules (7 operational, 1 for training and contingency purposes. See section O.7.3 for more details)

[34] Helios estimate

Element group	Element	Cost	Cost recurrence	Management and Procurement effort required[35]	Cost Source/ Notes
Remote Tower Centre	Annual running cost	£35K per module, £280K total	Annual	N/A	Supplier consultation plus assumption that the remote tower centre will consist of 8 modules (7 operational, 1 for training and contingency purposes. See section O.7.3 for more details)
Communication Costs	RT data network infrastructure initial cost	£55K per airport	15 years	Assumed to be included in the Airport RT infrastructure management effort	Based on information obtained from Capita regarding the SWAN network. Please note that Capita provided a breakdown of costs for the initial set-up and annual set up per airport, but in the modelling an average for all airports has been calculated and assumed based on the Capita input.
	RT data communications cost	£15K per airport	Annual	N/A	

O.7 ATS Staffing requirements

O.7.1 Employment cost

The employment cost inputs obtained from HIAL [24] are presented on the following page.

[35] Helios estimate

Table 43 ATS staff employment cost

[Redacted[1]]

O.7.2 Overarching assumptions

Assumption Area	Assumption	Source
Relocation Cost	Equal to 100% of their annual employment cost	Helios Opinion: a conservative assumption on the likely required size of the relocation package, given the socio-political environment
Severance Package	Not explicitly accounted for	In the case that ATCOs do not wish to relocate, they will be given a severance package or an alternative role within the company. We have not explicitly accounted for the severance package cost, as we have assumed it would be comparable to the relocation package cost. We have also assumed that in the case that ATCOs choose not to relocate, new ATCOs will be employed but this new employment is assumed not to exceed the existing employment rate.

Assumption Area	Assumption	Source
ATS Staffing Level Estimation	$$C = \frac{N \times D}{365 - R}$$ $$R = weekend\ days + leave\ allowance + public\ holidays + training + provision\ for\ sick\ leave$$ We have assumed that: $D = 365$ $$weekend\ days = 104$$ $$leave\ allowance\ [55] = 32$$ $$public\ holidays\ [56] = 8$$ $$training = 10$$ $$provision\ for\ sick\ leave = 5$$ Resulting in: $R = 159$	When estimating the ATCO numbers for the options we have used the SRATCOH approach consistent with the requirements set out by the UK CAA in the regulation CAP 670 [41]. **It is our understanding that HIAL is currently looking to move away from SRATCOH to a fatigue-based rostering system, but given the uncertainties with regards to the exact scope of the impact of the change, we have conservatively assumed that basing the assumptions based on SRATCOH would be most appropriate. Once the fatigue-based rostering system is implemented, further staffing efficiencies can be made across all options.** ***C*** *- ATCOs required* ***N*** *- equals the number of ATCOs required to attend for duties, including a relief to give breaks, each day. This will depend on the number of operational positions and the period for which they are scheduled to open.* ***D*** *- equals the number of days the unit provides services in a year* ***R*** *- equals the number of days an ATCO is not available for duty, i.e. rest days, annual leave, public holidays in lieu, allowance for sickness and training etc* When calculating the ATCOs required we have always rounded up to an integer.

O.7.3 ATCOs

The implementation of Remote Towers is expected to eventually bring some staffing efficiencies. Our calculations show that no staff reductions will be required, unless a multi-mode concept is introduced. In this case we expect that the required reductions will be within the natural attrition rate, and no redundancies will be made.

		Service	#ATCOS[36]	ATCO shifts/ day	Source
Benbecula	1b	ADI/APP	6	2.2	HIAL [30]. Number of average number of operational sifts has been calculated using the sample rosters received directly from the units. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
Benbecula	2b	ADI and APS	7	3.9	In option 2b the ADI service provision will be separated from the APS service provision in busy periods, but joined in a single position in quieter periods. We have assumed that the joint ADI/APS position will operate 25% of the time. We have also assumed that the majority of ATCOs will have dual ADI and APS ratings, hence allowing for rostering benefits to be generated. $C = \frac{3.9 \times 365}{206} = (6.9)7\ ATCOs$
Benbecula	2c	ADI	6	2.2	The centralisation of the APS is not expected to have an impact on the ADI staffing levels or operating hours
Benbecula	2c	APS	-	-	No APS ATCOs will be based in Benbecula in option 2c. See the end of this table for information on the staffing in the centralised facility
Benbecula	3	ADI (RT)	-	-	No ADI or APS ATCOs will be based in Benbecula in option 3. See the end of this table for information on the staffing in the centralised facility
Benbecula	3	APS	-	-	

[36] Number of ATCOs inclusive of SATCOs

		Service	#ATCOS[37]	ATCO shifts/ day	Source
Dundee	1b	ADI/APP	8	3.5	HIAL [28]. Number of average number of operational sifts has been calculated using the sample rosters received directly from the units. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	11	6.1	In option 2b the ADI service provision will be separated from the APS service provision in busy periods, but joined into a single position in quieter periods. We have assumed that the joint ADI/APS position will operate 25% of the time. We have also assumed that the majority of ATCOs will have dual ADI and APS ratings, hence allowing for rostering benefits to be generated $C = \frac{6.1 \times 365}{206} = (10.8) 11\ ATCOs$
	2c	ADI	8	3.5	The centralisation of the APS is not expected to have an impact on the ADI staffing levels or operating hours
		APS	-	-	No APS ATCOs will be based in Dundee in option 2c. See the end of this table for information on the staffing in the centralised facility
	3	ADI (RT)	-	-	No ADI or APS ATCOs will be based in Dundee in option 3. See the end of this table for information on the staffing in the centralised facility
		APS	-	-	

[37] Number of ATCOs inclusive of SATCOs

		Service	#ATCOS[38]	ATCO shifts/ day	Source
Kirkwall	1b	ADI/APP	7	3.2	HIAL [30]. Number of average number of operational sifts has been calculated using the sample rosters received directly from the units. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
Kirkwall	2b	ADI and APS	10	5.6	In option 2b the ADI service provision will be separated from the APS service provision in busy periods, but joined into a single position in quieter periods. We have assumed that the joint ADI/APS position will operate 25% of the time. We have also assumed that the majority of ATCOs will have dual ADI and APS ratings, hence allowing for rostering benefits to be generated. $C = \frac{5.6 \times 365}{206} = (9.9) 10\ ATCOs$
Kirkwall	2c	ADI	7	3.2	The centralisation of the APS is not expected to have an impact on the ADI staffing levels or operating hours.
Kirkwall	2c	APS	-	-	No APS staff will be based in Kirkwall in option 2c. See the end of this table for information on the staffing in the centralised facility.
Kirkwall	3	ADI (RT)	-	-	No ADI or APS staff will be based in Kirkwall in option 3. See the end of this table for information on the staffing in the centralised facility.
Kirkwall	3	APS	-	-	

[38] Number of ATCOs inclusive of SATCOs

		Service	#ATCOS[39]	ATCO shifts/ day	Source
Stornoway	1b	ADI/APP	7	3.1	HIAL [30]. Number of average number of operational sifts has been calculated using the sample rosters received directly from the units. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	10	5.4	In option 2b the ADI service provision will be separated from the APS service provision in busy periods, but joined into a single position in quieter periods. We have assumed that the joint ADI/APS position will operate 25% of the time. We have also assumed that the majority of ATCOs will have dual ADI and APS ratings, hence allowing for rostering benefits to be generated. $C = \frac{5.4 \times 365}{206} = (9.6) 10\ ATCOs$
	2c	ADI	7	3.1	The centralisation of the APS is not expected to have an impact on the ADI staffing levels or operating hours.
		APS	-	-	No APS ATCOs will be based in Stornoway in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	-	No ADI or APS ATCOs will be based in Stornoway in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	-	

[39] Number of ATCOs inclusive of SATCOs

		Service	#ATCOS[40]	ATCO shifts/ day	Source
Sumburgh	1b	ADI/APP	9	3.5	HIAL [30]. Number of average number of operational sifts has been calculated using the sample rosters received directly from the units. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	9	3.5	In option 2b APS in Sumburgh will still be provided by NATS, hence no change in ATCO staffing will be observed.
	2c	ADI	9	3.5	The centralisation of the APS is not expected to have an impact on the ADI staffing levels or operating hours.
		APS	-	-	No APS staff will be based in Sumburgh in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	-	No ADI or APS staff will be based in Sumburgh in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	-	

[40] Number of ATCOs inclusive of SATCOs

		Service	#ATCOS[41]	ATCO shifts/ day	Source
Wick	1b	ADI/APP	6	2.2	HIAL [30]. Number of average number of operational sifts has been calculated using the sample rosters received directly from the units. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	7	3.9	In option 2b the ADI service provision will be separated from the APS service provision in busy periods, but joined in a single position in quieter periods. We have assumed that the joint ADI/APS position will operate 25% of the time. We have also assumed that the majority of ATCOs will have dual ADI and APS ratings, hence allowing for rostering benefits to be generated. $C = \frac{3.9\times365}{206} = (6.9)7\ ATCOs$
	2c	ADI	6	2.2	The centralisation of the APS is not expected to have an impact on the ADI staffing levels or operating hours.
		APS	-	-	No APS ATCOs will be based in Wick in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	-	No ADI or APS ATCOs will be based in Wick in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	-	

[41] Number of ATCOs inclusive of SATCOs

		Service	#ATCOS[42]	ATCO shifts/ day	Source
Inverness	1b 2b	ADI and APS	15 (excluding MATS)	8	HIAL [30]. No information has been given on the number of operation shifts in Inverness but as we know that the operations take place on a near 24/7 basis, we have assumed 4 operational shifts per day for the ADI and 4 for the APS ATCO. As Inverness already has and APS position, no change to the operation is expected under options 1b (introduction of ATMs) and 2b (Introduction of a local APS position). Consequently, the staffing numbers will be as they are today.
	2c	ADI	8	4	If the APS position was moved away from Inverness to a centralised location the pool of ATCOs located in Inverness would be reduced. The ATCOs would also no longer operate on both APS and ADI positions. There would only be 4 ADI operational shifts per day resulting in the following: $C = \frac{4 \times 365}{206} = (7.1)8\ ATCOs$ Consequently, 7 controllers would be moved to the centralised facility.
		APS	-	-	No APS ATCOs will be based in Inverness in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	-	No ADI or APS ATCOs will be based in Inverness in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	-	

42 Number of ATCOs inclusive of SATCOs

		Service	#ATCOS[43]	ATCO shifts/ day	Source
	1b	ADI/APP	N/A	N/A	No centralised facility will be created in options 1b and 2b.
	2b	ADI and APS			
Centralised Facility	2c	ADI	N/A	N/A	In option 2c only APS control would be provided from the centralised facility.
		APS	32	See source column	In option 2c we have assumed that a Benbecula and Stornoway will be managed from one APS position, and Kirkwall and Wick from another APS position. Due to high volumes of traffic, Dundee, Inverness and Sumburgh will have a dedicated, single APS positions. In total there will be 5 APS ATCOs per shift. However, due to licencing challenges we have assumed that it would be impossible for one ATCO to hold an active licence for all 5 APS positions. Consequently, we have assumed that 1 group of ATCOs will have the appropriate validations for the APS service at Dundee, Inverness and Sumburgh and a separate group of ATCOs for the service at the remaining 4 ATC airports. We have assumed that on average the service will be provided through 3.5 shifts per day per position Dundee – Inverness – Sumburgh: $C = \frac{3\ positions\ \times 3.5\ shifts\ per\ \ day \times 365}{206} = (18.6)19\ ATCOs$ Benbecula & Stornoway - Kirkwall & Wick: $C = \frac{2\ positions\ \times 3.5\ shifts\ per\ \ day \times 365}{206} = (12.4)13\ ATCOs$
		Supervisor	4	See source column	We have assumed that two supervisory shifts per day would be required to support the centre ATC operations (for both options 2c and 3): $C = \frac{1\ position\ \times 2\ shifts\ per\ day \times 365}{206} = (3.5)4\ ATCOs$

[43] Number of ATCOs inclusive of SATCOs

	Service	#ATCOS[43]	ATCO shifts/ day	Source
3	ADI (RT)	34	See source column	In option 3 we have assumed that the ADI and APS services will be provided by separate pools of ATCOs with ATCOs holding multiple unit endorsements within the one rating. While creating one pool for all positions would result in more efficient rostering, we believe this is limited by licensing issues. The exact rostering and licensing approach within option 3 is very flexible and can be altered in line with the regulatory and internal requirements. With regards to ADI we have clustered low traffic volume airports into small Remote-Tower “sub-units” which share a single pool of ATCOs. Airports with low traffic volume are assumed to be operated in a multi-mode configuration (2 airports operated by one ATCOs), with Benbecula and Stornoway being operated from one position and Wick and Kirkwall (at off-peak times only) from another. We have also assumed that an ATCO can only be certified for one pair of airports, hence the rostering benefits can only be observed within the pair of airports: Staffing in the Benbecula-Stornoway RTC sub-unit In line with baseline assumptions, we expect an average of 2.2 shifts per day at Benbecula and 3.1 in Stornoway, resulting in an average of 3.1 shifts operated by the multi-mode module. Consequently: $C = \frac{3.1 \times 365}{206} = (5.5)\ 6\ ATCOs$ Staffing in the Kirkwall-Wick RTC sub-unit In line with baseline assumptions, we expect an average of 2.2 shifts per day at Wick and 3.2 in Kirkwall. We believe that the core shift will be operated in single-mode and the less busy shifts would be operated in multi-mode. Consequently, we have assumed that across the two airports on average 4 ATCO shifts per day will be required: $C = \frac{4 \times 365}{206} = (7.1) 8\ ATCOs$ Staffing in the Dundee, Sumburgh and Inverness RTC sub-unit Due to a high traffic volume we have assumed that Dundee, Sumburgh and Inverness will only operate in single mode, but due to a lower operations complexity, one ATCO will be able to hold a license for all 3 airports. For the Dundee CWP we will require 1 ATCO for an average 3.5 shifts per day, Sumburgh 3.5 and Inverness 4. Consequently this ‘sub-unit’ will have to be sufficiently large to staff 11 ADI shifts per day: $C = \frac{11 \times 365}{206} = (19.5) 20\ ATCOs$

Service	#ATCOS[43]	ATCO shifts/ day	Source
APS	32	See source column	In option 3 we have assumed that the ADI and APS services will be provided by separate pools of ATCOs with ATCOs holding multiple unit endorsements within the one rating. While creating one pool for all positions would result in more efficient rostering, we believe this is limited by licensing issues. The exact rostering and licensing approach within option 3 is very flexible and can be altered in line with the regulatory and internal requirements. In this analysis, in option 2c we have assumed that a Benbecula and Stornoway will be managed from one APS position, and Kirkwall and Wick from another APS position. Due to high volumes of traffic, Dundee, Inverness and Sumburgh will have a dedicated, single APS positions. In total there will be 5 APS ATCOs per shift. However, due to licencing challenges we have assumed that it would be impossible for one ATCO to hold an active licence for all 5 APS positions. Consequently, we have assumed that 1 group of ATCOs will be responsible for the APS service at Dundee, Inverness and Sumburgh and a separate group of ATCOs for the service at the remaining 4 ATC airports. We have assumed that on average the service will be provided through 3.5 shifts per day per position Dundee – Inverness – Sumburgh $C = \frac{3\, positions\ \times 3.5\, shifts\, per\, day \times 365}{206} = (18.6) 19\ ATCOs$ Benbecula & Stornoway - Kirkwall & Wick $C = \frac{2\, positions\ \times 3.5\, shifts\, per\, day \times 365}{206} = (12.4) 13\ ATCOs$

O.7.4 ATSAs

		Service	#ATSAs[44]	Source
Benbecula	1b	ADI/APP	0	HIAL [30] The implementation of ATMs is not expected to impact the staffing levels.
	2b	ADI and APS	0	It has been assumed that the addition of an APS position at the unit will not impact the ATSA staffing requirement.
	2c	ADI	0	The centralisation of the APS is not expected to have an impact on ATSA staffing levels or operating hours.
		APS	-	No APS ATCOs will be based in Benbecula in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	No ATS staff will be based in Benbecula in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	
Dundee	1b	ADI/APP	2	HIAL [30] The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	2	It has been assumed that the addition of an APS position at the unit will not impact the ATSA staffing requirement.
	2c	ADI	2	The centralisation of the APS is not expected to have an impact on ATSA staffing levels or operating hours.
		APS	-	No APS ATCOs will be based in Dundee in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	No ATS staff will be based in Dundee in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	

44 Number of ATSAs inclusive of SATSAs and ATSOAs

		Service	#ATSAs[45]	Source
Kirkwall	1b	ADI/APP	5	HIAL [30]. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	5	It has been assumed that the addition of an APS position at the unit will not impact the ATSA staffing requirement.
	2c	ADI	5	The centralisation of the APS is not expected to have an impact on the ATSA staffing levels or operating hours.
		APS	-	No APS ATCOs will be based in Kirkwall in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	No ATS staff will be based in Kirkwall in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	
Stornoway	1b	ADI/APP	4	HIAL [30]. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	4	It has been assumed that the addition of an APS position at the unit will not impact the ATSA staffing requirement.
	2c	ADI	4	The centralisation of the APS is not expected to have an impact on ATSA staffing levels or operating hours.
		APS	-	No APS ATCOs will be based in Stornoway in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	No ATS staff will be based in Stornoway in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	

45 Number of ATSAs inclusive of SATSAs and ATSOAs

		Service	#ATSAs[46]	Source
Sumburgh	1b	ADI/APP	5	HIAL [30]. The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	5	No change is expected at Sumburgh in 2b.
	2c	ADI	5	The centralisation of the APS is not expected to have an impact on ATSA staffing levels or operating hours.
		APS	-	No ATS staff will be based in Sumburgh in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	No ATS staff will be based in Sumburgh in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	
Wick	1b	ADI/APP	0	HIAL [30] The implementation of ATMs is not expected to impact the staffing levels or operating hours.
	2b	ADI and APS	0	It has been assumed that the addition of an APS position at the unit will not impact the ATSA staffing requirement.
	2c	ADI	0	The centralisation of the APS is not expected to have an impact on ATSA staffing levels or operating hours.
		APS	-	No APS ATCOs will be based in Wick in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	No ATS staff will be based in Wick in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	

[46] Number of ATSAs inclusive of SATSAs and ATSOAs

		Service	#ATSAs[47]	Source
Inverness	1b 2b	ADI and APS	8	HIAL [30] As Inverness already has and APS position, no change to the operation is expected under options 1b (introduction of ATMs) and 2b (Introduction of a local APS position). Consequently, the staffing numbers will be as they are today.
	2c	ADI	8	The centralisation of the APS is not expected to have an impact on ATSA staffing levels or operating hours.
		APS	-	No APS ATCOs will be based in Inverness in option 2c. See the end of this table for information on the staffing in the centralised facility.
	3	ADI (RT)	-	No ADI or APS staff will be based in Inverness in option 3. See the end of this table for information on the staffing in the centralised facility.
		APS	-	

[47] Number of ATSAs inclusive of SATSAs and ATSOAs

		Service	#ATSAs[48]	Source
Centralised Facility	1b	ADI/APP	N/A	No centralised facility will be created in options 1b and 2b.
	2b	ADI & APS		
	2c	ADI	N/A	In option 2c only APS control would be provided from the centralised facility.
		APS	8	We have assumed that 5 APS positions would be required. Assuming that one ATSA can support 4 positions simultaneously, 2 ATSAs would be required for an average of 2 shifts per day (assuming that ATSAs may work longer shifts than ATCOs). This translates to an average of 4 ATSA/ATSOAs shifts per day: $C = \frac{4 \times 365}{206} = (7.1) 8\ ATSAs/ATSOAs$
	3	ADI (RT)	15	It has been assumed that in option 3 ADI and APS would be provided from the same control room and that the ATSAs would be shared between those positions. We have assumed that 7 RT positions and 5 APS positions would be required. Assuming that one ATSA can support 4 positions simultaneously, 3 ATSAs would be required for an average of 2 shifts per day (assuming that ATSAs may work longer shifts than ATCOs). Additionally, two ATSOA shift per night would be required to cover the OOH requirement. This translates to an average of 8 ATSA/ATSOAs shifts per day: $C = \frac{8 \times 365}{206} = (14.2) 15\ ATSAs/ATSOAs$
		APS		

[48] Number of ATSAs inclusive of SATSAs and ATSOAs

O.7.5 Managerial oversight

The creation of a new centre particularly for option 3 would likely result in a change in the corporate structure and governance of HIAL. Determining the most appropriate structure is the subject of a separate detailed analysis with the close involvement of the HR team. Such a detailed assessment has not been carried out for this feasibility and scoping study, but nevertheless a high level outline has been suggested for further consideration by HIAL management. Our high-level outline includes managerial oversight and keyroles/positions and is presented in Figure 87. We expect the majority of the positions will be filled by existing staff, whose roles and responsibilities would have to be redefined. From a modelling perspective any additional ATS staff have been captured eg to account for roles needed in addition to the operational staff to fulfil CAP670 requirements, for example OJTI, Assessor and occurrence investigation roles.

We have assumed the following:

- The centre would become a focus for ATS and key roles maytherefore also re-locate to the centre, for example GMATS, DGMATS and AFIS coordinator roles. A new directorate may also be required at corporate level, hence the proposal for a Director ATS role.
- Manager APS, Manager ADI, and engineering managers will be full-time roles which do not exist today, though could potentially be filled from existing staff. In the model these positions are considered as 3 FTEs, on top of what is required by the SRATCOH calculation. In the case of a centralised APS (option 2c) the Manager ADI position would not be required.
- The training manager and safety & standards manager would be operational ATCOs who would be supported by a team of OJTIs, assessors and occurrence investigators, who would also be operational ATCOs. We believe that these roles could be covered by the additional 3.5FTE ATCOs that result from overestimating (rounding up) the ATS staff needed to cover the SRATCOH CAP670 requirements for option 3, and the additional 2FTEs available from the overestimate in option 2c calculated in O.7.3. A more detailed analysis of full training and competency needs would be required to validate and finalise the precise staffing numbers.

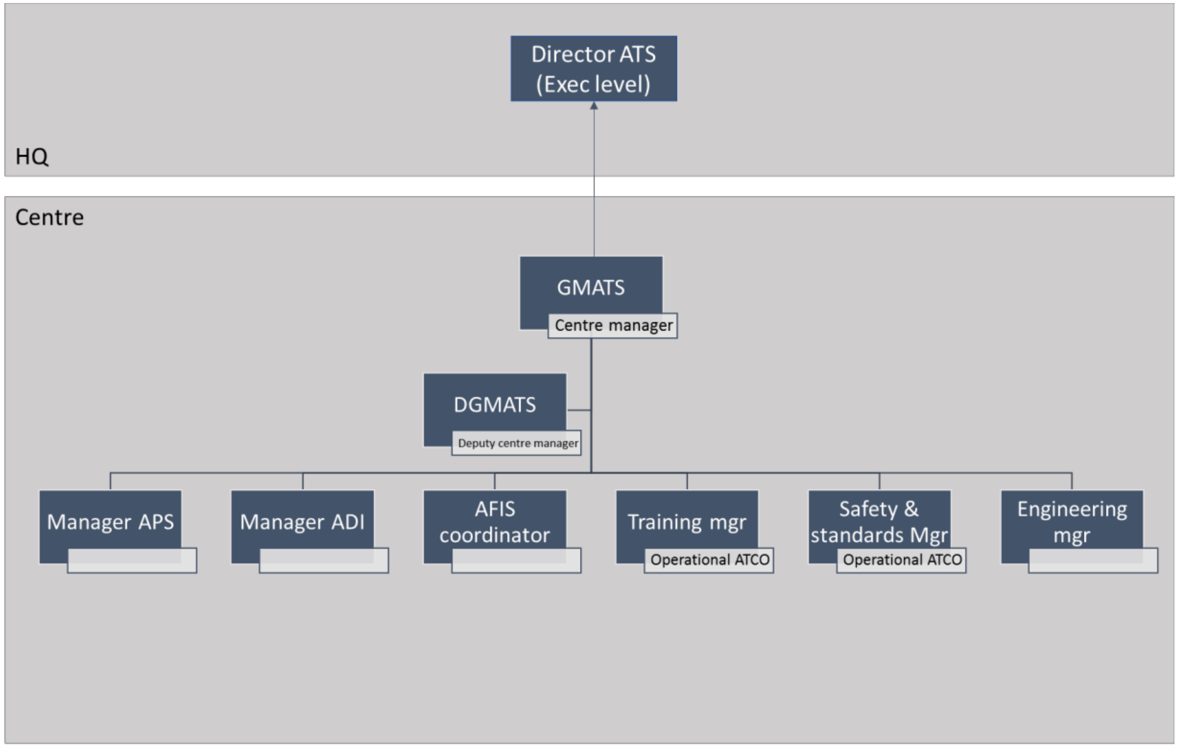

Figure 87 Sample high-level wire diagram

O.7.6 Training Assumptions

Training programme	1a	2b	2c	3	Sub element	Value	Source
Aerodrome Traffic Monitors	✓	-	-	-	Course fee per ATCO	£1.5K	Based on cost of 1-week training courses provided by Global ATS [64]
					Course duration	5 days	Helios assumption
					Travel and subsistence cost per ATCO per course	£1K	In line with costs observed when sending ATCOs to the south of England for MET training [67]. Accommodation for a week per ATCO: £691 Food per week: £245 Return flights: £725
APS training	-	✓	✓	✓	Course fee per ATCO	£20.0K	Global ATS [64]
					Course duration	10 weeks (50 days)	
					Travel and subsistence cost per ATCO per course	£10.8K	In line with costs observed when sending ATCOs to the south of England for MET training [67]: Accommodation for a week per ATCO: £691 (£6,910 total., Food per week: £245 (£2,450 total), return flights: £1,450 assuming two return trips
EFS Training	-	-	-	✓	Course fee per ATCO	£1.5K	Based on cost of 1-week training courses provided by Global ATS [64]
					Course duration	5 days	Helios assumption
					Travel and subsistence cost per ATCO per course	£1K	In line with costs observed when sending ATCOs to the south of England for MET training [67]: Accommodation for a week per ATCO: £69, food per week: £245, return flights: £725

Training programme	1a	2b	2c	3	Sub element	Value	Source
Remote Tower (single-mode)	-	-	-	✓	Course fee per ATCO	£1.5K	Based on cost of 1-week training courses provided by Global ATS [64]
					Course duration	5 days	Entry Point North [66]. Further strengthened by information from NATS, who informed us that minimal training is required to move to RT as it is primarily related to a change of perspective, which is also observed when one moves to a new tower. In the case of a move to a new tower at LHR such training took a week and in Manchester it was only a day. (This is assuming that the CWP configuration will be identical to the existing tower – for that reason training related to the introduction of EFPs is presented separately (above))
					Travel and subsistence cost per ATCO per course	£1K	In line with costs observed when sending ATCOs to the south of England for MET training [67]: Accommodation for a week per ATCO: £691. Food per week: £245. Return flights: £725
Remote Tower (multi-mode)	-	-	-	✓	Course fee per ATCO	£20.0K	Assumed it would be of equal complexity as an APS training course. APS assumptions based on information from Global ATS [64]
					Course duration	50 days	
					Travel and subsistence cost per ATCO per course	£10.8K	In line with costs observed when sending ATCOs to the south of England for MET training [67]: Accommodation for a week per ATCO: £691 (£6,910 total) Food per week: £245 (£2,450 total) Return flights: £1,450 assuming two return trips

P Sensitivity Analyses

A number of sensitivity analyses have been carried out to show how the output of the financial analysis would change if certain assumptions were altered. This allows to create a better understanding in the confidence we may place in the analysis.

P.1 CBA timespan

The core analysis has focused on assessing the relative costs of the options over a 15 year horizon. The aim of this sensitivity is to asses if the balance of the results would differ if we reduced or increased this time horizon.

Changing the timespan of the CBA does in fact affect the outcome of the results:

- In the 10 year horizon option 2b is the most favourable, but options 2c and 3 are nearly identical from a financial perspective
- In the 15 year horizon option 2c becomes least favourable from a financial perspective.
- However, in a 20 year time horizon the balance shifts and the gap between options 2b 3 becomes closes. This is due to the fact that in options 2b and 2c more ATS staff are required than in option 3, the cost of which becomes more visible over a longer period of time.

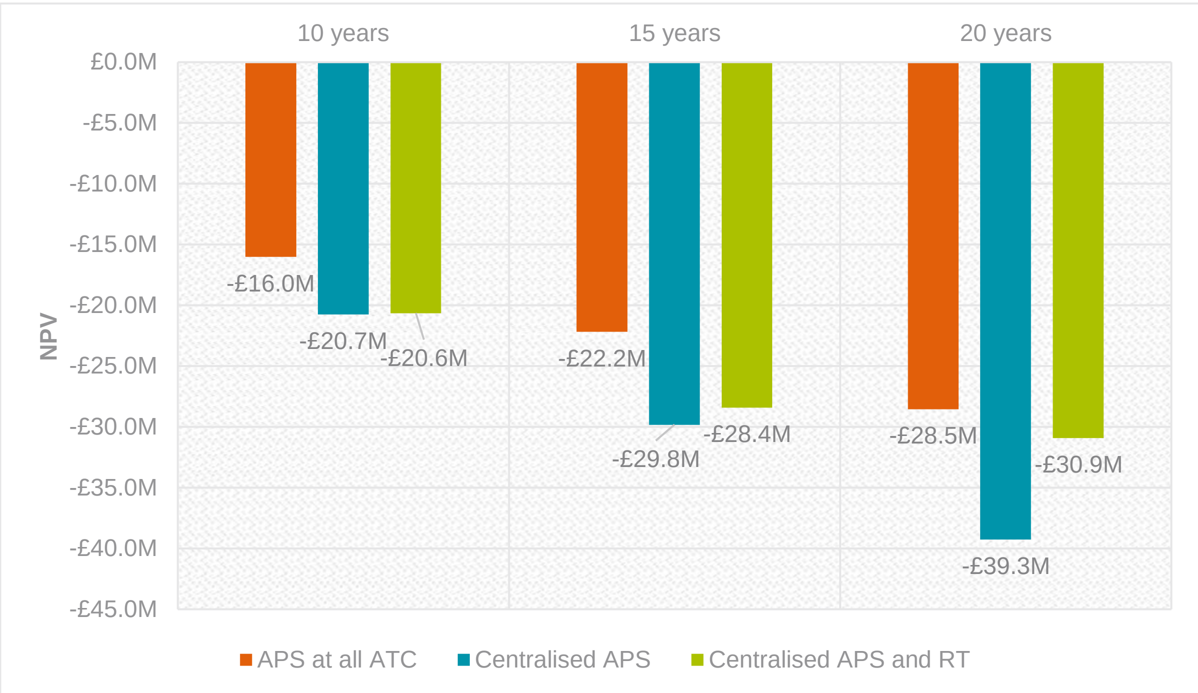

Figure 88 CBA timespan sensitivity analysis

P.2 Discount rate

In the baseline analysis a discount rate of 5.5% was assumed. No matter what discount rate is used, over a 15 year horizon option 2b is seen as least costly. If the real discount rate observed by HIAL is less than 10% option 3 becomes most favourable than option 2c. If it is indeed larger than 10%, option 2c becomes more favourable than option 3 from a financial perspective. This is due to the fact that in option 2b the costs are more equally distributed across the years.

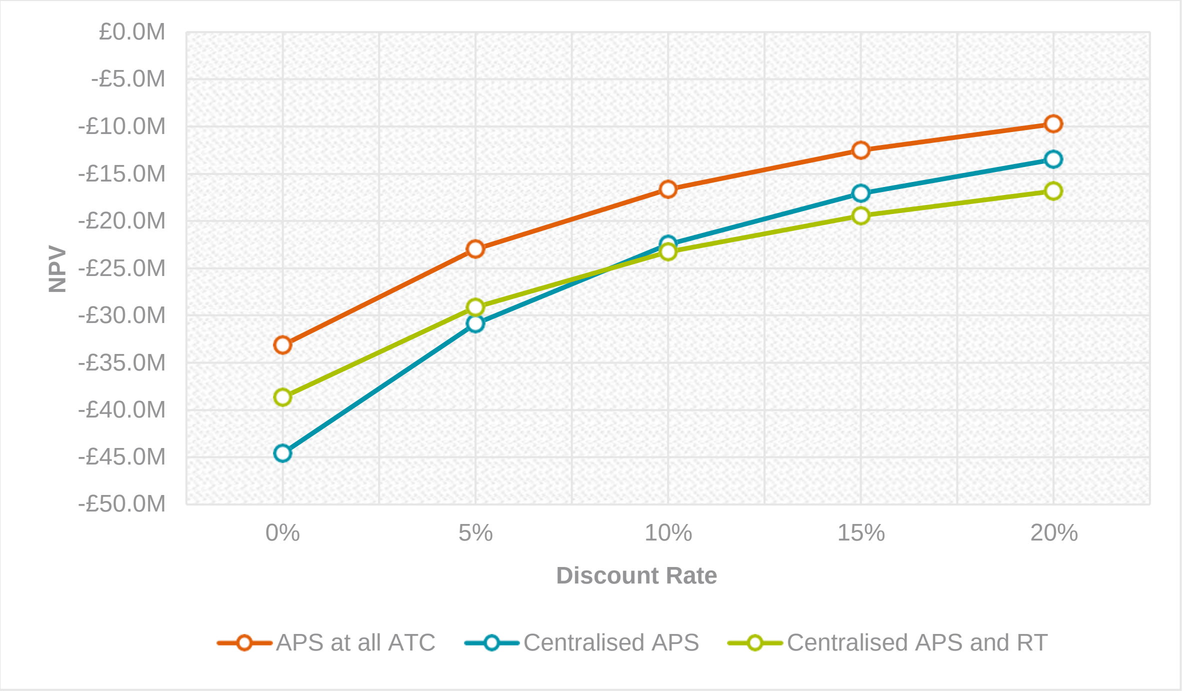

Figure 89 Discount rate sensitivity analysis

Q Communications quote from Scottish Wide Area Network (SWAN)

The following table presents the outputs of an exercise undertaken with SWAN Scottish Wide Area Network regarding the possibilities for connectivity to the ATC airports, assuming dual redundancy 100mb links.

[Redacted[3]]

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[49] This price is approximate, and may well be lower. A full price would only be available once order is placed. A more detailed price would be available from BT via a 'standalone' survey (a cost of £300, per site). Price includes excess construction cost (ie BT charge, including for diverse routing in some cases). It essentially covers the cost of getting the airport connected to the nearest SWAN network node

[50] All those with "+S" in column I include full diversity

[51] Annual service cost includes data charges

Footnote – Classification of Redactions

Number	Explanation
1	Information has been removed where it is considered personal information and to publish that information may breach one or more of the data protection principles. The types of information that have been redacted include: • Names • Personal contact details • Personal opinions that are related to personal circumstances • Information that may allow the deduction of personal information relating to people
2	Information has been removed where publication may prejudice the effective conduct of public affairs. Examples are information that may substantially inhibit the free and frank exchange of views for the purposes of deliberation, and information that, if published, may prevent HIAL from effectively managing future change or transition.
3	Information has been removed where publication may substantially prejudice either HIAL's or another third party's commercial interests.
4	Information has been removed where publication may endanger HIAL's ability to appropriately manage and maintain health and safety matters.