TURKS AND CAICOS ISLANDS AIRPORTS AUTHORITY

STRATEGIC MASTER PLAN FOR THE TCIAA

B.3. Airspace assessment and future requirements

October 2024

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Objectives

- The objective of this report is to **analyse the status of the Air Navigation Service provision in Turks and Caicos Islands**. The assessment includes a detailed review of current airspace configurations, ATS structures and procedures, and CNS infrastructure to identify potential gaps and needs of the TCIAA:
  1. **Review of current Airspace configuration and operational capabilities**: Assessment of the current capabilities of the national airspace by performing a detailed look at the airspace configuration and structures, determining the level of alignment of these elements with the international industry standards, and identifying any potential improvements to enhance operational benefits
  2. **Review of current ATM/CNS infrastructure and equipment**: Analysis of the current ATM/CNS assets and capabilities to identify any potential issues and/or constraints and evaluate potential improvements, focused on Communications and Navigation capabilities
  3. **Remote Towers Technology**: Overview of remote towers technologies, including systems, operational modes, aplicable regulations and standards, showing examples of implementation worldwide
  4. **Gap analysis of procedures and CNS infrastructure**: Development of recommendations for the improvement of ANS service provision in the TCI based on the findings from the previous analyses
- All the analyses are based on the data published at the **Turks and Caicos Islands AIP**, and complemented with the **traffic information** provided by the TCIAA and the **information gathered during the site visit** to the Territory (airports and equipment, airspace structure, CNS infrastructure)
- **Surveillance and Air Traffic Control services**, which are not provided in the Turks and Caicos Islands as of today, are in the **scope of the Surveillance project** to be developed during the next two years, aiming at transitioning from procedural traffic control to radar-based ATC provision

Content

Airspace configuration and operational capabilities

ATM/CNS infrastructure and equipment

Remote Tower technology

Gap analysis and recommendations

The Airspace and ATS procedures analysis will provide a quick overview of the current flight procedures to identify potential needs

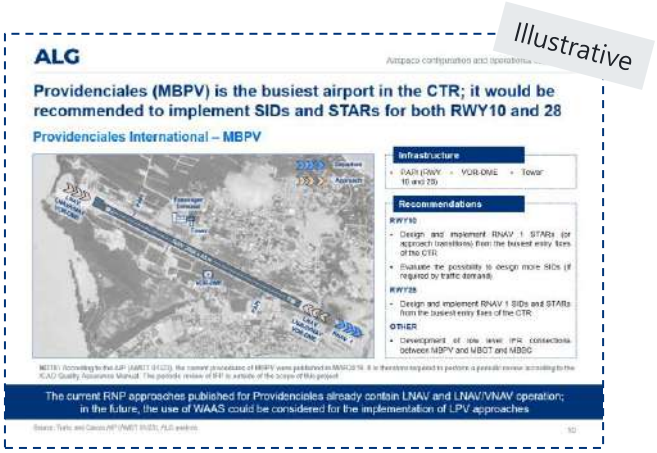
Methodology for the review of current Airspace configuration

1 Analysis of current airspace capabilities and structures

- Airspace volumes, structures, routes, holds, procedures and other relevant elements

2 Assessment of alignment with international standards and improvement identification

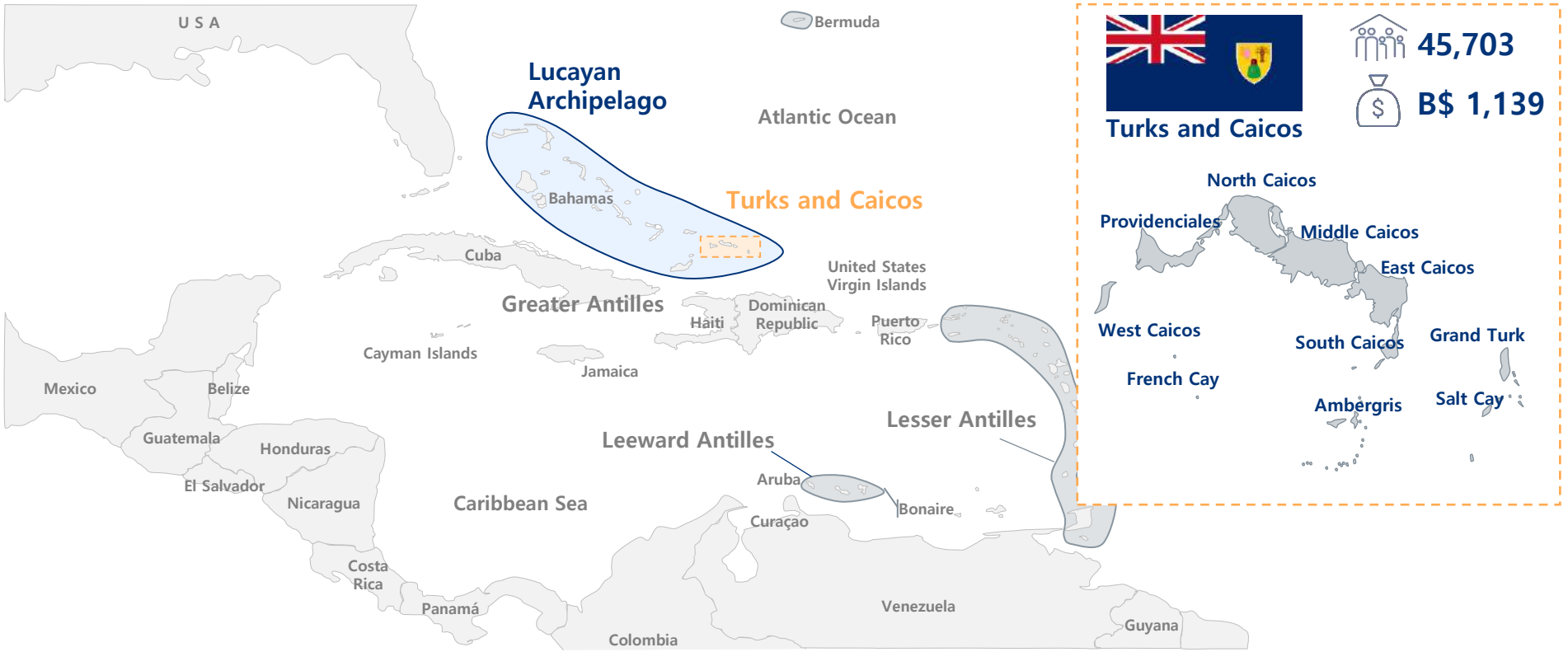
- Determine level of alignment with international industry standards
- Potential improvements identification to enhance operational benefits



Source: ALG analysis

Turks and Caicos Islands are in the Lucayan archipelago, and the country is one of the most populated British overseas territories

Turks and Caicos overview

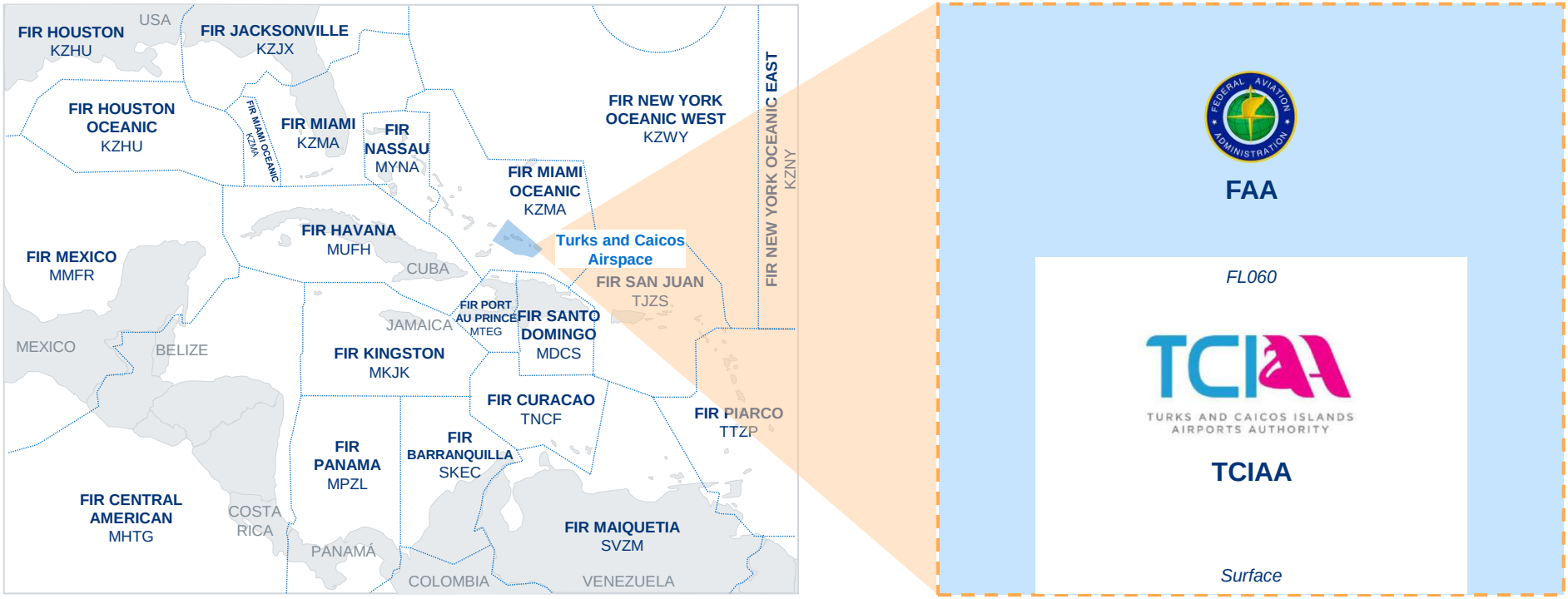


Turks and Caicos is composed by 8 main islands and more than 22 smaller ones, covering a total of 238 square miles

Source: World Bank 2022, ALG analysis

The Turks and Caicos Islands' airspace is included within the Miami Oceanic FIR, with a maximum altitude of 6,000 feet

Airspace design overview

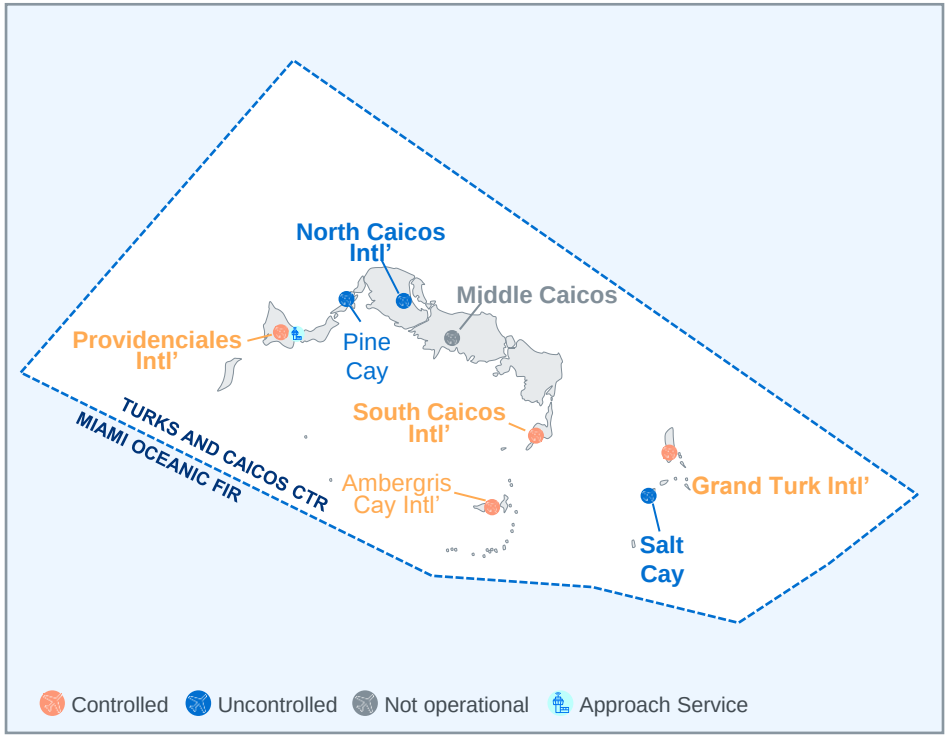


The TCIAA is responsible for the provision of ANS services up to FL060 in its sovereign airspace, above which the En-Route ATC service is provided by the FAA

Source: Turks and Caicos AIP, ALG analysis

The TCIAA manages 6 of the 8 airports of the TCI, being four of them international airports and 2 domestic ones

Turks and Caicos airport network characterization



Aerodrome Name (ICAO)	Location	Runway	Airport Type
Providenciales Intl' (MBPV)	Providenciales	10/28	International
Grand Turk / Jags Mccartney Intl' (MBGT)	Grand Turk	12/30	International
South Caicos Intl' (MBSC)	South Caicos	11/29	International
North Caicos Intl' (MBNC)	North Caicos	08/26	International
Salt Cay (MBSY)	Salt Cay	08/26	Domestic
Middle Caicos (MBMC)	Middle Caicos	12/30	Domestic
Ambergris Cay Intl' (MBAC)	Ambergris Cay	07/25	International
Pine Cay (MBPI)	Pine Cay	11/29	Domestic

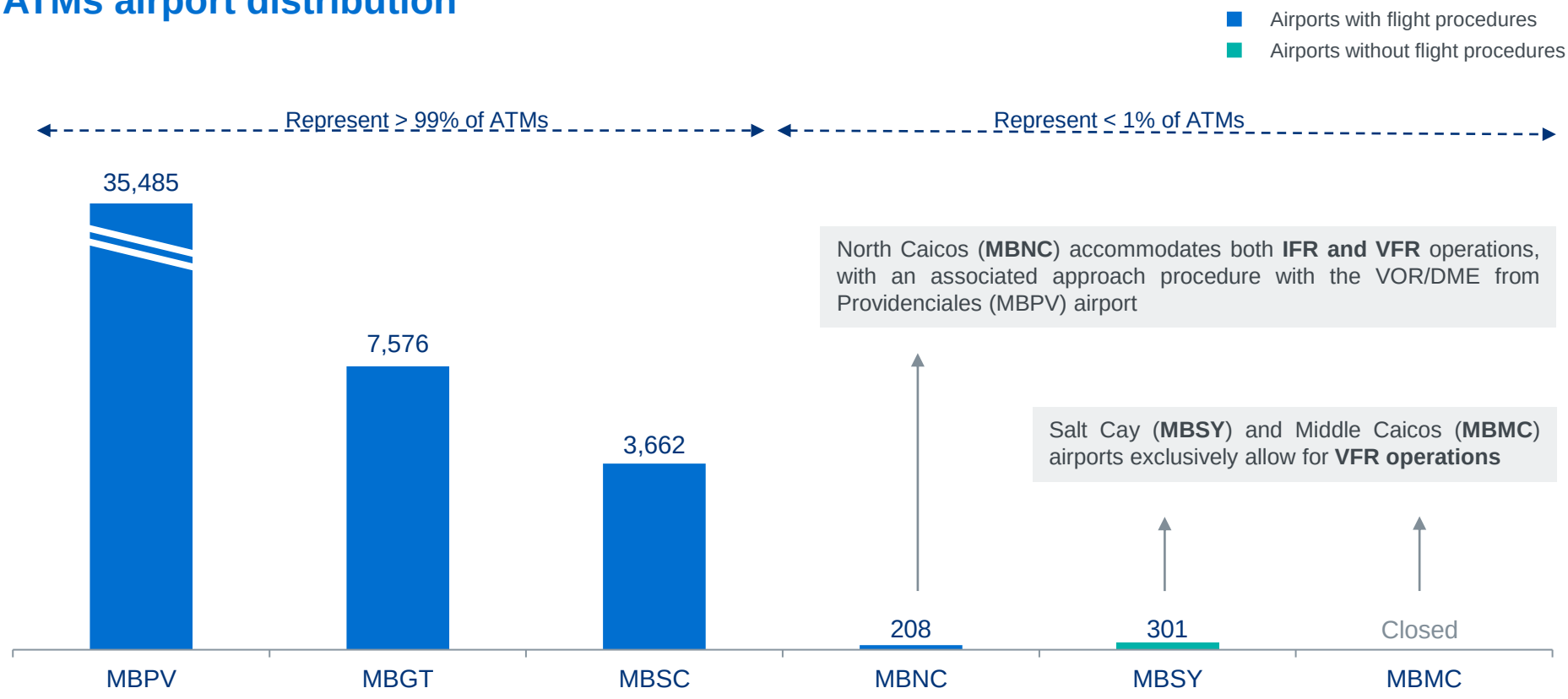
Private aerodromes. Not managed by the TCIAA

Providenciales, Grand Turk and South Caicos are the most important airports of the country, whereas Ambergris Cay and Pine Cay are privately owned aerodromes

Source: Turks and Caicos AIP, ALG analysis

The aggregate operations of Providenciales, Grand Turk and South Caicos account for more than 99% of total traffic in the Territory

ATMs airport distribution

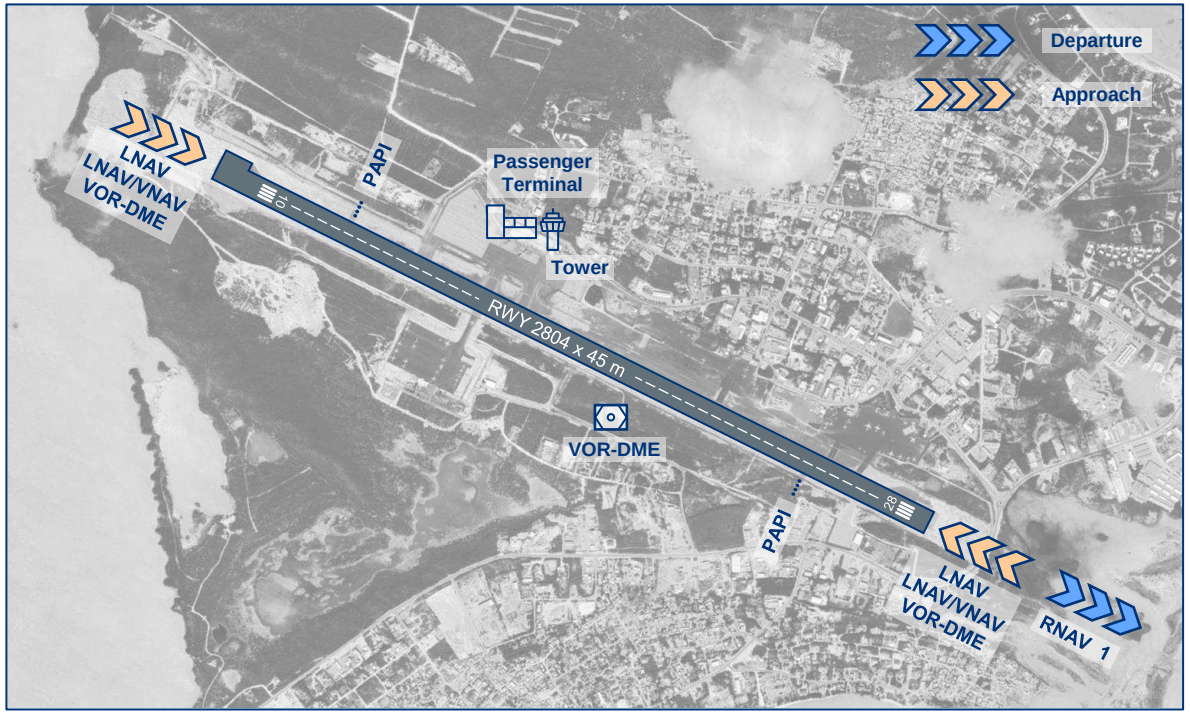


The three main airports are provided with flight procedures, accommodating IFR and VFR flights, while Salt Cay can be reached only by VFR operations

Source: Turks and Caicos AIP, ALG analysis

Providenciales (MBPV) is the busiest airport in the CTR; it would be recommended to implement SIDs and STARs for both RWY10 and 28

Providenciales International – MBPV



Infrastructure

- PAPI (RWY 10 and 28)
- VOR-DME
- Tower

Recommendations

RWY10

- Design and implement RNAV 1 STARs (or approach transitions) from the busiest entry fixes of the CTR
- Evaluate the possibility to design more SIDs (if required by traffic demand)

RWY28

- Design and implement RNAV 1 SIDs and STARs from the busiest entry fixes of the CTR

OTHER

- Development of low level IFR connections between MBPV and MBGT and MBSC

NOTE: According to the AIP (AMDT 01/23), the current procedures of MBPV were published in MAR2019. It is therefore required to perform a periodic review according to the ICAO Quality Assurance Manual. The periodic review of IFP is outside of the scope of this project

The current RNP approaches published for Providenciales already contain LNAV and LNAV/VNAV operation; in the future, the use of WAAS could be considered for the implementation of LPV approaches

Source: Turks and Caicos AIP (AMDT 01/23), ALG analysis

The implementation of SIDs and STARs at Grand Turk will significantly increase the predictability and safety of the operations

Jags McCartney International Airport Grand Turk – MBGT

Infrastructure

- PAPI (RWY 12 and 30)
- VORTAC
- Tower

Recommendations

RWY12 & RWY30

- **RNAV 1 SIDs and STARs (or approach transitions)** are recommended for both runway ends
- The upgrade of the **RNP approach charts to LNAV/VNAV** is also recommended, as far as there is a reliable METEO service on ground providing accurate information on QNH setting

OTHER

- Development of low level IFR connections between MBGT and MBPV and MBSC

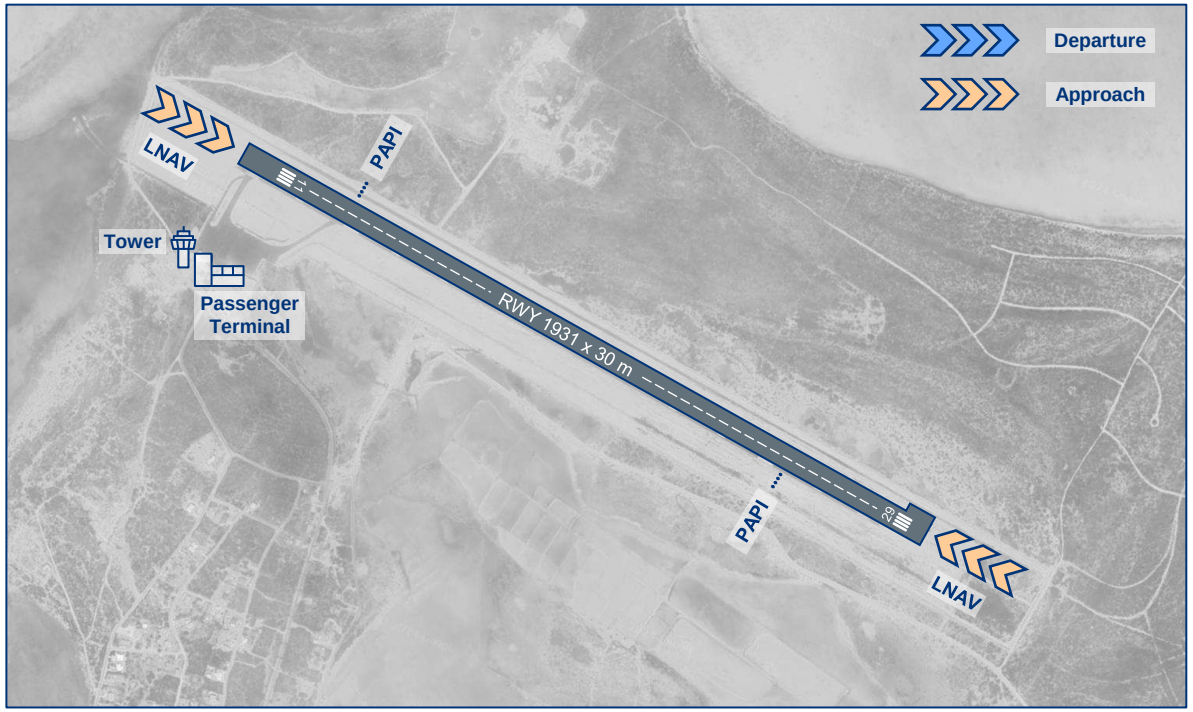
NOTE: According to the AIP (AMDT 01/23), the current procedures of MBPB were published in MAR2019. It is therefore required to perform a periodic review according to the ICAO Quality Assurance Manual. The periodic review of IFP is outside of the scope of this project

RNP approaches down to LNAV/VNAV minima are currently not authorised at this airport, although they could improve the performance of navigation; it might be worth to further analyse the reasons behind this situation

Source: Turks and Caicos AIP (AMDT 01/23), ALG analysis

A similar situation is observed at South Caicos airport, where the only IFR procedures published are non-precision approaches

South Caicos International - MBSC



Infrastructure

- PAPI (RWY 11 and 29)
- Tower

Recommendations

RWY11 & RWY29

- **RNAV 1 SIDs and STARs (or approach transitions)** are recommended, if possible, for both runway ends
- The upgrade of the **RNP approach charts to LNAV/VNAV** is also recommended, as far as there is a reliable METEO service on ground providing accurate information on QNH setting

OTHER

- Development of low level IFR connections between MBSC and MBPV and MBGT

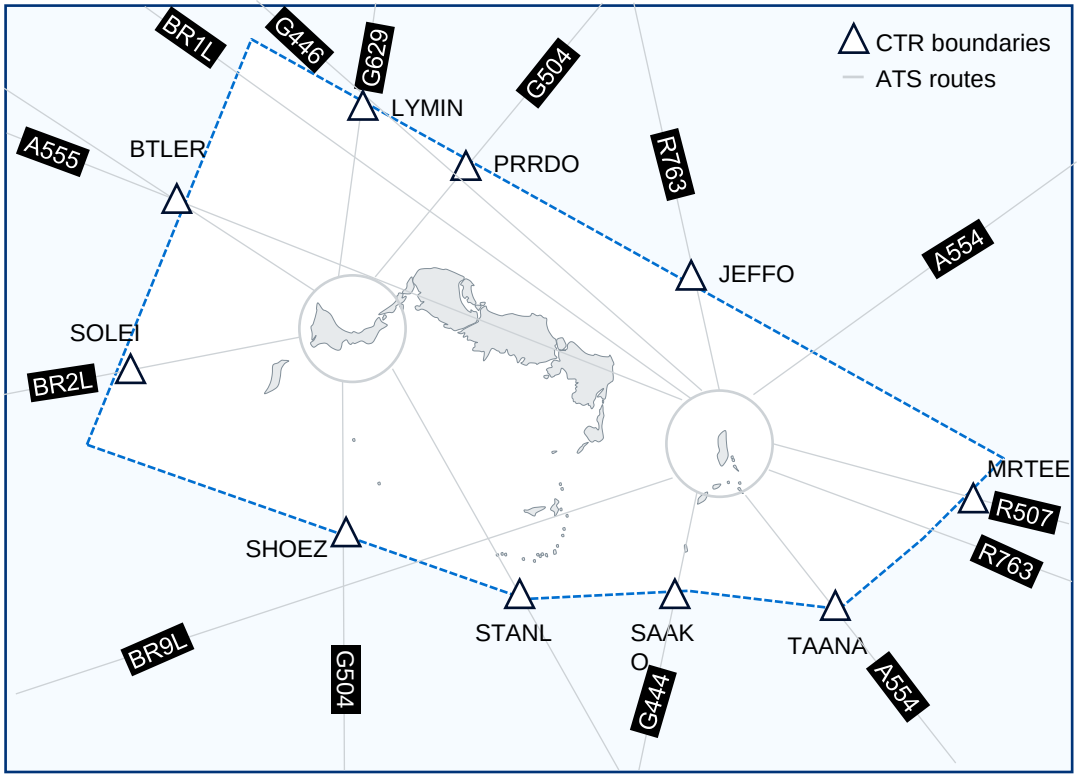
NOTE: According to the AIP (AMDT 01/23), the current procedures of MBSC were published in MAR2019. It is therefore required to perform a periodic review according to the ICAO Quality Assurance Manual. The periodic review of IFP is outside of the scope of this project

The implementation of SIDs and STARs (or approach transitions) for the main airports of the Turks and Caicos CTR will reduce ATCO workload and improve the safety of the operations

Source: AIP (AMDT 01/23), ALG analysis

ATS routes connected to the CTR are bidirectional, remarking the need for SIDs and STARs to ensure the vertical separation at transfer points

Turks and Caicos CTR boundaries & ATS routes



- Transfer Control Points (**TCP**) have been defined from **VOR/DME based** ATS routes, which is **not optimal** from a pure flight efficiency perspective
- Miami must ensure aircraft cross Arrival Transition Areas (ATAs) fixes at a **specific altitude**, which might jeopardize the possibility to conduct Continuous Descent Operations (**CDO**)
- *All this information will be studied in greater detail in the Radar SUR project, which is expected to be developed in the coming months*

The traffic share of the entry and exit fixes of the CTR should be analyzed to optimize the future design of terminal procedures

Source: AIP (AMDT 01/23), ALG analysis.

Content

Airspace configuration and operational capabilities

ATM/CNS infrastructure and equipment

Remote Tower technology

Gap analysis and recommendations

This section provides a preliminary identification of the current needs for additional infrastructure implementation

Methodology for the review of current ATM/CNS infrastructure and equipment

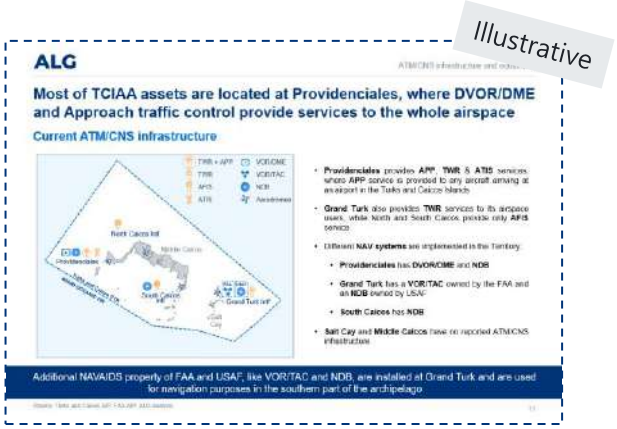
1 Analysis of ATM/CNS assets and capabilities

- Identification of current assets and capabilities
- Identify issues and constraints
- Evaluate potential improvements

2 Evaluation capabilities

- Mapping antenna locations, routes and airport facilities for COM coverage
- Evaluation of current assets and capabilities with recommended infrastructure for service provision
- Development of coverage maps to identify potential gaps

Illustrative



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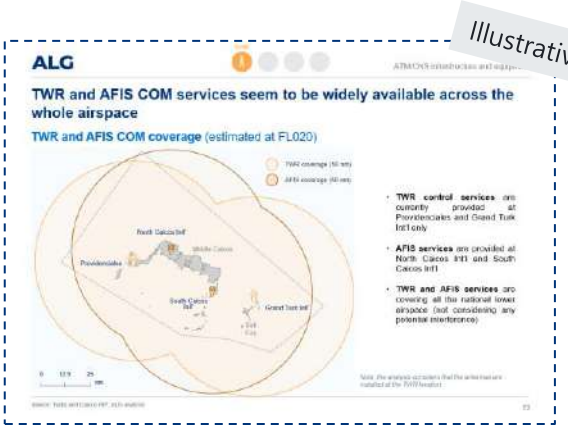
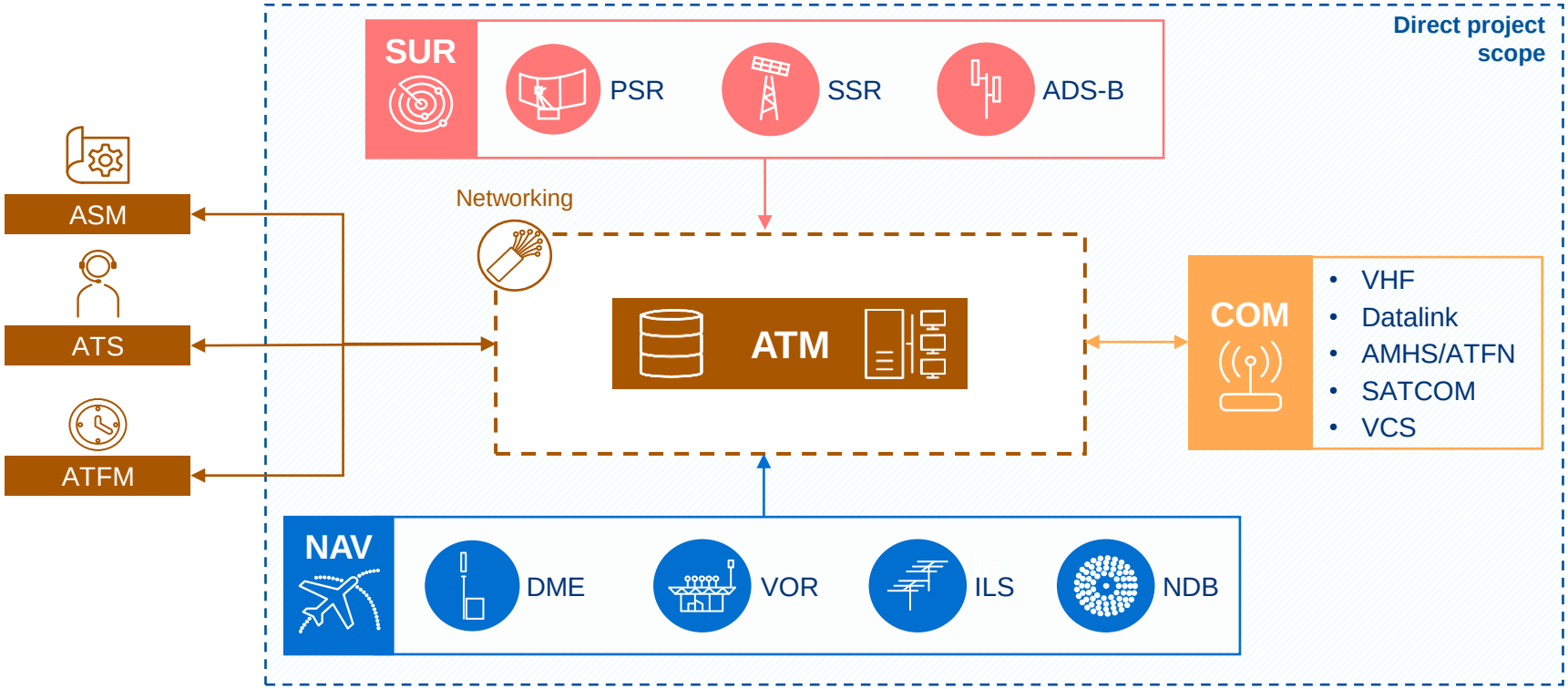


Source: ALG analysis

ATM and CNS systems are part of a complex ecosystem and work cooperatively to ensure a safe provision of ANS

ATM and CNS systems

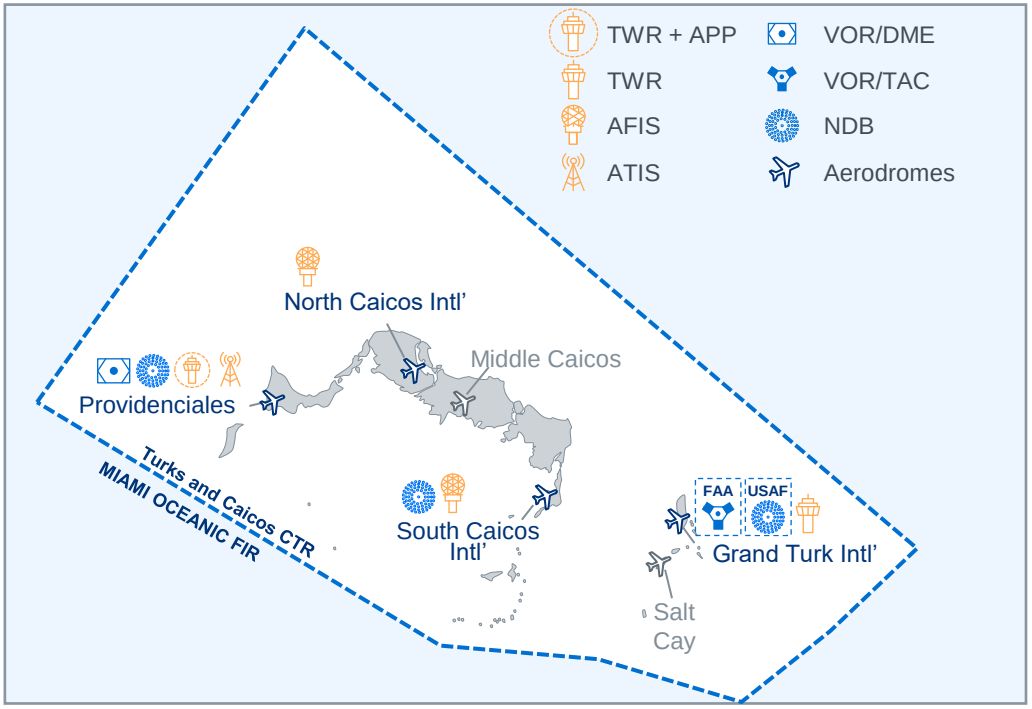


The type of systems implemented and their location are analyzed to assess the quality and availability of services provided throughout the Turks and Caicos Islands airspace

Source: ALG analysis

Most of TCIAA assets are located at Providenciales, where DVOR/DME and Approach traffic control provide services to the whole airspace

Current ATM/CNS infrastructure



- **Providenciales** provides **APP**, **TWR** & **ATIS** services, where **APP** service is provided to any aircraft arriving at an airport in the Turks and Caicos Islands
- **Grand Turk** also provides **TWR** services to its airspace users, while North and South Caicos provide only **AFIS** service
- Different **NAV systems** are implemented in the Territory:
  - **Providenciales** has **DVOR/DME** and **NDB**
  - **Grand Turk** has a **VOR/TAC** owned by the FAA and an **NDB** owned by USAF
  - **South Caicos** has **NDB**
- **Salt Cay** and **Middle Caicos** have no reported ATM/CNS infrastructure

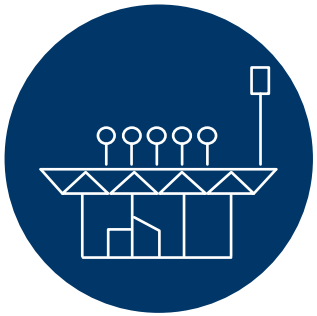
Additional NAVAIDS property of FAA and USAF, like VOR/TAC and NDB, are installed at Grand Turk and are used for navigation purposes in the southern part of the archipelago

Source: Turks and Caicos AIP, FAA AIP, ALG analysis

Initial coverage maps have been developed for COM and NAV, analyzing the availability of service provision in the whole airspace

Coverage maps categories

COM



NAV

SUR

ATC

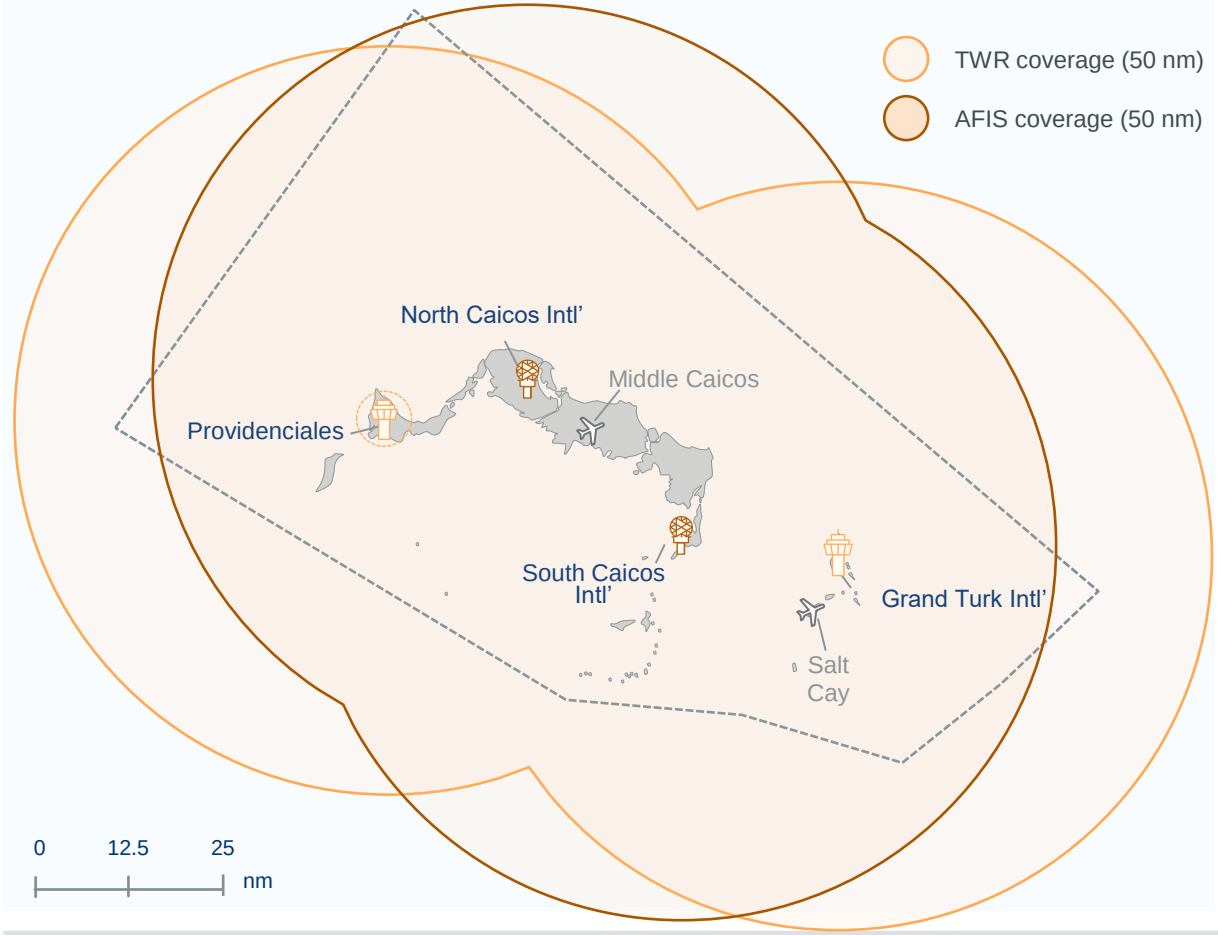
No SUR and ATC services are provided in Turks and Caicos as of today, situation expected to change with the Surveillance project

SUR and ATC systems are in the scope of the Surveillance project to be developed during the next two years, aiming at transitioning from procedural traffic control to radar-based ATC provision

Source: ALG analysis

TWR and AFIS COM services seem to be widely available across the whole airspace

TWR and AFIS COM coverage (estimated at FL020)



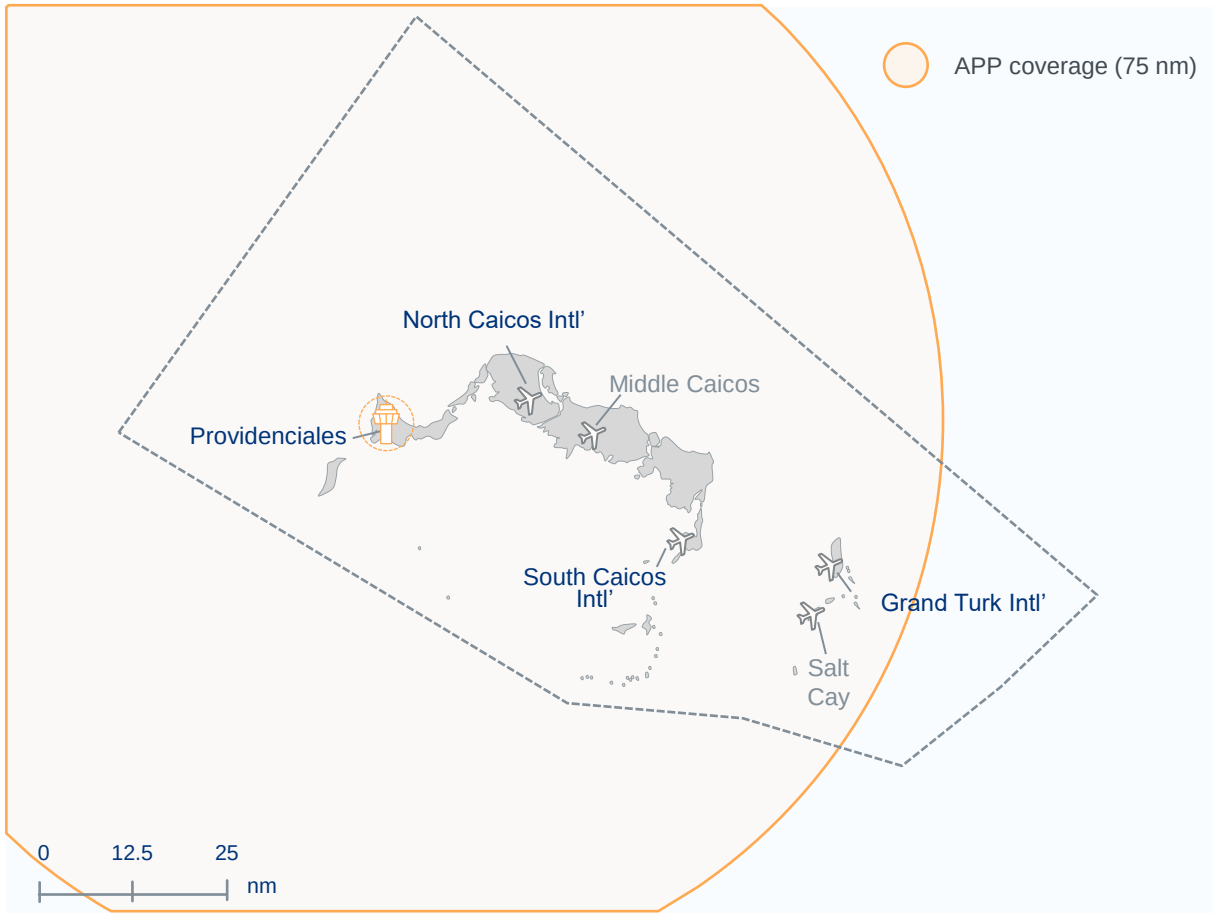
- **TWR control services** are currently provided at Providenciales and Grand Turk Int'l only
- **AFIS services** are provided at North Caicos Int'l and South Caicos Int'l
- **TWR and AFIS services** are covering all the national lower airspace (not considering any potential interference)

Note: the analysis considers that the antennas are installed at the TWR location

Source: Turks and Caicos AIP, ALG analysis

APP service is provided across the whole airspace, with a potential lack of coverage in the south-eastern part of the airspace

APP COM coverage (estimated at FL060)



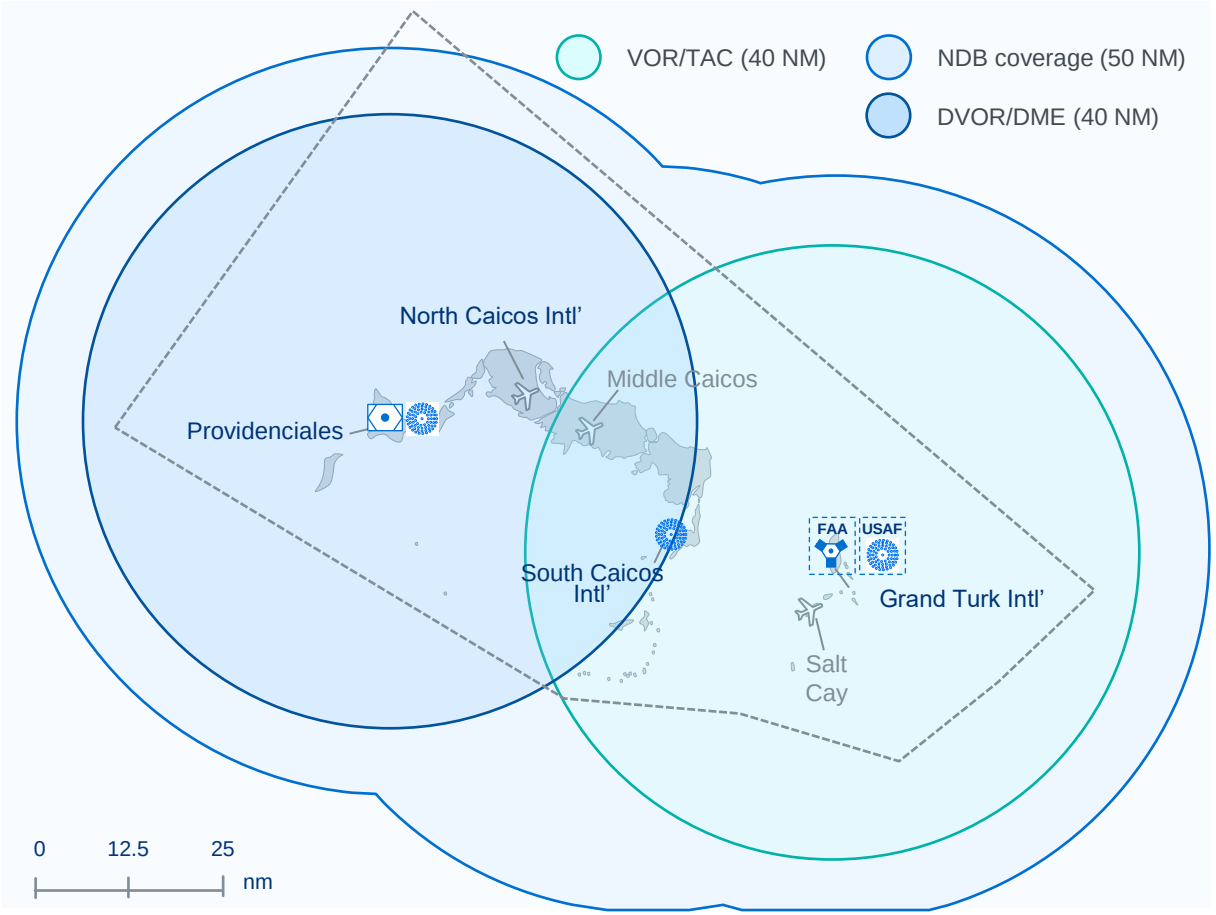
- **Providenciales** is equipped with radio communication for **approach service provision** (126.00 MHz) covering almost whole Turks and Caicos Islands Territory
- **APP coverage** is limited approximately to 10 nm to the East of Grand Turk, with a potential lack of coverage in the south-eastern part of the airspace

Note: the analysis considers that the antennas are installed at the TWR location

Source: Turks and Caicos AIP, ALG analysis

TCIAA NAV systems are complemented by a VOR/TAC and NDB provided by the FAA in Grand Turk

NAV coverage (estimated at FL060)



- **Providenciales** is equipped with **DVOR/DME** and **NDB**
- The **DVOR/DME** is used for **Terminal operations** at Providenciales and North Caicos Intl'
- **Grand Turk** is equipped with a **VOR/TAC** (FAA owned) and **NDB** (USAF owned)
- The **VOR/TAC** is used for **Terminal operations** at Grand Turk
- Such **NAV** infrastructure provides a **complete coverage** of the CTR
- It should be remarked that NDB systems are being discontinued worldwide

Note: NAV systems coverage is confirmed through the information provided (radius) in the FAA AIP

Source: Turks and Caicos AIP, FAA AIP, ALG analysis

Content

Airspace configuration and operational capabilities

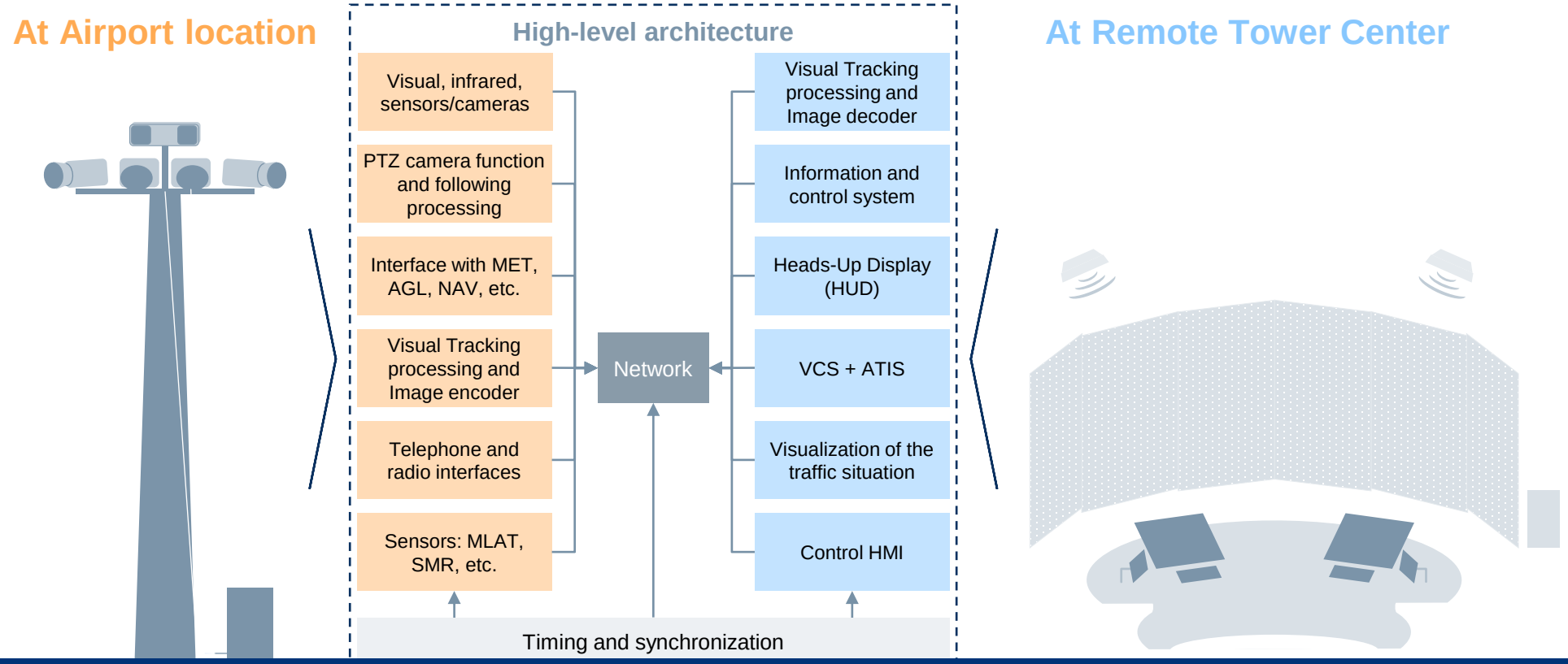
ATM/CNS infrastructure and equipment

Remote Tower technology

Gap analysis and recommendations

The Remote Tower concept is a mature alternative to the construction or refurbishment of physical control towers

The remote tower structure



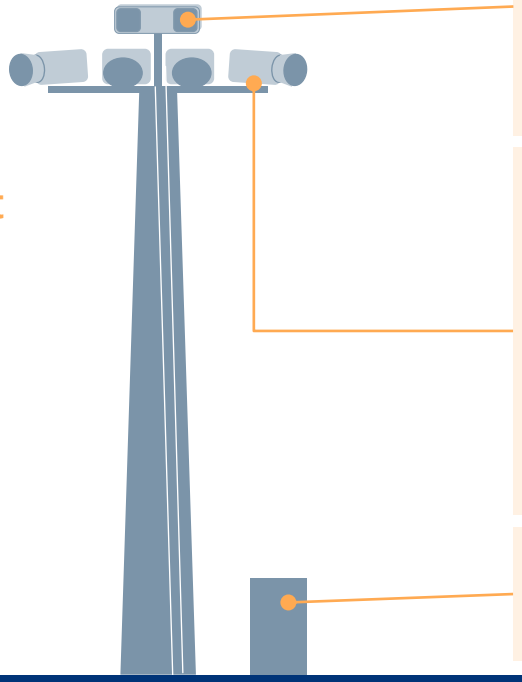
Remote Tower systems are clearly divided into two categories based on its location: cameras, sensors and interfaces are deployed at the airport, while controllers supporting systems are implemented at the remote center

Source: ALG Analysis

Cameras and sensors at the airport can be tailored to local needs, offering an airfield view equal to or even better than a traditional TWR

Remote Tower basic elements - Airport location

At Airport location



1. Pan-Till-Zoom (PTZ) camera(s)

Camera capable of remote directional and zoom control, implemented in substitution of controller binoculars

2. Signal Light Gun

Focused bright light beam to be used in case of radio failure to communicate with an aircraft

3. Panorama camera(s)

Provide a 360º high-resolution view of the airport area through a set of fixed cameras or a single rotating one

4. Area microphone

Provide a complete situational awareness to the ATCO in the remote center

5. Camera cleaning system

Each camera is provided with a cleaning system to ensure its proper functioning

7. Principal and Redundant WAN

Double communication line to ensure back-up in case of fail

Enhanced technologies could be included in the set of sensors of a Remote Tower to improve the service provision, as for example night and infrared view

Source: ALG Analysis

Control Center systems are customized taking into account controllers needs and requirements to optimize operational performances

Remote Tower basic elements - Control Center location

Head-Up

Environment speakers

Reproduction of external sounds captured at the airport to increase the ATCO situational awareness

Landscape video-wall

Video Wall composed by screen showing the video captured by panorama camera(s)

Display Processors (DP)

Perform de-compression and decoding of video signals

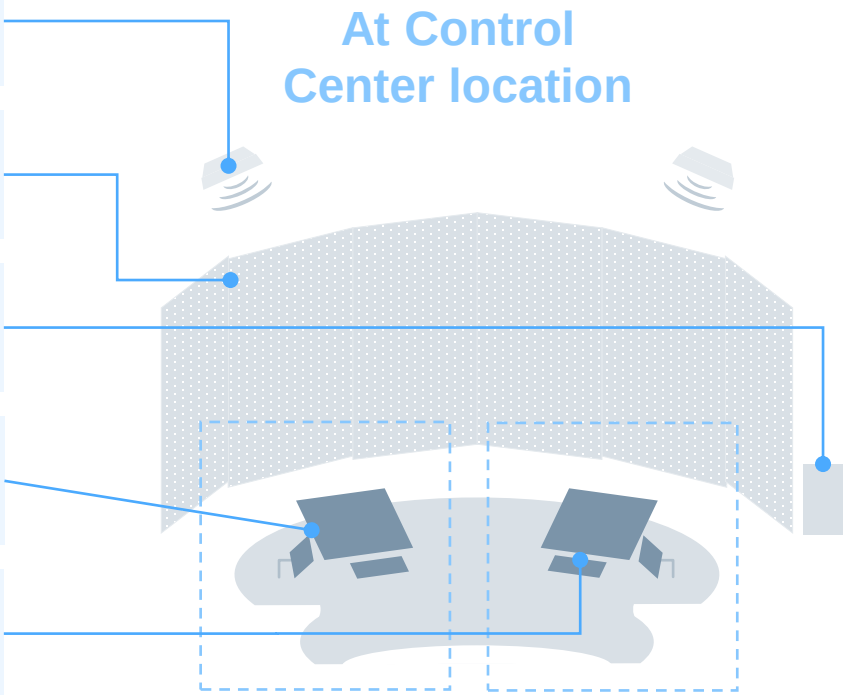
Head-Down

Controller Working Position (CWP)

Human-Machine Interfaces (HMI) integrating services and tools needed by the controller for a correct provision of ATC

Supervisor Controller Position

HMI enabling remote control of tower settings and functionalities, including performance supervision



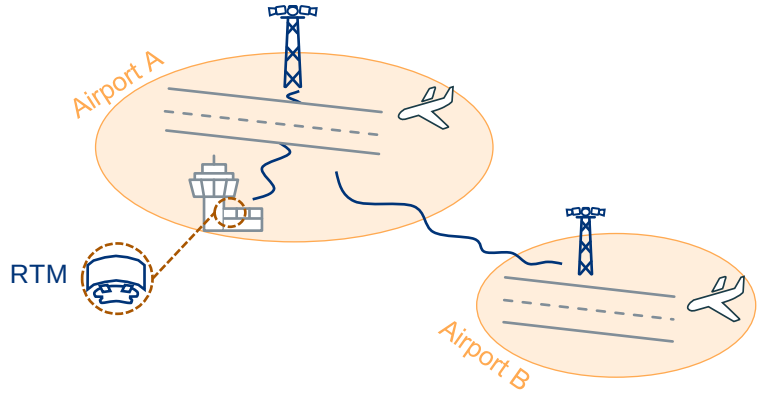
Both head-up and head-down displays are essential to controllers' best service providing, allowing for a realistic view of the airfield while having detailed knowledge of the operational data

Source: ALG Analysis

Two types of Remote Tower concepts are identified depending on the location from where the services are provided

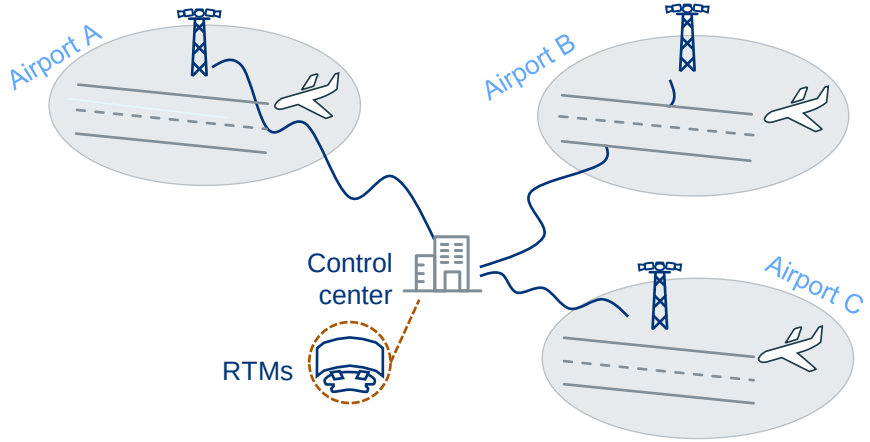
Digital and Remote Tower Concepts

Digital Tower (services provided locally)



- Control Centre (and Positions) are **located at the airport**
- ATC services to **additional remote airports** could be provided
- This concept is usually implemented as solution at **medium and large airports**

Remote Tower (services provided remotely)



- Control Centre (and Positions) are **located remotely** within the same control center
- ATC services to all the **remote airports** controlled by the remote center
- This concept is usually implemented as solution for multiple **small and medium airports**

RTM: Remote Tower Module

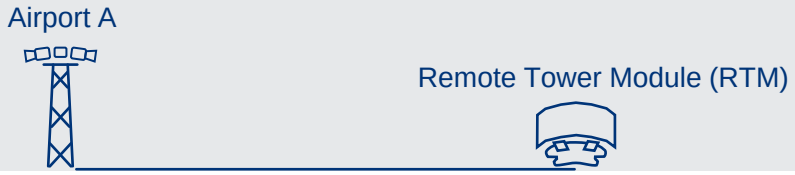
The choice of the type of RT solution and Control Center to implement is usually influenced by performance and cost-efficiency factors, as well as the relocation of controllers and the social acceptance of the new operational model

Source: ALG Analysis

There are up to four operating modes for implementing a remote tower, depending on the specific airport needs and its location

Operating modes

Single



Single mode

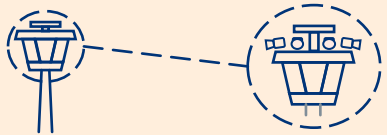
A single RTM controls the operations of a single airport from the control position. Remote control centers are composed of several positions, managing different airports with a 1:1 configuration

Multiple

Multiple mode

A single RTM controls the operations of more than one airport from the control center (1:X configuration, only if compatibility with traffic peaks is assured). The control center can be located at any airport or far away

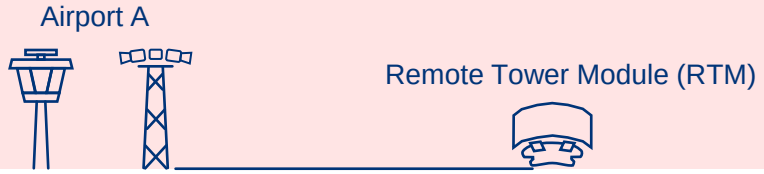
Enhanced



Enhanced Conventional Tower

Remote tower technologies are installed at a conventional tower, enabling previously not available capabilities (e.g. hotspot monitoring, low visibility conditions and night vision)

Contingency



Contingency mode

Control tower is installed at the airport as contingency measure in case of not operability of the conventional tower (e.g. security issues, unreachability by air traffic controllers shifts)

Given the characteristics of Turks and Caicos Islands archipelago, the multiple mode – once sufficient technological maturity is reached – will be the best option for controlling remote TCIAA airports in the future

Source: ALG Analysis

Technical standards and regulations are already available and being enhanced in line with systems and technologies advancements

Current regulatory landscape

ICAO Doc 4444 and Doc 9426

Content:

- Doc 4444 Amendment 8 (Nov 2018) introduced **support for remote ATS**
- ATMOPSP reinitiated Remote ATS Sub-group for **developing specific GM and provisions** if necessary
- Doc 9426 (ATS Planning manual) likely to include a **new section on remote ATS** (few years needed)

Not up-to-date, not reflecting last evolutions of the sector

Rule Making Task RMT.0624

Content:

- **Guidance material**, **technical requirements** and **safety assessment** for the provision of remote aerodrome and air traffic services (Gm Issue 2, Feb '19)
- AMC & GM complementing "ATCO Licensing" Regulation (EU) 2915/249
- **Compliance and Guidance material** to Comm. Regulation

Regularly updated, towards the definition of certification specifications (by 2023/Q4)

WG-100 ED-240 / A / B

Content:

- Constantly developing and delivering minimum **aviation system performance standards** for remote tower optical systems, according to sector evolutions
- **Recently** included additional specification for **visual tracking** based on **AI capabilities**

Regularly updated with last developments in the sector

Guidance Material for Remote and Digital Towers

Content:

- **Introduction** to the remote and digital tower **concept and technologies**
- Answer **specific questions** that ANSPs
- Provide an **accessible learning experience**

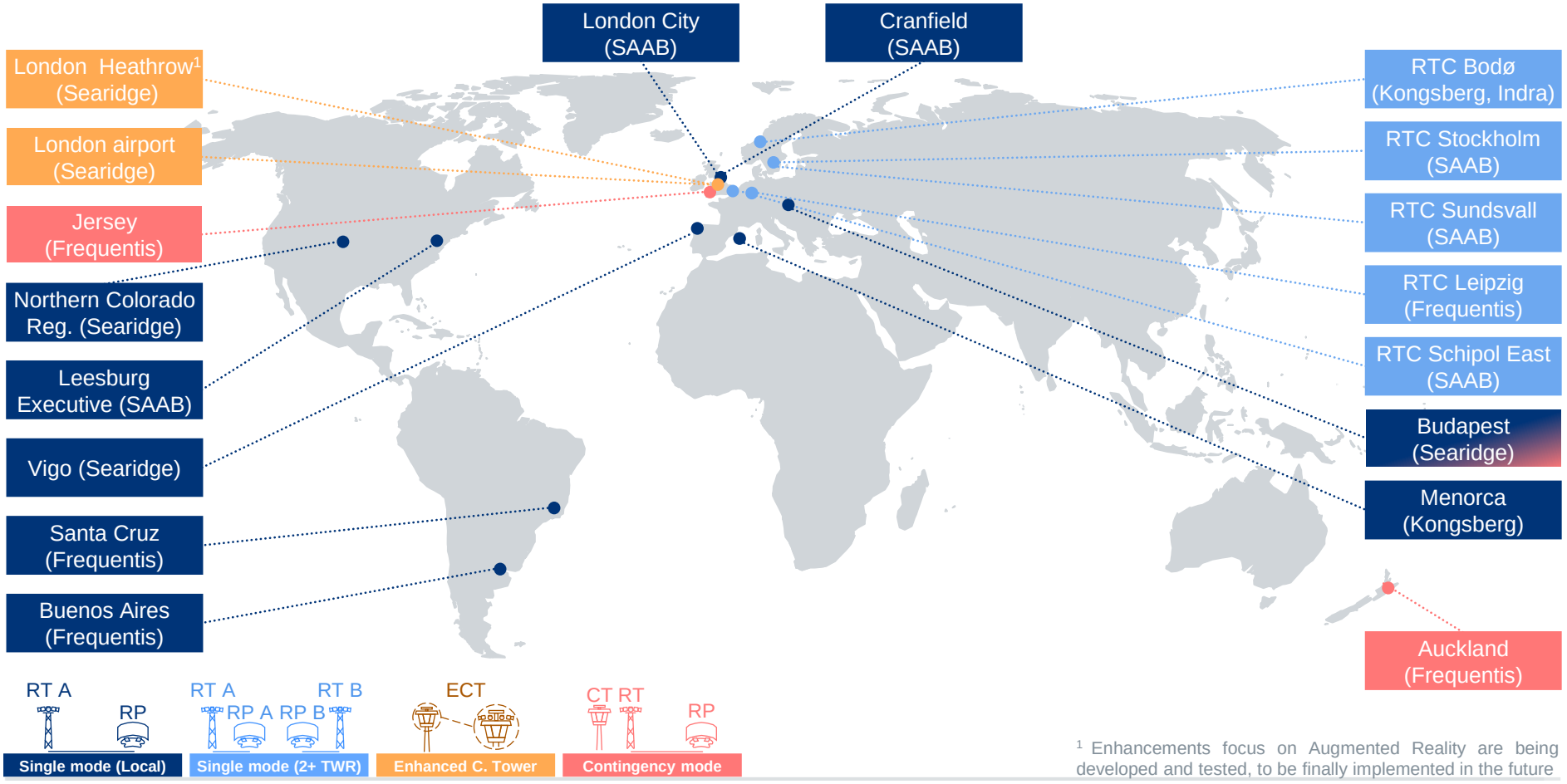
Regularly updated with last developments in the sector

Current regulatory landscape is well-advanced, thanks mainly by the growing interest of CAAs, ANSPs, and Airport Operators in implementing Remote Tower technologies

Source: ALG Analysis

The RT solution has been already implemented in several locations worldwide, being Norway and Sweden at the forefront of the sector

Digital towers operating worldwide



[1] Enhancements focus on Augmented Reality are being developed and tested, to be finally implemented in the future

Source: ALG Analysis

Content

This section conducts a preliminary identification of the current needs for additional infrastructure implementation

Methodology for the gap analysis of procedures and CNS infrastructure

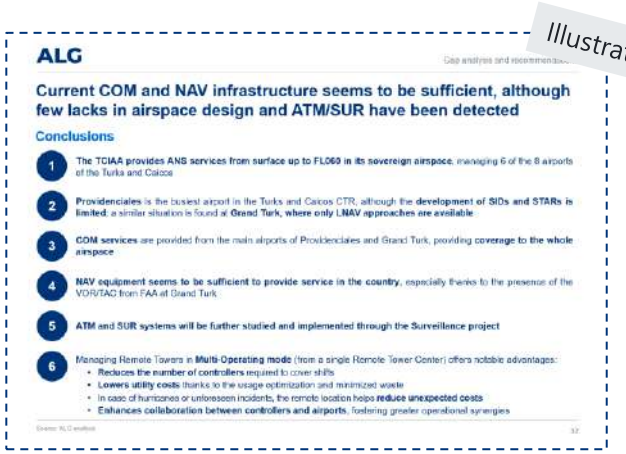
1 Consolidation of findings and proposal

- Collection of findings from Airspace configuration
- Collection of findings from ATM/CNS Infrastructure
- Collection of findings from Remote Tower

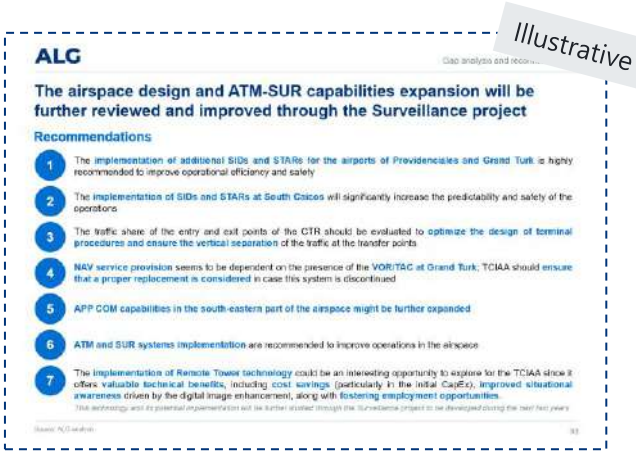
2 Execution of gap analysis and recommendations

- Development of recommendations for the improvement of ANS service provision and deployment of Remote Tower technology in the Turks and Caicos Islands

Illustrative



Illustrative



Source: ALG analysis

Current COM and NAV infrastructure seems to be sufficient, although few lacks in airspace design and ATM/SUR have been detected

Conclusions

1. **The TCIAA provides ANS services from surface up to FL060 in its sovereign airspace**, managing 6 of the 8 airports of the Turks and Caicos

2. **Providenciales** is the busiest airport in the Turks and Caicos CTR, although the **development of SIDs and STARs is limited**; a similar situation is found at **Grand Turk, where only LNAV approaches are available**

3. **COM services** are provided from the main airports of Providenciales and Grand Turk, providing **coverage to the whole airspace**

4. **NAV equipment seems to be sufficient to provide service in the country**, especially thanks to the presence of the VOR/TAC from FAA at Grand Turk

5. **ATM and SUR systems will be further studied and implemented through the Surveillance project**

6. Managing Remote Towers in **Multi-Operating mode** (from a single Remote Tower Center) offers notable advantages:
   - **Reduces the number of controllers** required to cover shifts
   - **Lowers utility costs** thanks to the usage optimization and minimized waste
   - In case of hurricanes or unforeseen incidents, the remote location helps **reduce unexpected costs**
   - **Enhances collaboration between controllers and airports**, fostering greater operational synergies

Source: ALG analysis

The airspace design and ATM-SUR capabilities expansion will be further reviewed and improved through the Surveillance project

Recommendations

1. The **implementation of additional SIDs and STARs for the airports of Providenciales and Grand Turk** is highly recommended to improve operational efficiency and safety

2. The **implementation of SIDs and STARs at South Caicos** will significantly increase the predictability and safety of the operations

3. The traffic share of the entry and exit points of the CTR should be evaluated to **optimize the design of terminal procedures and ensure the vertical separation** of the traffic at the transfer points

4. **NAV service provision** seems to be dependent on the presence of the **VOR/TAC at Grand Turk**; TCIAA should **ensure that a proper replacement is considered** in case this system is discontinued

5. **APP COM capabilities in the south-eastern part of the airspace might be further expanded**

6. **ATM and SUR systems implementation** are recommended to improve operations in the airspace

7. The **implementation of Remote Tower technology** could be an interesting opportunity to explore for the TCIAA since it offers **valuable technical benefits**, including **cost savings** (particularly in the initial CapEx), **improved situational awareness** driven by the digital image enhancement, along with **fostering employment opportunities**.

   This technology and its potential implementation will be further studied through the Surveillance project to be developed during the next two years

Source: ALG analysis

ALG

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