Enclosure 4

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MITRE

Center for Advanced
Aviation System Development

Cancún Airport Terminal Maneuvering Area Redesign

Summary of Recent MITRE Team Trip to Cancún

Prepared for

Aeropuertos y Servicios Auxiliares

June 2015

Principal Acronyms and Abbreviations

ACC	Area Control Center
APP	Approach Control
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ft	feet
HITL	Human-in-the-Loop
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
KMSP	Minneapolis/St. Paul International Airport
MITRE	The MITRE Corporation
MMCZ	Aeropuerto Internacional de Cozumel
MMUN	Aeropuerto Internacional de Cancún
MSL	Mean Sea Level
NAICM	Nuevo Aeropuerto Internacional de la Ciudad de México
NM	Nautical Mile
PMT	Project Management Team
RNAV	Area Navigation
SENEAM	Servicios a la Navegación en el Espacio Aéreo Mexicano
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival Route
TMA	Terminal Maneuvering Area
VFR	Visual Flight Rules

1. Introduction

The MITRE Corporation (MITRE) is assisting Aeropuertos y Servicios Auxiliares and the aviation authorities of Mexico with the implementation of a new airport, referred to in this document as Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM), to replace the current Aeropuerto Internacional de la Ciudad de México. The proposed runway layout of NAICM will allow for dual- and triple-independent arrival and departure operations. In connection with that, MITRE is assisting the Mexican aviation authorities in implementing independent arrival and departure operations at Aeropuerto Internacional de Cancún (hereinafter referred to by its 4-letter International Civil Aviation Organization [ICAO] code of MMUN) to and from its two existing parallel runways. This would provide a significant increase in capacity for MMUN. Moreover, it would also allow MMUN to serve as a test location where Mexican air traffic controllers could obtain an understanding of the issues associated with independent operations, and gain valuable experience for the future implementation of such procedures at NAICM.

MITRE has been working closely with Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM) since late 2014 providing important guidance and support regarding the transition to independent operations in Mexico. For example, MITRE provided information on the principal requirements for surveillance, display, and communications for conducting dual- and triple-independent operations, as well as important airspace and Air Traffic Control (ATC) elements to be considered in preparing NAICM and MMUN for conducting these complex operations. Assistance regarding the key elements for consideration during SENEAM's MMUN redesign work, including initial MITRE-developed airspace concepts intended to facilitate the airspace redesign process with SENEAM, were also provided.

MITRE also provided guidance to SENEAM on its development of a project plan to support the implementation of dual independent operations at MMUN. SENEAM's project plan, which is still a work in progress, will include the necessary milestones to design and implement dual independent operations at MMUN. In providing this support, the MITRE team has worked very closely with CTA. Bruce Magallón, the Adjunct Director of Air Traffic. CTA. Magallón also serves as MITRE's SENEAM-related Point of Contact as well as the overall MMUN project leader. Various organizational meetings with CTA. Magallón have been held that resulted in the development of the above-mentioned SENEAM project plan along with a SENEAM Project Management Team (PMT) structure. As a result, the SENEAM and MITRE teams have an organized and well thought-out plan to appropriately advance on the implementation of dual independent operations at MMUN.

To support the MMUN project, a large team of MITRE engineers visited Cancún from 18 through 22 May 2015 to assist SENEAM in the redesign of the MMUN airspace to support dual independent operations. The objectives of the visit were as follows:

- To meet with SENEAM project leaders to discuss, plan, and coordinate various project-related matters

- To visit the MMUN Approach Control (APP), MMUN Air Traffic Control Tower (ATCT) and Mérida Area Control Center (ACC) to gather information that will assist MITRE in facilitating its airspace redesign support to SENEAM
- To visit the controller training center in Mérida to gather information on the simulation capabilities currently available
- To conduct a workshop to develop an airspace design for dual independent arrival and departure operations at MMUN

This report is intended to describe the key activities that occurred during MITRE's visit, and to highlight key actions and decisions that were made during the airspace design workshop that was conducted. This document is structured as follows:

- Section 1 provides background and context for MITRE's airspace work at MMUN
- Section 2 summarizes the meetings, discussions and visits that were held
- Section 3 provides a summary of the main actions and decisions that were occurred during the visit
- Section 4 provides closing remarks

2. Meetings, Discussions, Facility Visits and Airspace Design Workshop

This section provides a description of the meetings, discussions and visits that took place during MITRE's 18 through 22 May 2015 visit to Cancún. During this visit, an intense airspace design workshop was held with a dedicated SENEAM airspace design team to develop an airspace concept for dual independent arrival and departure operations at MMUN. The rest of this section is divided into subsections that reflect the topics that were discussed during MITRE's visit.

2.1 SENEAM-MITRE Planning and Coordination Meeting

Part of the MITRE team met with CTA. Magallón and CTA. Fernando Villasana Cruz, the Vice Manager of Air Traffic Services at MMUN and local Cancún project leader, to review the project and its milestones. The strategy for using MMUN as a test location for implementing independent procedures similar to those being planned for NAICM was also discussed. The following bullets describe the briefings that MITRE presented and the key topics that were discussed:

- Overview of the 18 through 22 May 2015 Visit Agenda
    - MITRE presented an overview of the agenda for the week to provide SENEAM with the necessary time to conduct any coordination necessary for the upcoming presentations and discussions. The activities for each day were discussed and any modifications were made to accommodate the participants' schedules.

- Project Status
  - A project status briefing was presented by MITRE to update CTA. Villasana on the preparatory work that MITRE has been conducting and the outcome of other technical meetings that were conducted over the past few months. The briefing included information on the overall objective of the MMUN project, a review of the roles and responsibilities of both MITRE and SENEAM, as well as a description of activities already conducted.
- Overview of Key Project Plan Milestones
  - MITRE presented a briefing on the key milestones that should be included in SENEAM's MMUN project plan. It is important to mention that the timeframe for implementing independent arrival and departure procedures at MMUN is initially planned for 2018. The milestones in the project plan therefore include activities that would occur in the time range from 2015 to 2018.

    The briefing was divided into two parts: the first part emphasized in some detail the numerous milestones that should occur during 2015, while the second part covered, at a higher level, the milestones from year 2016 through 2018. The key MMUN project milestones for SENEAM to achieve in 2015 include:

    - Preparation of an acquisition document (Operational and Technical Requirements) for the additional ATC equipment needed to support dual independent operations
    - Establishment of operation room layouts (MMUN APP, MMUN ATCT, and Mérida ACC, if necessary) and controller working position equipment layouts
    - Preparation of an acquisition document for two Instrument Landing Systems (ILSs) and two Approach Lighting Systems for Runways 30L and 30R
    - Decision on the location (i.e., in Mexico or at MITRE's laboratory) of the first Human-in-the-Loop (HITL) simulations for MMUN. Note that this decision depends on the appropriateness of the capabilities of SENEAM's current simulation equipment to conduct HITLs, as well as the potential need and timing for SENEAM to acquire appropriate equipment to conduct HITLs, if necessary. See next bullet.
    - Decision regarding the acquisition of HITL simulation equipment for both MMUN and NAICM. Decisions on purchasing such equipment would have to be made at the highest level in SENEAM. Other associated decisions on where to locate such equipment and what facilities need to be provided must also be made.

- Completion of an airspace design concept for the MMUN area that includes procedures for Aeropuerto Internacional de Cozumel (ICAO Code: MMCZ), in both runway directions (MMUN Runways 12 and 30, and MMCZ Runways 11 and 29). The design should consider important factors such as Visual Flight Rules (VFR) routes and procedures, connection to the enroute routes, as well as ATC sectorization to support the procedures.

- SENEAM's Project Management Plan (Roadmap) and PMT
  - CTA. Magallón presented SENEAM's MMUN project plan along with its PMT. The head of the PMT is the person responsible for all the activities related to implementing independent arrival and departure operations at MMUN. CTA. Magallón will oversee the PMT structure, and will set up the remaining organization and assign the responsibilities of each position.

    SENEAM understands the importance of having controllers from the Mérida ACC and MMUN APP and ATCT "buy-in" to the various changes that need to occur for the successful implementation of independent arrival and departure operations at MMUN. There is also full agreement that there is a need to include the major airlines operating at MMUN (and other stakeholders) in the airspace planning task at the appropriate time. Successfully implementing independent arrival and departure operations at MMUN, even though there may not be a traffic demand need for it at this time, is an important step towards successfully implementing dual- and triple-independent arrival and departure operations at NAICM.
  - MITRE emphasized the need for regular meetings and telephone conference calls. It was agreed to plan on having regular telephone conference calls with CTA. Magallón and CTA. Villasana, and with other members of the MMUN airspace design team at appropriate times, in order to maintain momentum on the project and meet the many milestones contained in the project plan. Timing for each telephone conference call will be coordinated individually at mutually agreed upon times.

- MITRE reviewed and discussed several other key items, including:
  - Outstanding data items and the clarification of questions that MITRE had on some of the data that was received from SENEAM
  - Methods for exchanging airspace design data between SENEAM and MITRE
  - Additions to the existing training facilities (simulators and classrooms) that are being planned for at SENEAM's Headquarters complex in Mexico City
  - MITRE engagement with Dirección General de Aeronáutica Civil
  - Location of the new MMUN APP. Two options exist: for the MMUN APP to remain at the current location and expand facilities there, or to relocate the MMUN APP to the base of the existing MMUN ATCT. Both options offer

advantages and disadvantages. An early decision is needed due to the time required for any new construction work.

2.2 MITRE Visit to MMUN APP and MMUN ATCT Facilities

MITRE engineers visited the MMUN APP and MMUN ATCT to develop a better understanding of the operations currently being conducted at the facilities. Key topic areas that were observed and/or discussed during the visit to the facilities were:

- The handling of Instrument Flight Rules and VFR traffic near MMUN since MMUN ATCT "owns" no airspace
- Distances or times to separate aircraft on the final approach course(s) and for aircraft departing MMUN
- Hand-off procedures between the MMUN ATCT and MMUN APP, and between MMUN APP and Mérida ACC
- Existing control room layout for both the MMUN APP and MMUN ATCT, as well as the schedule of opening and closing sectors
- Sector workload issues, sector capacity numbers and "hotspots" for aircraft conflicts within the MMUN Terminal Maneuvering Area (TMA)
- Communication and coordination procedures with other ATC facilities regarding the aircraft arrival schedule

2.3 Technical Presentations and Discussions

MITRE made several technical presentations to SENEAM's airspace design team that consisted of representatives from Mérida ACC, MMUN APP and MMUN ATCT. The purpose of the presentations was to inform the airspace design team of the work that MITRE has been conducting regarding the implementation of independent operations at MMUN.

- Overview of the Project
    - The purpose of the presentation was to explain to the airspace design team the project objectives, MITRE's and SENEAM's roles and responsibilities and the project status. The agenda for the rest of the week was also reviewed and an overview and outcome of the planning meeting that was held the previous day was provided.
- Airspace Design Methodology, Initial Data Analysis, Operational Requirements and Notional Airspace Concepts for MMUN
    - The purpose of this presentation was to discuss MITRE's airspace design methodology, the results of its initial analysis of MMUN operational statistics, dual independent operational requirements, as well as the notional airspace concepts that MITRE developed for MMUN that were used as a starting point for more detailed airspace design work. See the enclosure to MITRE

Technical Letter F500-L15-015, *Cancún Airport Terminal Maneuvering Area Redesign-Airspace Methodology, Initial Data Analysis and Notional Airspace Concepts,* dated March 2015 for additional information.

Several intense discussions on other important technical matters were also conducted during MITRE's visit. The following describes a few of the key items that were discussed at length:

- SENEAM Initial Airspace Concepts and Operational Issues at MMUN
    - SENEAM's airspace design team had researched other airports that had an airport configuration similar to that of MMUN to develop their own initial airspace design concept. The concept they developed was similar to that of the Minneapolis-Saint Paul International Airport (ICAO code KMSP) in the United States, which has a similar runway orientation as MMUN and conducts independent operations. The SENEAM concept included routes designed to offload traffic onto the adjacent runway to assist with balancing traffic demand between the two runways. The Standard Terminal Arrival Routes (STARs) inside the MMUN TMA would be based on Area Navigation (RNAV) 1. The departure routes that currently exist would change very little.
    - SENEAM also provided information on current operational issues at MMUN that include sector workload, unpredictability of the length of final on a day-to-day basis and areas of crossing traffic. Ideally, the airspace design implemented to support dual independent arrival and departure operations at MMUN would also address these important issues.
- SENEAM Proposed Operations Room Layout
    - SENEAM presented their proposed control room layout for the expanded MMUN APP along with the equipment and positions. MITRE made some suggestions for changes to the layout presented and the reasoning for those changes.

      One important note to make is that ATC sectorization for the new airspace design has not yet been defined. This could have an important impact on the final MMUN APP operations room layout, with potentially more controller positions needed. The operations room layout should not be finalized until the sectorization has been defined. Space for future expansion should also be considered.
- Discussion with Official from Aeropuertos del Sureste
    - Ing. Carlos Trueba Coll, the Director of MMUN, met with the MITRE and SENEAM teams to discuss airport-related matters. The purpose of the meeting was to introduce the MITRE team to Mr. Trueba and make him fully aware of the work that MITRE was conducting for MMUN. The discussion with Mr. Trueba was extremely useful and he provided the MITRE and SENEAM teams with helpful information regarding MMUN. MITRE now

has an excellent relationship with Mr. Trueba who offered to provide assistance on the project.

2.4 MITRE Visit to the Mérida ACC and Training Facilities

MITRE travelled to Mérida to visit the Mérida ACC to observe operations and hold discussions with controllers. MITRE also visited the training facilities located at the Mérida ACC in order to understand the capabilities of the training equipment for potential use in conducting simulation evaluations. The key topics discussed and covered during the visit to the Mérida ACC facility include the following:

- Operations Room
  - The dimensions and responsibilities of four sectors that serve the MMUN TMA
  - The type of radar and the coverage areas, as well as the radar separation standards used between aircraft
  - The hand-off requirements between the sectors and the surrounding ACCs
  - The existence of any sector capacity limitations and the times of the day that the sectors are opened or closed
  - The existence of any noise sensitive areas or other restrictions not published in the Aeronautical Information Publication
  - The typical traffic demand the sectors experience and sector operating procedures
- Training Facility
  - The five possible simulation positions (each simulating two controller positions) with a possibility of four pseudo-pilot stations
  - The current simulator only has replay capability and does not collect metrics
  - The modification of the waypoint, navigational aids, and other environmental data is a manual process
  - The creation/modification of the flight plan file requires about two minutes per flight and is done manually for each flight. This is a time consuming process and does not allow for quick creation and/or modification to the scenario of the simulation. The manual modification process can lead to data entry errors.
- Other Key Topics
  - SENEAM provided MITRE with a demonstration of the enroute airspace design concept called the "Arrival Master" that they were considering for the enroute airspace. This concept includes two point-merge arrival structures that are located in the enroute airspace and would deliver aircraft to the TMA

well inside the TMA's airspace. The concept is that one of the point-merge arrival structures would feed one runway at MMUN and the other point-merge arrival structure would feed the other runway.

MITRE provided feedback on this concept to CTA. Magallón, including pros and cons in relation to its application to an independent operational environment. Another important consideration was that this type of concept is not being considered for use at NAICM, which would reduce the benefit of using MMUN as a test location for eventual independent operations at NAICM. Afterwards, a decision was made by SENEAM to pursue a different concept that would be similar to the enroute route structure being planned for NAICM.

2.5 SENEAM-MITRE Airspace Workshop

The airspace design workshop sessions were an opportunity for SENEAM and MITRE to further develop airspace design concepts for dual independent arrival and departure operations at MMUN. The workshops consisted of drawing the design ideas first on paper and then transcribing them into MITRE's Terminal Area Route Generation Evaluation and Traffic Simulation airspace design tool.

The SENEAM team also worked independently and developed additional airspace concepts during MITRE's visit to Mérida, which were then presented to MITRE for review and feedback. The results of the airspace design workshop sessions are shown in Figures 1 and 2 below. Although the designs are still a work in progress, they represent a very strong foundation for which to build upon.

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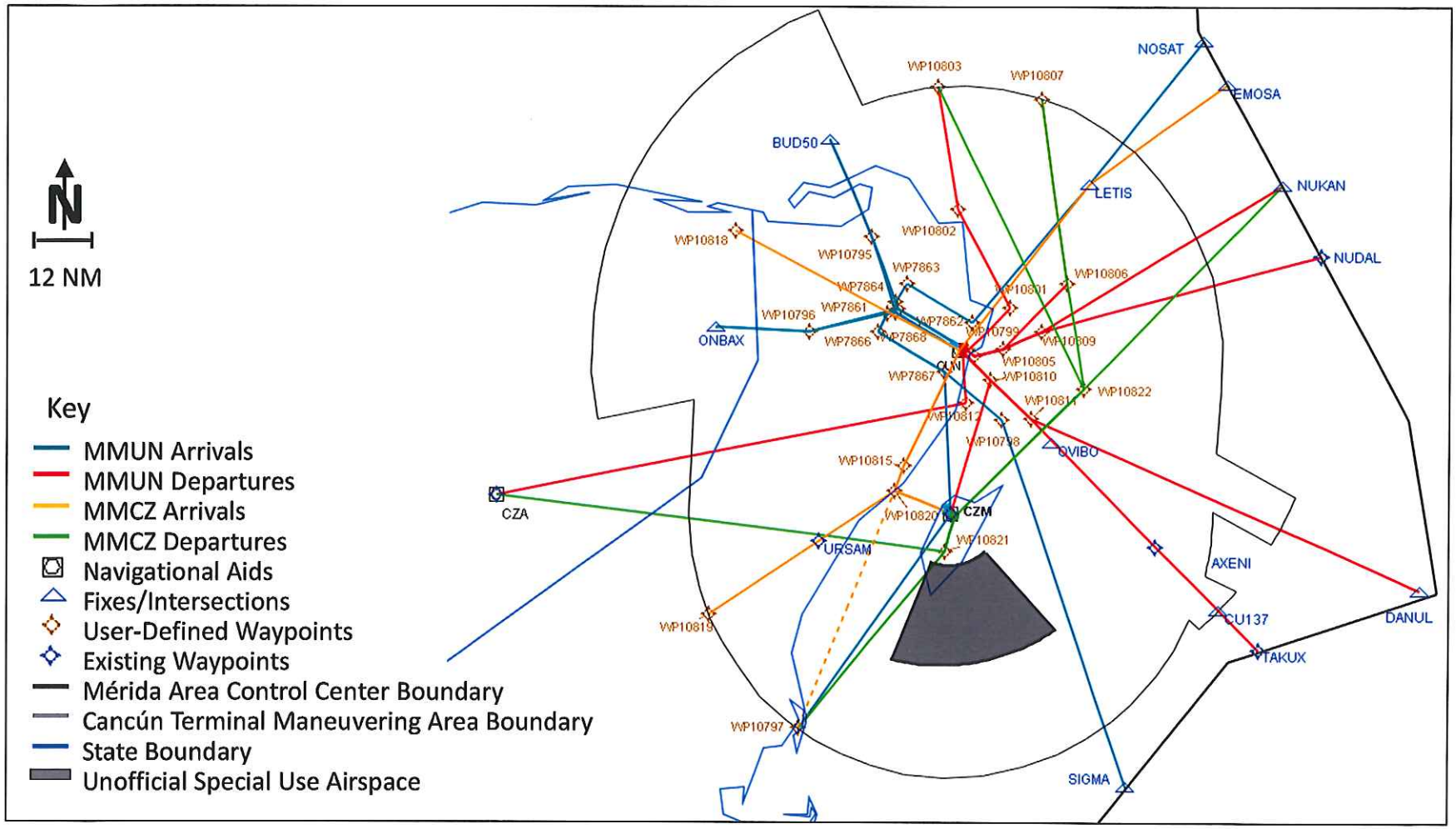

Figure 1. Airspace Concept for MMUN Runway 12 Direction and MMCZ Runway 11 Direction (Not to be Considered Final)

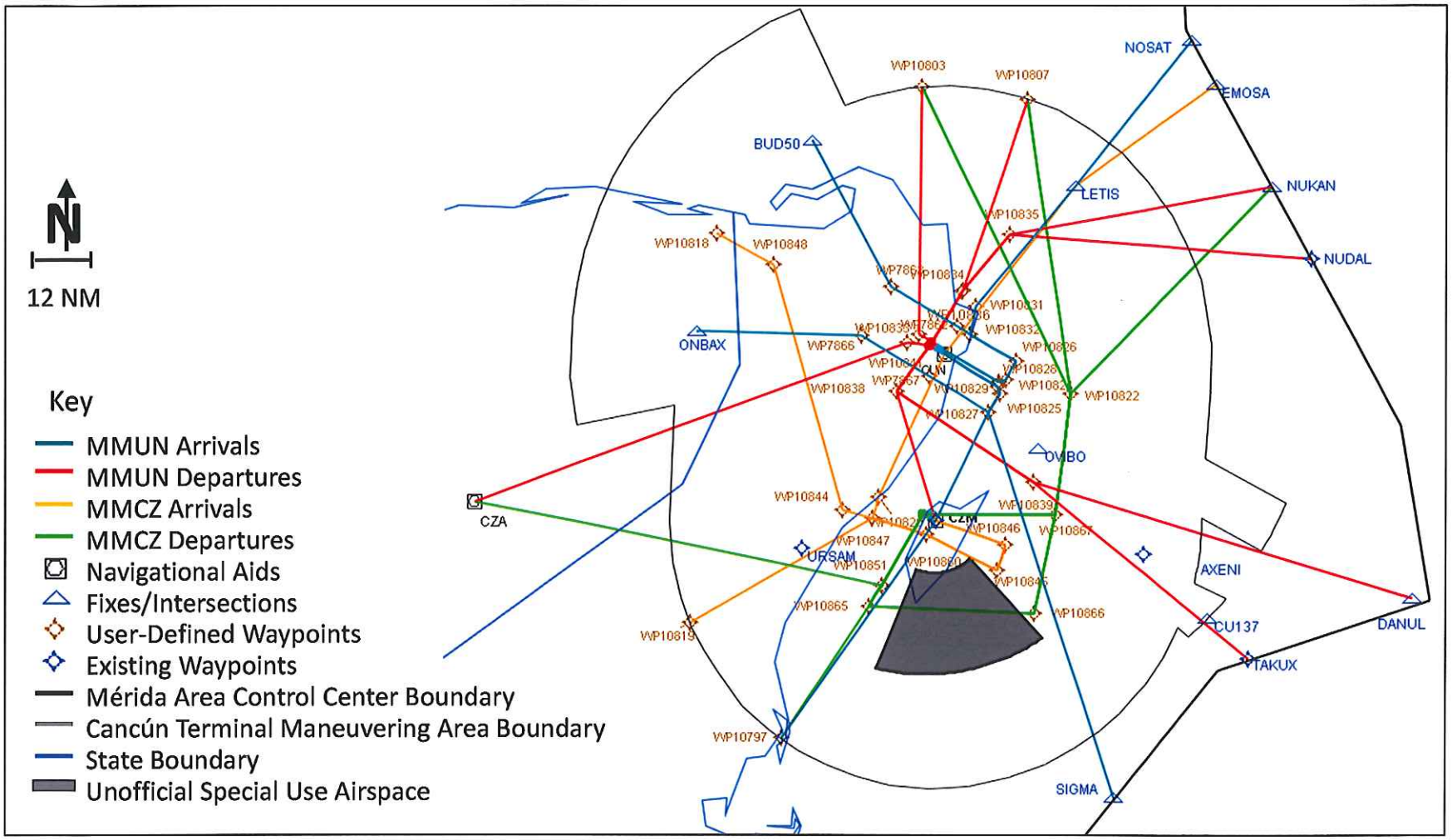

Figure 2. Airspace Concept for MMUN Runway 30 Direction and MMCZ Runway 29 Direction
(Not to be Considered Final)

3. Key Decisions and Actions

This section provides a summary list of the key decisions and action items that were the result of the technical meetings, facility visits and airspace workshops conducted during the week of 18 through 22 May 2015 in Cancún. These decisions were the result of discussions that were held between MITRE and SENEAM concerning the airspace design that is being developed. The action items concentrated on those tasks that need to be completed primarily by SENEAM by the next airspace workshop (tentatively being planned for the late summer/early fall 2015 timeframe) with support and guidance from MITRE along the way.

3.1 Key Decisions

- For MMUN, the airspace design will use RNAV 1 STARs to ILS approaches. For non-RNAV-equipped aircraft, the controllers will radar vector these aircraft to an ILS approach.
- The same final approach course intercept altitudes of 2000 feet (ft) Mean Sea Level (MSL) for Runway 12R and 30L, and 3000 ft MSL for Runway 12L and 30R will be utilized
- The downwind legs are route segments parallel to, and six nautical miles (NM) from the final approach course
- The entry and exit points on the Mérida ACC boundary will remain the same as today
- The existing arrival "cone" concept will not be included in the airspace design for dual independent operations at MMUN
- New entry and exit points were defined on the proposed MMUN TMA boundary (reduction of the TMA boundary in the northwest and extension of the TMA boundary to the Havana ACC). These are denoted by the letters "WP" followed by a number. Such waypoints will eventually need to be allocated a 5-letter pronounceable code. The entry and exit points for both MMUN and MMCZ are listed below.
    - MMUN Entry Points
        - NOSAT
        - BUD50
        - ONBAX
        - New waypoint in the south (WP10797)
        - SIGMA
    - MMUN Exit Points
        - NUKAN

        - Two new waypoints in the north (WP10807 and WP10803)
        - New waypoint on the west serving CZA (currently not named or displayed)
        - TAKUX
        - DANUL
        - NUDAL
    - MMCZ Entry Points
        - EMOSA
        - New waypoint midway between BUD50 and ONBAX (WP10818)
        - New waypoint to the southwest (WP10819)
        - Conventional route new entry waypoint (WP10797)
    - MMCZ Exit Points
        - NUKAN
        - Two new waypoints in the north (WP10807 and WP10803)
        - New waypoint on the west serving CZA (currently not named or displayed)
        - New waypoint in the south (WP10797)
- The departures for Runway 12R and Runway 30L will diverge from the departures from Runway 12L and Runway 30R, the straight ahead departures, by at least 15 degrees
- Both RNAV and conventional navigation Standard Instrument Departures (SIDs) are needed at MMCZ
- Only RNAV SIDs are necessary at MMUN with radar vectoring by the controllers used to transition aircraft from the runway to the beginning of the SID. It is possible that conventional SIDs will need to be developed for low-performing aircraft (this has yet to be decided).
- The vertical altitude of the TMA will be expanded to Flight Level 245
- MMUN will use open transitions to the final approach course. STARs will end at a point in space on the downwind at a specified altitude and speed, and controllers will vector the aircraft to the final approach course. Whether or not to have a "fail safe" procedure to transition the aircraft onto the final approach course in the event of a radar or radio failure has yet to be decided.

3.2 Key Actions

- SENEAM will begin to explore the idea of expanding the current TMA boundaries east to the Havana Flight Information Region boundary between SIGMA and NOSAT
- MITRE will provide hard copies of the charts of the airspace concepts to SENEAM along with the latitude and longitude coordinates of each of the points on each route definition. (Note: this was completed on 29 May 2015.)
- SENEAM will refine the airspace concepts to:
    - Determine if the filed flight distance can be reduced
    - Develop the conventional routes that are necessary
    - Determine the vertical constraints necessary for each route profile to separate the routes procedurally where two routes cross
- SENEAM will determine the holding locations and altitudes for aircraft inside and outside the TMA
- SENEAM will coordinate with the controllers at the Mérida ACC regarding the proposed airspace design concept for the MMUN TMA that was developed during the airspace workshop
- SENEAM will begin to coordinate with Mérida ACC to consider reducing the northwest portion of the TMA from 70 NM from MMUN to 50 NM from MMUN
- SENEAM will send their finalized design to MITRE for review and feedback
- SENEAM will begin to analyze and develop a sectorization concept for the proposed airspace design including the enroute airspace

4. Closing Remarks

MITRE's visit to Cancún to meet with officials from SENEAM was extremely successful. MITRE was able to gain insight into SENEAM's project plan and PMT structure, and review the importance of near-term milestones with the Cancún project leaders. Additional data was obtained during the visit and many outstanding issues were clarified. MITRE was able to observe traffic and gather information on the operations at Mérida ACC, MMUN APP and MMUN ATCT. The airspace workshop described in this document was conducted with a dedicated SENEAM airspace design team and resulted in an airspace design for both MMUN and MMCZ with the potential to support dual independent operations at MMUN.