Current Status and Future Navigation Requirements for Mexico City New Airport
NUEVO AEROPUERTO DE LA CIUDAD DE MÉXICO

- **120 millones de pasajeros al año**
- **1.2 millones de toneladas de carga anuales**
- **160 mil empleos en la etapa de construcción**
- **600 mil en la etapa de operación**
- **4 mil 430 hectáreas, seis veces más que el actual**
- **6 pistas de operación triple simultánea**
- **400 mil m³ de construcción en edificio terminal**

**RESPONSABILIDAD AMBIENTAL**

- **100%** del suministro para su operación provendrá de fuentes energéticas renovables
- **70%** del uso del agua vendrá de sus propias aguas residuales tratadas
- **1er** aeropuerto, fuera de Europa, con una huella neutral en carbono

**¿POR QUÉ UN NUEVO AEROPUERTO?**

1. Generará empleo
2. Aumentará las inversiones
3. Elevará la productividad
4. Fortalecerá el ambiente de negocios
5. Permitirá desarrollo regional equilibrado
New Mexico City Airport in figures:

- 120 million passengers per year;
- 1.2 million tons of shipping cargo per year;
- 4,430 Ha. (6 times bigger than the current airport);
- 6 runways operating simultaneously;
- 1st airport outside Europe with a neutral carbon footprint;
- Largest airport in Latin America;
- 11.3 billion USD investment (aprox.);
- Operational in 2020 (expected).
“State-of-the-art navigation systems are as important—or more—than having world class civil engineering and a stunning architecture”

Air Navigation Systems:

A. **In-land deployed systems** - Are the most common, based on ground stations emitting radiofrequency signals received by on-board equipments to calculate flight position.

B. **Satellite navigation systems** – First established by U.S. in 1959 called *TRANSIT* *(by the time Russia developed TSIKADA)*; in 1967 was open to civil navigation; 1973 GPS was developed by U.S., then GLONASS, then GALILEO.

C. **Inertial navigation systems** – Autonomous navigation systems based on inertial forces, providing constant information on the position of the flight and parameters of speed and direction *(e.g. when flying above the ocean and there are no ground segments to provide support)*.
Requirements for performance of Navigation Systems:

According to the International Civil Aviation Organization (ICAO) there are four main requirements:

- The **accuracy** means the level of concordance between the estimated position of an aircraft and its real position.

- The **availability** is the portion of time during which the system complies with the performance requirements under certain conditions.

- The **integrity** is the function of a system that warns the users in an opportune way when the system should not be used.

- The **continuity** is the probability that a system will still be available for a determined period.
The CNS/ATM systems (Air Traffic Communications, Navigation and Surveillance/ Administration) are communication, navigation and surveillance systems that use digital technologies among them, satellite systems along with diverse levels of automation, in support of a global system of air traffic management.

- Communication: Exchange of voice and data information between the pilot and air traffic controllers.
- Navigation: Indicates the position and the location of the aircraft for the flight crew.
- Surveillance: Indicates the location and position of the aircraft to the air traffic controllers, includes the communication of the information for the navigation from the aircraft to the air traffic control centers which facilitates the continuous route of the relative positions of the aircraft.

There are three basic approaches in relation with the setting up and the management of CNS/ATM systems. These can be grouped together as national, regional and global systems. It is possible to choose for a combination of these approaches, depending on the different contexts.
Performance Based Navigation (PBN):

Is a point-to-point (take off – landing) navigation non depending on a specific technology or equipment. More than 10 years ago, FAA approved GPS for operational use.

Advantages:

• Reduce the need to maintain routes and procedures based on specific sensors and associated costs;
• Avoid the need of developing operations based on sensors that evolves with the navigation systems;
• Provide a more efficient use of Space;
Required Navigation Performance (RNP)

Developed by ICAO in the 1990’s as a standard for the requirements of current Air Space. Is defined as precision performance of navigation required to operate in a determined Air Space.

Air Navigation (RNAV)

RNAV is a navigation method that allows an aircraft to fly in any desired trajectory without the need of flying through waypoints predetermined by ground sectors.
Example of the advantages of PBN (RNP and RNAV)
Elements of GNSS:

The two central satellite constellations are the GPS and the GLONASS provided by the United States of America and the Russian Federation respectively.

These two systems provide independent competences and can be used in the combination with future central satellite constellations and systems of augmentation.

The existing central constellations are not good enough for the strict aeronautic requirements to satisfy the operational requirements in different stages of flight, these constellations demand an augmentation in shape of an Aircraft-Based Augmentation System (ABAS), Satellite-Based Augmentation System (SBAS), or Ground-Based Augmentation System (GBAS).

The Global Position System (GPS) and the Global Navigation Satellite System (GLONASS) have the capacity of providing the exact position information and currently globally.
SISTEMAS DE AUGMENTACIÓN BASADOS EN TIERRA (GBAS) 

GPS 

GALILEO (TBD) 

GLONASS 

SISTEMAS DE AUGMENTACIÓN BASADOS EN SATÉLITES (SBAS) 

SISTEMAS DE AUGMENTACIÓN BASADOS EN LA AERONAVE (ABAS)
Transition to GNSS

The implantation of the Global Navigation Satellite System (GNSS) will be carried out in an evolutionary manner, allowing the introduction of improvements in the system. The transition to the satellite navigation implies:

1. The coordinates conversion
2. Equip the aircrafts with a GNSS receptor, adequate for the ABAS function
3. Promulgation of Procedures
4. Implantation of the GNSS initially as a supplementary/primary mean and later on,
5. Implantation of the GNSS as a unique mean

The main stages of the GNSS transition are reached when:

1. The GNSS is approved as a supplementary use,
2. The GNSS is approved as a primary use,
3. The service is taken down of the conventional system.

As soon as the GNSS is cleared up fit as a primary use, a firm economic pressure to eliminate off the service the conventional systems. The use of the installations should be supervised and the ones that have the least consequences for the users taken down.
Architecture of a GNSS System
GNSS Augmentation Systems

There are mainly 3 types of Augmentation:

Aviation GNSS applications and products have been one of the main drivers of GNSS Augmentation systems. The ICAO GNSS Standards defines three architectures to augment GNSS constellations for aviation:

• ABAS (Aircraft Based Augmentation Systems);
• GBAS (Ground Based Augmentation System); and
• SBAS (Satellite Based Augmentation System).

Present ground-based navigation aids are monitored, and the monitor takes action if erroneous signals are being radiated. On the present configuration of the GNSS system it may take considerable time before users become aware of any malfunctioning.
**ABAS**

The Aircraft based augmentation can provide GNSS information as necessary for supplemental means of navigation.

An ABAS is basically a system that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft.

**GBAS**

The GBAS provide GNSS integrity monitoring through data obtained from the ground. They also increase the accuracy of satellite navigation, clearing the way for GNSS precision approach and landing.

A ground station at the airport transmits locally-relevant corrections, integrity data and approach data to aircraft at the terminal area in the VHF band.
SBAS

SBAS systems implemented in several regions improves the accuracy, reliability and integrity of the GPS signal. GNSS-SBAS navigators that meet international organizations regulations (such as ICAO, FAA, Eurocontrol) may be used for sole means of navigation for all phases of flight, including precision approach at airports.

The SBAS systems offer an opportunity for airports to gain Instrument Landing System (ILS) approach capability without the purchase or installation of any ground-based navigation equipment at the airport.
WAAS

WAAS is an extremely accurate navigation system developed for civil aviation. Before WAAS, the U.S. National Airspace System (NAS) did not have the potential to provide horizontal and vertical navigation for approach operations for all users at all locations. With WAAS, this capability is a reality.

WAAS provides service for all classes of aircraft in all phases of flight - including en route navigation, airport departures, and airport arrivals. This includes vertically-guided landing approaches in instrument meteorological conditions at all qualified locations throughout the NAS.

The WAAS allow GPS to be used as a primary means of navigation from takeoff through Category I precision approach. Other modes of transportation also benefit from the increased accuracy, availability, and integrity that WAAS delivers. The WAAS broadcast message improves GPS signal accuracy from 100 meters to approximately 7 meters.
SEGMENTO ESPACIAL
- GPS
- GLONAS
- GALILEO
- IRNSS
- QSJJ

SEGMENTO DE USUARIO
- ANTENA
- RECEPTOR
- CALCULO DE RANGO
- CALCULO DE NAVEGACION

SEGMENTO DE CONTROL
- ESTACION DE MONITOREO
- ESTACION DE CONTROL
Current situation in Mexico

Navigation in Mexico is based on:

- VOR (VHFOmnidirectional Radio Range);
- NDB (non-directional (radio) beacon);
- DME (Distance Measuring Equipment);
- ILS (Instrumemtal Landing System);
- INS (Inertial Navigation System);
- MLS (Microwave Landing System);
- RADAR (radio detection and ranging);
- PSR (Primary Surveillance Radar);
- SSR (Secondary surveillance radar).

But this is NOT enough!
The technologies mentioned above proved to be not-so-efficient in terms of fuel consumption and air traffic control.
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Conclusions and Recommendations

• The new International Airport of Mexico City is projected to be operational by 2020.

• By 2025 the PBN will be a standard in US, after the successful implementation of the NextGen Program.

• Time and resources can be saved if Mexico starts promoting this navigation technologies among the country.

• Advantages for Mexico towards implementing this technology:

1. WAAS Coverage;
2. We are still in the planning stage of the new airport;
3. Opportunity to be at the state of the art in air security and navigation.
Some of the benefits of having a National Augmentation System or to civil aviation will be:

1. Greater runway capability;
2. Reduced separation standards which allow increased capacity in a given airspace without increased risk;
3. More direct enroute flight paths;
4. New precision approach services;
5. Reduced and simplified equipment on board aircraft;
6. Significant government cost savings due to the elimination of maintenance costs associated with older, more expensive ground-based navigation aids (to include NDBs, VORs, DMEs, and most Category 1 ILSs)
• Other types of transportation and applications would also benefit from the increased accuracy, availability, and integrity that an augmentation system provides.

• Based on comparison, the new airport should support at least one RNAV STAR procedure and one RNP approach procedure.

• RNAV procedures can provide benefit in all phases of flight, including departure, en route, arrival, approach, and transitioning airspace. For example, Standard Terminal Arrivals (STARs) can:

1. Increase predictability of operations;
2. Reduce controller/aircraft communications;
3. Reduce fuel burn with more continuous vertical descents;
4. Reduce miles flown in Terminal Radar Approach Control (TRACON) airspace;
5. Reduce interaction between dependent flows in multiplex airspace.
• RNAV and RNP specifications facilitate more efficient design of airspace and procedures which collectively result in improved safety, access, capacity, predictability, operational efficiency, and environment.
Thank you!

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