AEM

AGENCIA
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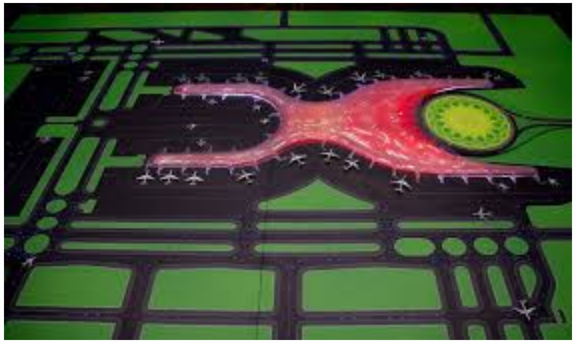
MEXICANA

Current Status and Future Navigation Requirements for Mexico City New Airport



NUEVO AEROPUERTO
DE LA CIUDAD DE MÉXICO

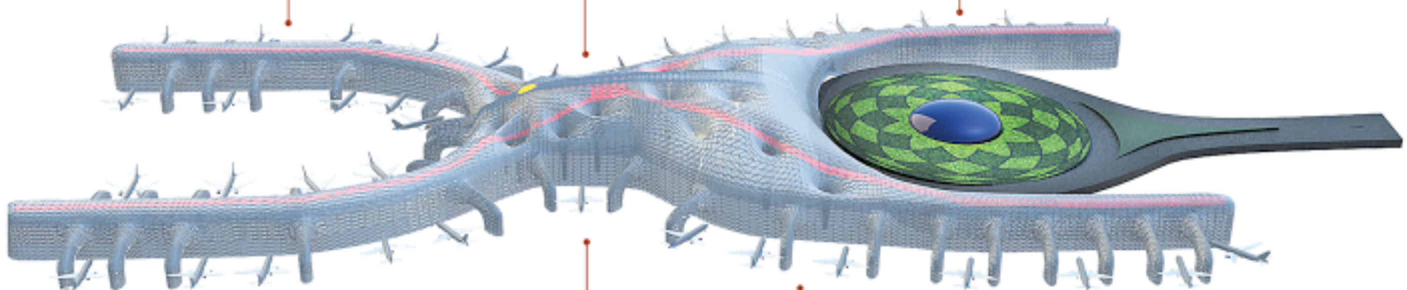
Infografía por • Wendy Rosales

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



El aeropuerto más grande de Lationamérica

4 mil 430 hectáreas, seis veces más que el actual

6 pistas de operación triple simultánea

400 mil m² 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 tan 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 arquitecture"

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 stablished 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.

CNS/ATM Systems

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.

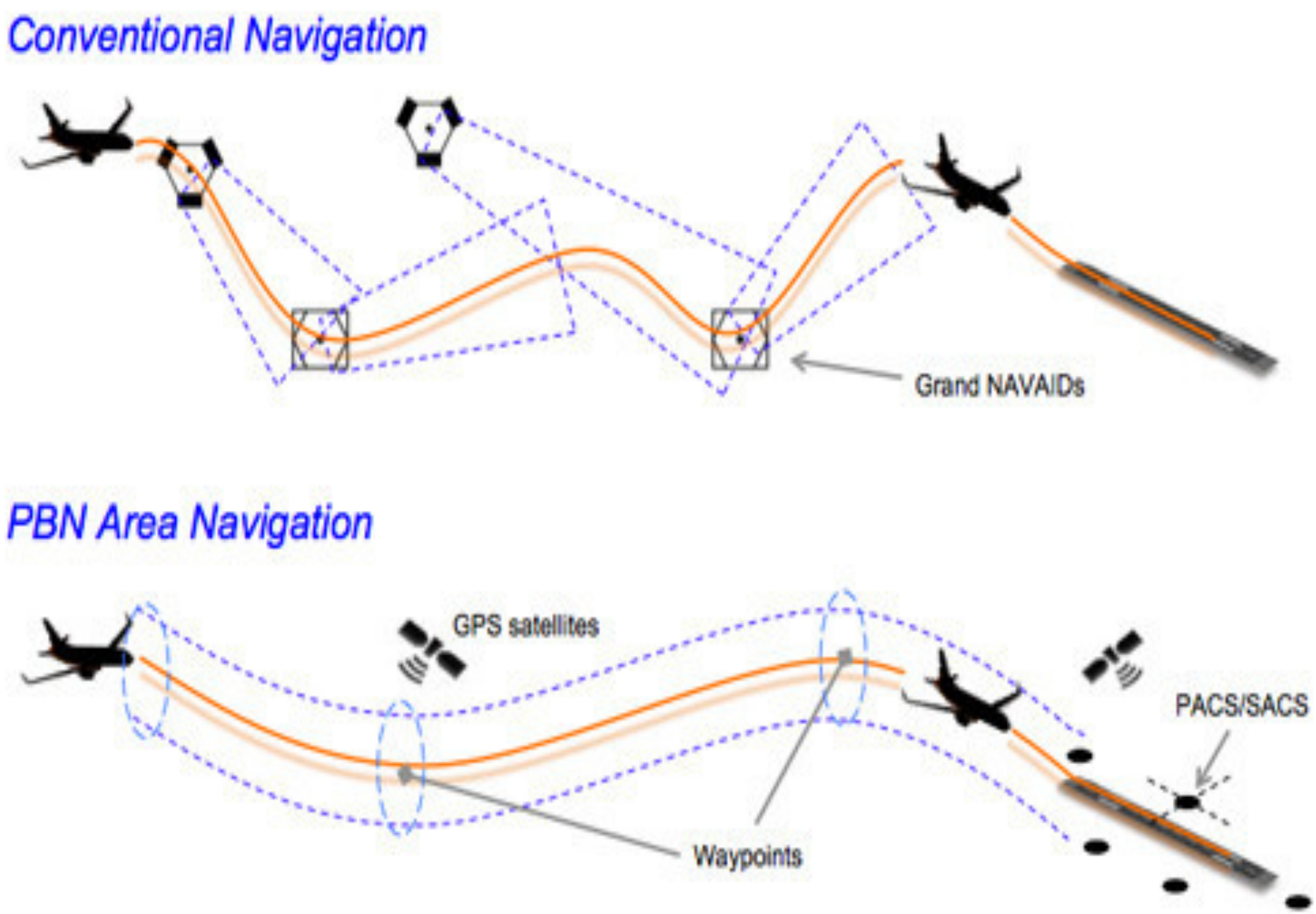
There are three basic approaches in relation with the setting up and the management of CNS/ATM systems. These can be grouped together as national, regional and global systems. It is possible to choose for a combination of these approaches, depending on the different contexts.

Performance Based Navigation (PBN):

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

Advantages:

- Reduce the need to maintain rutes 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;

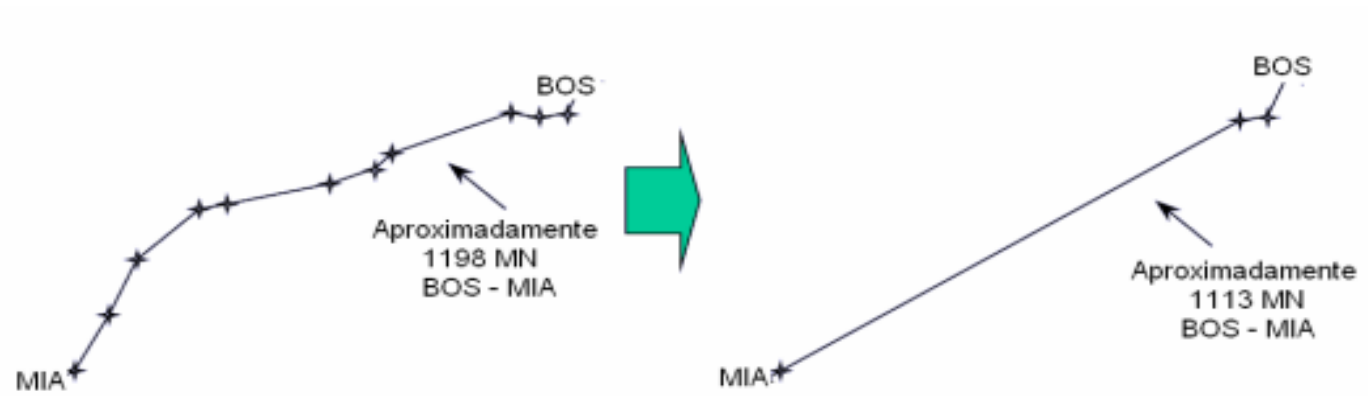

Conventional Navigation
Grand NAVAIDs
PBN Area Navigation
GPS satellites
PACS/SACS
Waypoints

Required Navigation Performance (RNP)

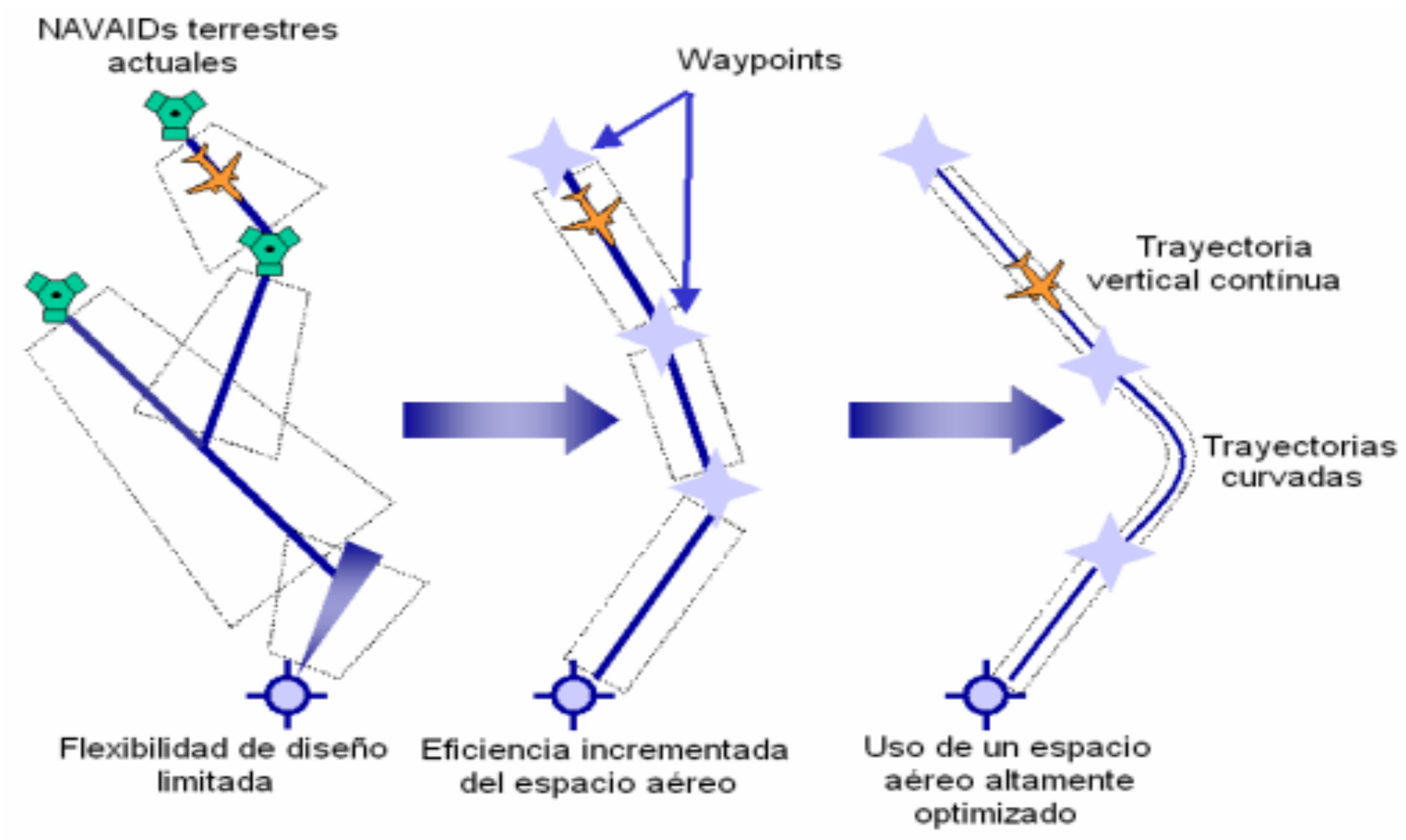
Developed by ICAO in the 1990´s as a standard for the requirements of current air Space. Is defined as precission performance of navigation required to operate in a determined air Space.

Air Navigation (RNAV)

RNAV is a navigation method that allows an aircraft to fly in any desired trayectory 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 AUMENTACIÓN
BASADOS EN TIERRA
(GBAS)
GPS
GALILEO
(TBD)
GNSS
GLONASS
SISTEMAS DE AUMENTACIÓN
BASADOS EN SATÉLITES
(SBAS)
SISTEMAS DE AUMENTACIÓN
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:

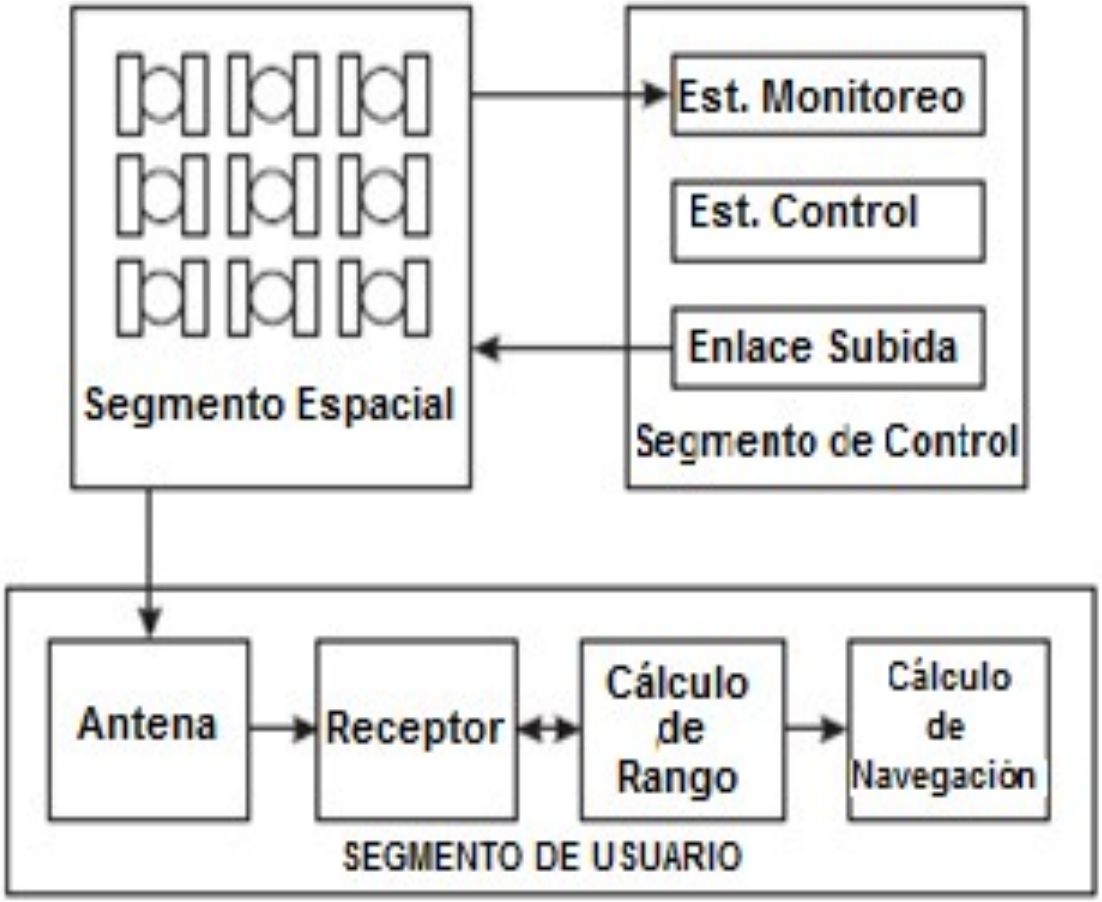
1. The coordinates conversion
2. Equip the aircrafts with a GNSS receptor, adequate for the ABAS function
3. Promulgation of Procedures
4. Implantation of the GNSS initially as a supplementary/ primary mean and later on,
5. Implantation of the GNSS as a unique mean

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

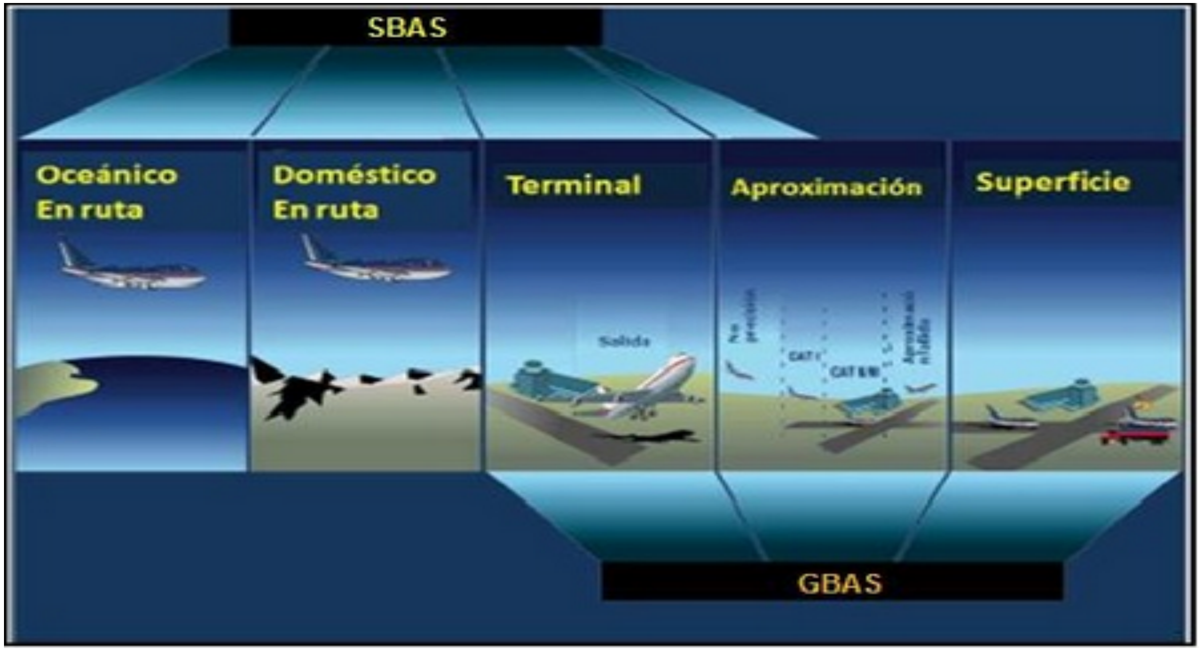
The GBAS provide GNSS integrity monitoring through data obtained from the ground. They also increase the accuracy of satellite navigation, clearing the way for GNSS precision approach and landing.

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 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.

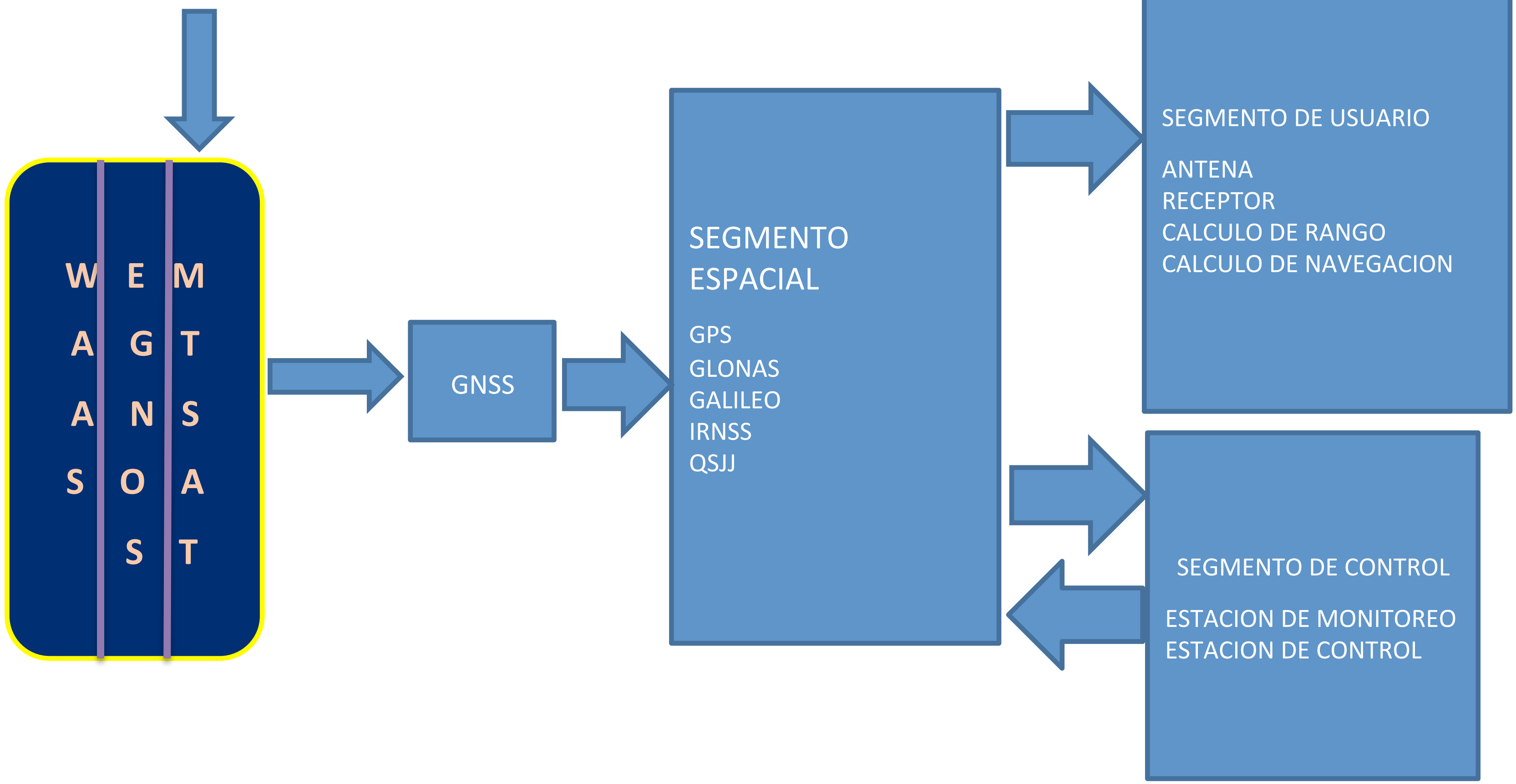


WAAS

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.



W A A S
E G N O S
M T S A T
GNSS
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 (Isntrumental 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 consumpmtion and air traffic control.

ESTACION MONITORA	NUMERO MAXIMO DE SATELITES GPS VISTO	NUMERO MINIMO DE SATELITES GPS VISTO	ESTACION MONITORA	NUMERO MAXIMO DE SATELITES GPS VISTO	NUMERO MINIMO DE SATELITES GPS VISTO
ACAPULCO	14	8	MAZATLAN	13	8
AGUASCALIENTES	13	8	MERIDA	13	7
CAMPECHE	14	7	MEXICALI	13	7
CANCUN	13	6	MONTERREY	13	7
CD_ACUÑA	13	6	NOGALES	13	6
CD_CARMEN	13	6	NUEVO_LAREDO	13	7
CD_JUAREZ	13	6	OAXACA	14	8
CD_MEXICO	14	8	PALENQUE	14	7
CD_OBREGON	13	7	PTO_ESCONDIDO	14	8
CHETUMAL	13	6	PTO_VALLARTA	13	8
CHIHUAHUA	13	6	QUERETARO	12	7
COZUMEL	13	6	SAN_LUIS_POTOSI	13	8
CULIACAN	13	7	TAMPICO	13	7
GUADALAJARA	13	8	TAPACHULA	14	7
GUAYMAS	13	7	TIJUANA	13	7
HERMOSILLO	13	7	TOLUCA	14	8
ISLA SOCORRO	14	7	TORREON	14	7
LA_PAZ	13	8	URUAPAN	14	8
LOS_CABOS	13	7	VERACRUZ	14	8
LOS_MOCHIS	13	7	VILLAHERMOSA	14	7
MANZANILLO	13	8	ZACATECAS	13	8
MATAMOROS	13	7	ZIHUATANEJO	14	8

ESTACION MONITORA	NUMERO MAXIMO DE SATELITES GLONASS VISTO	NUMERO MINIMO DE SATELITES GLONASS VISTO	ESTACION MONITORA	NUMERO MAXIMO DE SATELITES GLONASS VISTO	NUMERO MINIMO DE SATELITES GLONASS VISTO
CANCUN	11	5	MONTERREY	11	4
CD_ACUÑA	11	5	NOGALES	11	5
CD_CARMEN	11	5	NUEVO_LAREDO	11	4
CD_JUAREZ	11	5	PALENQUE	11	5
CD_MEXICO	12	4	PTO_ESCONDIDO	12	4
CHETUMAL	11	5	PTO_VALLARTA	12	4
CHIHUAHUA	11	5	LOS_CABOS	12	5
CULIACAN	11	5	TAMPICO	12	4
HERMOSILLO	11	5	TAPACHULA	11	5
ISLA SOCORRO	12	4	TORREON	11	4
MATAMOROS	11	5	VERACRUZ	12	4
MERIDA	11	5	ZACATECAS	12	4
MEXICALI	11	5	ZIHUATANEJO	12	4

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 de 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 !

SCT

SECRETARÍA DE COMUNICACIONES Y TRANSPORTES

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