



# **CELESTE**

## **Final Review Meeting**

**Galileo cooperation Project for Latin America**

### **WP 3110 & 3221:**

## **Galileo Services Introduction - Aviation**

GIC's premises

Sao José dos Campos, March 2007

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- Development of Galileo enablers for aviation
  - Levels of enablers

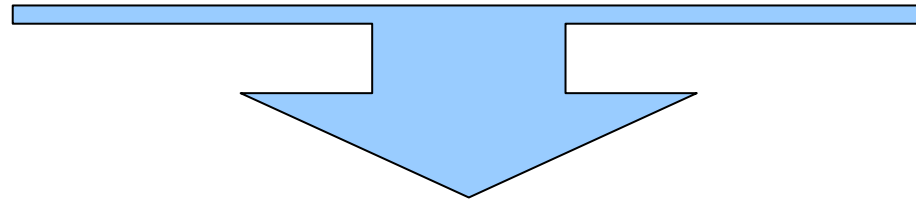
# Scope of WP 3110 and 3221

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- WP 3000: Galileo Services Introduction in Latin America (LA)
  - WP 3100: Selection of Targeted Markets (STM)
    - WP 3110: Field of Aviation
  - WP 3200: Development of Galileo Enablers
    - WP 3220: Applications
      - » WP 3221: Aviation
- Deliverables as inputs for D.3.1 and D.3.2 respectively

# Objetives

- **Support the Galileo Services Introduction by the selection of the aviation markets**
- Allow migration towards GPS (SBAS)/Galileo based applications, by:
  - Assessment of current situation of the aviation sector in LA
  - Current use of GNSS -> performances achieved
  - Identification of new applications



- **Development of Galileo Enablers**
- Level of enablers

# Aviation Market in LA

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## – Background information

- Traffic increase
- Increasing pressure to lower costs
- GNSS is revolutionizing the air navigation: sole means of navigation for all phases of flight (“*gate to gate*”).
- Technical/operational requirements: GNSS augmentations (GBAS/ABAS/SBAS)
- Aviation: Regulated market
- Navigation performance:
  - Accuracy, availability, continuity and integrity

# Aviation Market in LA (Cont)

<b>Navigation Performance</b>	<b>Definition</b>
<b>Accuracy</b>	The degree of conformance between the estimated or measured position [or other parameter] of a platform at a given time and its true position (or other parameter).
<b>Availability</b>	The ability of the system to provide useable service within the specified coverage area
<b>Continuity</b>	The ability of the total system (comprising all elements necessary to maintain aircraft position within the defined airspace) to perform its function without interruption during the intended operation
<b>Integrity</b>	The ability of the system to provide timely warnings to users when the system should not be used for navigation

# Aviation Market in LA (Cont)

## – Background information (Cont)

- ICAO Regional Group GREPECAS - Operational evolution of GNSS:
  - Mid Term: GPS (/GLONASS) with SBAS
  - Long Term: Civil GNSS (GPS + GALILEO + SBAS)
- Activities developed in the LA region:
  - ICAO Projects RLA/00/009-SBAS/WAAS Trials (CSTB)
  - EC EDISA
  - ICAO co-operation initiative RLA/03/902 SACCSA

# Aviation Market in LA (Cont)

## – Background information (Cont)

- Performance confirmed:
  - Accuracy better than 10m.
  - Integrity level up to APV I (approach with vertical guidance with a vertical AL of 50m.)
    - » New air navigation applications in the region based in: Integrity provision for en-route and approach with vertical guidance operations.



GPS + SBAS + ABAS

# Aviation Market in LA (Cont)

## – Performance benefits (GNSS for Aviation)

- Closer aircraft separation standards for more efficient ATM
- Precise airfield and landing aid to all airports
- Airport surface traffic management
- In-flight monitoring of position
- Arctic navigation (compass not reliable)
- Seamless (global) air space management
- Monitoring of wing deflection in flight

**However: GPS-based avionics alone are not sufficient to achieve accuracy, integrity and availability requirements, because of its lack of integrity alarm.**

**→ Overcome by means of the use of SBAS and Galileo**

# Aviation Market in LA (Cont)

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## – Galileo/SBAS performance add-on benefits:

- CAT I precision approach capabilities
- Precision and non-precision all-weather approaches
- Vertical guidance at all runway ends
- Increased efficiency in flight Ops. Management
  - Improvement exploitation of airspace
  - Increase in number of airports with precision approach capabilities
- Minimum En-route Altitude (MEA) at or near Minimum Obstruction Clearance Altitude (MOCA)
- Operations in areas with insufficient conventional NAVAID infrastructure
- Easier access to lower Required Navigation Performance (RPN)

# Aviation Market in LA (Cont)

## – Galileo/SBAS economical add-on benefits:

- Increased safety → Reduction of costs related to accidents, injury and property damages (NPA statistics higher than PA). Seamless (global) air space management.
- Precision navigation for point-to-point flights
- Direct routing
- Free flight
- Curved/segmented PA
- Lower minima at non-ILS equipped runways
- Increase number of operations per hour
- Less expensive/more accurate avionics

→ Saves money&time

# Aviation Market in LA (Cont)

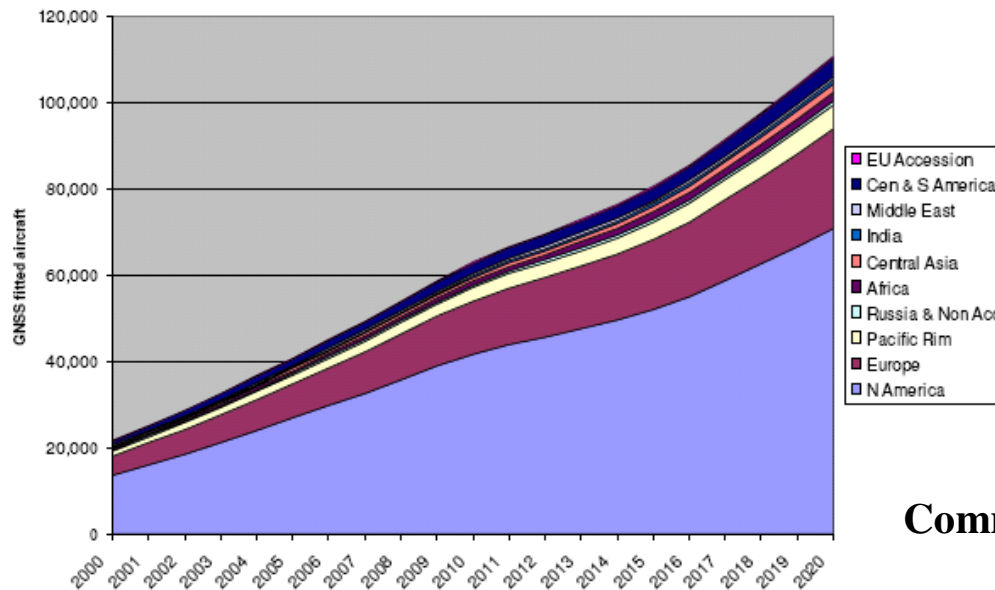
## – Selected applications for aviation of GNSS

- Commercial air transport → Used in all flight phases
  - Free flight
  - Critical flight phases (take off & landing) PA
  - Monitoring and surveillance
- Surface movement and guidance control
- Leisure: Ultra-light aircraft, balloons and recreational flights
- Helicopters: Galileo SoL + SBAS to guide SAR helicopters in worst conditions.

# Aviation Market in LA (Cont)

## – GNSS Market for Aviation in LA

- Growth of traffic expected to exceed airspace capabilities in a near future
- Two separate user communities
  - Commercial air transport → Transport of passengers and freights
  - General Aviation
- Growth and regional distribution estimation from *EC Galilei Studies*



Commercial aviation terminals

# Aviation Market in LA (Cont)

## – GNSS Market for Aviation in LA (cont.)

- Aviation industry characterized by “fragmentation” of the market with numerous competitors operating in relative small domestic markets; (estimation one-tenth of the NA domestic market)
- Intra-regional air traffic market will grow at an average rate of 7.9 % annually: one of the fastest in the world.
  - South America only: 8.5% annually.
- Traffic South America and North America: 6.2%
- Traffic Latin America and Europe: 4.9%
- Brazil and Mexico represent the majority of the market
  - Brazil’s aeronautical system is one of the 5 largest in the world.
    - » Biggest in LA.

# ICAO Regional Plan for LA

- **GREPECAS** (ICAO Regional Air Navigation Planning and Implementation Group for CAR/SAM regions)
- Deficiencies in the current CNS/ATM system for this region:
  - CNS for oceanic areas limited to the use of VLF/Omega and LORAN C → Wide separations in ocean air space
  - Particular geography in LA → Limited accessibility areas (Amazonas rain forest, Andean mountains and numerous archipelagos in the CAR)
    - Difficult to install CNS: Constraint ATM
    - AFTN (Terrestrial coms.) limitations.
  - Lack of radar installations → No reduction of the separations within aircrafts
  - Dependence on ground NAVAIDS
  - Different separation criteria applied to FIR limits



# ICAO Regional Plan for LA (Cont)

**Constraints overcome by means of the use of GNSS applications associated to the RNP concept:**

- ✓ **Improve the covertures**
- ✓ **Allow NAV capabilities in all air spaces & continuous way**
- ✓ **Maintaining & improving integrity, precision and throughput parameters according to the CNS/ATM requirements.**



# ICAO Regional Plan for LA (cont)

- **GNSS applications in the CAR/SAM Region adopted by GREPECAS (by airspace):**

AIRSPACE	SUPPLEMENTARY MEANS (NPA)	PRIMARY MEANS
Low-density en route oceanic/ continental airspace	Not applicable	GNSS + On board augmentation (NPA)
High-density continental airspace	GNSS + On board augmentation	GNSS + On board augmentation + SBAS (CAT I)
High-density oceanic airspace	GNSS + On board augmentation	GNSS + On board augmentation + SBAS (CAT I)
High-density terminal areas	GNSS + On board augmentation	GNSS + On board augmentation + SBAS/GBAS (CAT I, II and III)

- **GNSS + ABAS will permit NPA**
- **GNSS + SBAS + ABAS will permit the use of GNSS as primary navigation method for NPA and PA up to CAT I**
- **GNSS + GBAS + ABAS will permit PA of Category I, II and III**

**Different level of Augmentations to achieve the performances requirements defined in the ICAO Annex 10.**

# ICAO Regional Plan for LA (cont)

## – Regional Strategy

- Maintain the ILS as the ICAO PA and landing system as long as necessary, as long as it remains operationally acceptable and economical beneficial.
- Promote short-term:
  - GNSS in support of NPA Ops.
  - Augmented GNSS for CAT I Ops.
  - Studies for CAT II and III Augmented GNSS Ops.
  - Use of SARPS and guidance material of ICAO
  - Application of RNP for approach/landing/departure Ops.
  - Use of Multimode Receiver (MMR)

**Galileo + SBAS can clearly contribute to the Regional Plan**

# **New application/markets**

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- **Advanced Surface Movement Guidance and Control System (ASMGCS)**
  - Displaying the integer identification of suitably equipment mobiles (vehicles or aircrafts) on the maneuvering area of airports.
  - Survey & Control of surface Ops. in the CAR/SAM region carried out by visual means and conventional communications.

# New application/markets (cont)

## – Helicopters market

- SoL, SAR, surveillance Ops.
- Underdeveloped highways infrastructures Vs growing industries
- Growing markets:
  - **Commercial:** Corporate, VIP (executive) and private ownership
    - » Lack of infrastructure for safe travel and inaccessibility of some areas
  - **Governmental:** Military and paramilitary (law enforcement, fire squads, police and public entities)
- Per country:
  - » **Brazil:** largest helicopter market in LA (expansion 2x above the rest of the world)
  - » **Mexico:** 2nd largest helicopter operator in LA
  - » **Chile:** Incrementing fleet for fire squads
  - » **Venezuela:** Incrementing fleet for military and civil applications (oil platforms)

# New application/markets (cont)

## – Main actors and decision makers

- Regional strategy on GNSS for LA driven by civil aviation community
- High regulated industry relying on the co-operation between states → ICAO is the international body acting as a forum for co-operation.
  - Delivers recommendation in form of SARPs
  - SARPs for GNSS approved by ICAO in 2000
  - Important: Galileo SIS and receivers are certified for use by the civil aviation authorities

*Regulation → Allowance of use*

*Equipment manufactures, plane makers,  
airlines and air traffic bodies → Adoption of use*

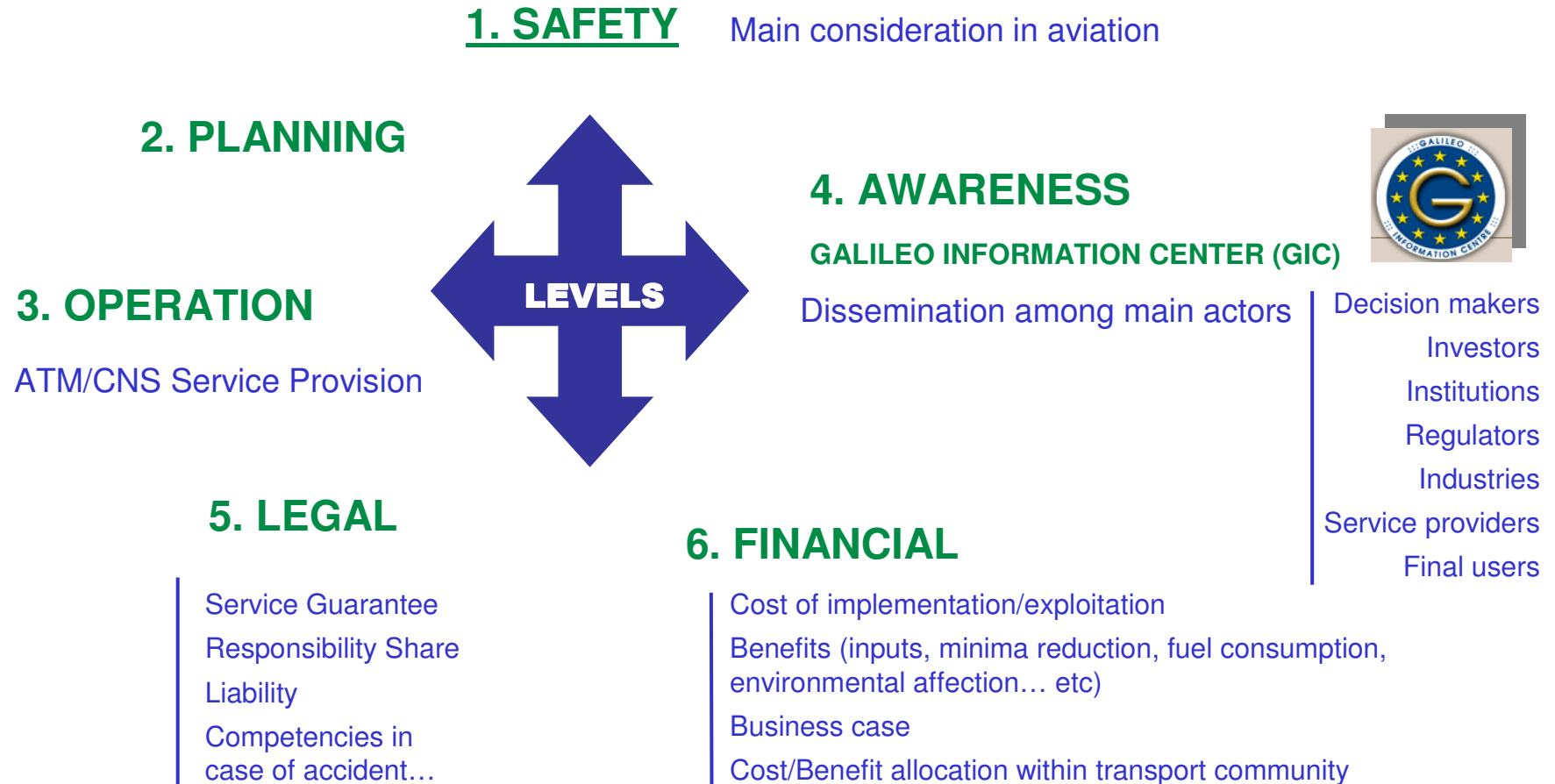
- **Conclusion: National Air Traffic Management authorities in conjunction with ICAO, IATA, AOPA and national governments**

# Galileo Enablers – Aviation

## – Galileo Enablers

- Elements required to guarantee a timely implementation and provision of Galileo related services.
  - Technical: E.g. receivers
  - Non-technical
    - » public regulations
    - » standards
    - » certification
- Determine the availability, cost and validation of the operational improvement itself → Standard Project Lifecycle

# Enablers - Levels



# Derivation of Enablers

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## – Previous work done by

- ANSP and Civil Aeronautic Authorities in CAR/SAM Area
- GNSS augmentation Trials in CAR/SAM Region:
  - RLA/00/009 WAAS, RLA/03/902 EGNOS
- GJU/GSA Projects
  - GIANT
- EUROCONTROL
  - RAFG
  - ANT
- ICAO
  - GREPECAS
  - ANSEP
  - OCP

Level	Area	Identifier	Enablers
<b>SAFETY</b>	Global	SAFE.1	Safety Case
	Local	SAFE.2	Regulatory Process for GNSS
<b>PLANNING</b>	Global	PLAN.1	Availability of Equipment
	Global	PLAN.2	Training Material
	Local	PLAN.3	Implementation guidance material
<b>OPERATION</b>	Global	OPER.1	Monitoring/Recording of GNSS performance
	Global	OPER.2	Instrument Procedures Design
	Global	OPER.3	Ground/Flight Inspection Requirements
	Global	OPER.4	Aerodrome Infrastructure Requirements
	Global	OPER.5	Airworthiness and Operational Approval Criteria
	Global	OPER.6	Requirements for Aeronautical Information Publication (AIP)
	Local	OPER.7	ATC procedures and contingency procedures
<b>AWARENESS</b>	Local	AWAR.1	Awareness plan and Flight demonstrations
<b>LEGAL</b>	Global	LEGL.1	Requirements for SBAS Status Monitoring
	Local	LEGL.2	Legal aspects, guarantee and liability
<b>FINANCIAL</b>	Global	FINL.1	Cost Allocation Model for Aviation

# Safety Level (enabler 1/6)

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- **SAFE.1 – Safety case**
  - ICAO Annex 11 requires the development of a safety assessment
- **SAFE.2 – Regulatory Process for GNSS**
  - Regulatory framework conducting to the suitable certification of the system and its applications

## **Planning Level (enabler 2/6)**

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- **PLAN.1 – Availability of equipment**
  - Receivers to be available for the aviation community
- **PLAN.2 – Training material**
  - For the pilots and the ATC staff
- **PLAN.3 – Implementation guidance material**
  - ICAO Doc 9849, GNSS Manual

## **Operation Level (enabler 3/6)**

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- OPER.1 – Monitoring/Recording of GNSS performance**
- OPER.2 – Instrument procedures design**
- OPER.3 – Ground/Flight inspection requirements**
- OPER.4 – Aerodrome infrastructure requirements**
- OPER.5 – Airworthiness and operational approval criteria**
- OPER.6 – Requirements for AIP**
- OPER.7 – ATC and ATC contingency procedures**

# **Awareness Level (enabler 4/6)**

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- A WAR.1 – Awareness and flight demonstrations**

## **Legal Level (enabler 5/6)**

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- LEGL.1 – Requirements for SBAS Status Monitoring**
- LEGL.2 – Legal aspects, guarantee and liability**

## **Financial Level (enabler 6/6)**

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- FINL.1 – Cost allocation model for aviation**

Thanks you