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CISAS-UPD

GNSS signal authentication and applications in the aeronautics domain

Sciences and Technologies for Aeronautics
and Satellite Applications

Oscar Pozzobon

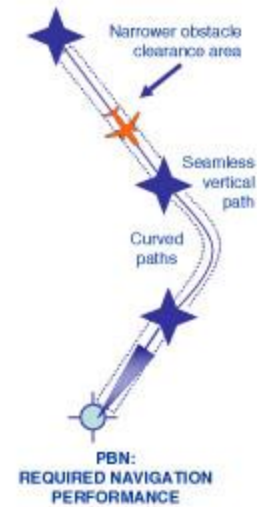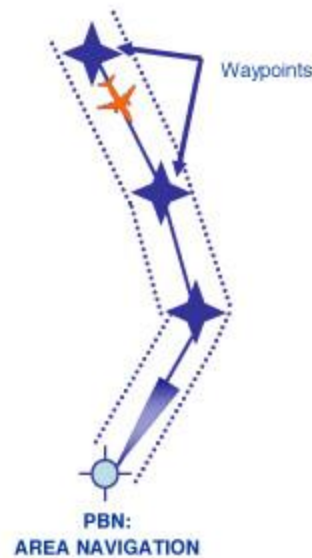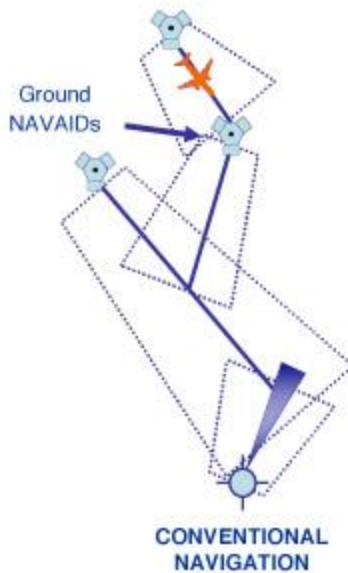**Padova, 24/10/16**

Phd Program

- Emerging use of GNSS in aviation
  - ☐ Performance based navigation
    - RNAV
  - ☐ RNP

- The following flight phases are considered critical for the increasing use of GNSS :
  - ☐ INITIAL CLIMB (ICL)
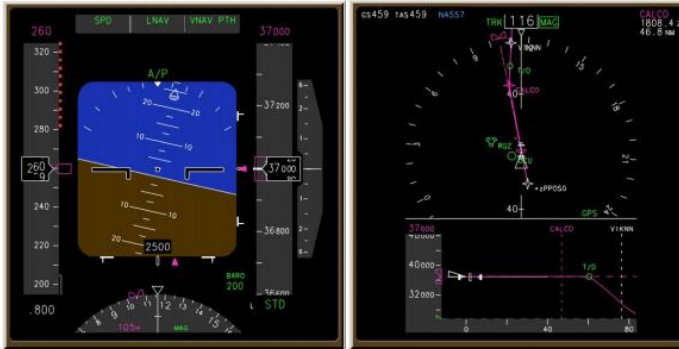 - ☐ EN ROUTE (ENR)
  - ☐ APPROACH (APR)

Ground NAVAIDs

CONVENTIONAL NAVIGATION

Waypoints

PBN: AREA NAVIGATION

Narrower obstacle clearance area

Seamless vertical path

Curved paths

PBN: REQUIRED NAVIGATION PERFORMANCE

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Lateral, Vertical and Longitudinal (Temporal) Display of RNP/ANP

Primary Flight Display

Navigation Display

MCDU Pages

Risk

P(EP>TSE)

Path Definition Error

Desired Path

Defined Path

Path Steering Error

TotalSystem Error

Position Estimation Error

Estimated Position

True Position
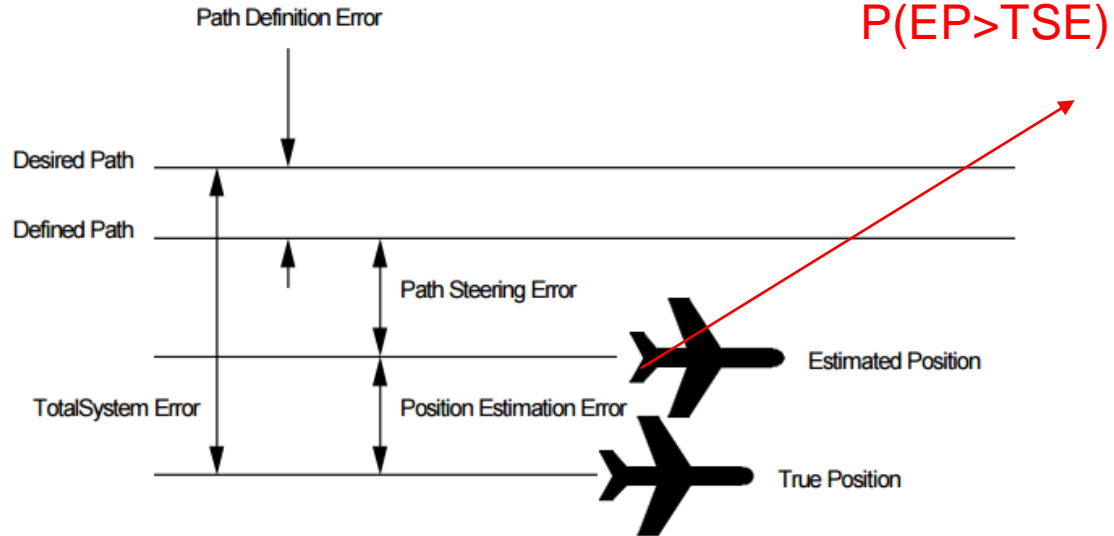
- **ACCURACY**
  - ☐ Aircraft must remain within accuracy limit 95% of flight time
    - Maximum TSE with 95% probability <= 1 x RNP
- **INTEGRITY**
  - ☐ Probability to transgress the containment limit set at 2 x RNP without alert must be <10-5/FH
- **CONTINUITY**
  - ☐ Probability of RNP capability loss with alert must be <10-4/FH

Generic FMS

Other Avionics interfaces

IRS

Air data

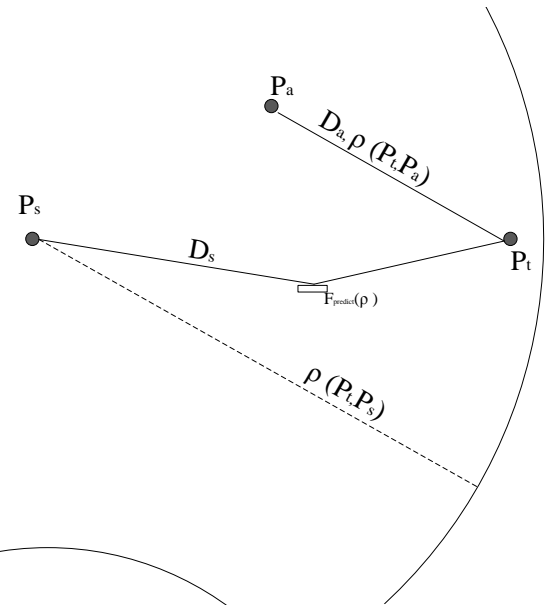FMS

GNSS

CDU

ANP <= RNP

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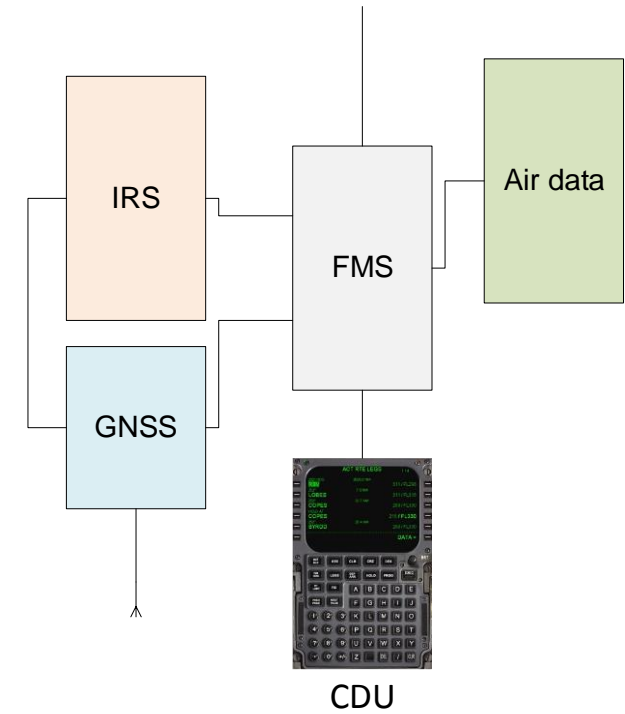
Postulate 1

"A GNSS solution is as trusted as both the data processed and the range estimated are obtained by the desired source and for which the radio wave had no unpredictable interactions in the path"
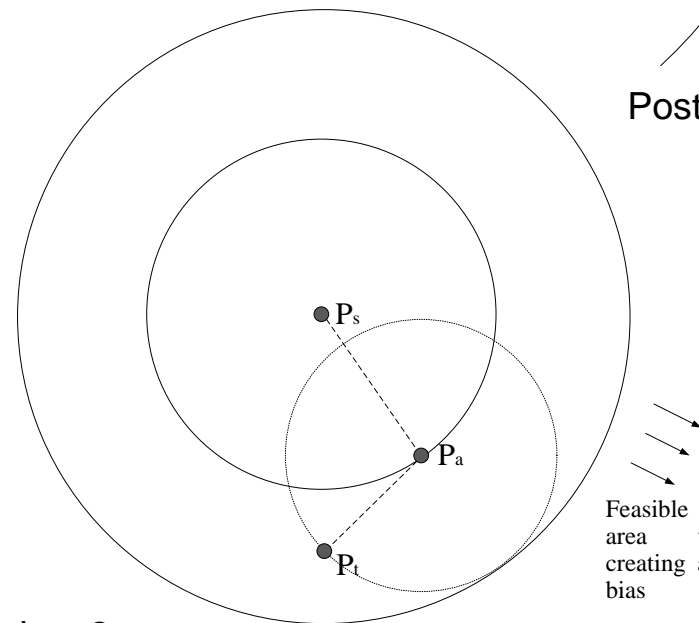
Postulate 2

"The limit of a feasible attack area without creating a clock bias is the outer area of a sphere where the center is the satellite and the radius the sum of the satellite-to-attacker and attacker-to-target distance."
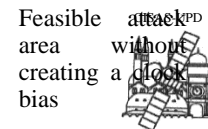
Postulate 3

"A GNSS position, time and velocity is as trusted as the trust than can be given to both the GNSS solution function and the time information used as input"

P_a

$D_a, \rho\ (P_t, P_a)$

P_s

D_s

P_t

$F_{predict}(\rho\ )$

$\rho\ (P_t, P_s)$

Postulate 1 concept

P_s

P_a

P_t

Feasible attack area without creating a clock bias

Postulate 2 concept

- **List of publications during the course (2014-2016):**

- Supersonic GNSS Authentication Codes, Oscar Pozzobon, Giovanni Gamba, Matteo Canale, Samuele Fantinato, Qascom S.r.l., Italy, ION GNSS+ 2014, Sept. 8-12, 2014, Tampa, Florida, US.

- Preparing for the Galileo Commercial Service – Proof of Concept and Demonstrator Development, I. Rodríguez, G. Tobías, D. Calle, J.M. Martín, GMV, Spain; O. Pozzobon, M. Canale, Qascom, Italy; D. Maharaj, P. Walker, CGI, UK; E. Göhler, Ifen GmbH, Germany; P. Toor, Veripos, UK; I. Fernández, European Commission, Belgium, ION GNSS+ 2014, Sept. 8-12, 2014, Tampa, Florida, US.

- The Spoofing Estimating Delay Lock Loop, paper accepted at ESA/IEEE Navitec 2014, ESA/ESTEC, Noordwijk, 3-5 December 2014.

- Performance Comparison of Different Data Authentication Solutions for the Galileo CS, paper accepted at ESA/IEEE Navitec 2014, ESA/ESTEC, Noordwijk, 3-5 December 2014.

- Oscar Pozzobon et al, "Cooperative DSP-EKF in Integrated GNSS-INS for User-Based Authentication Estimation", ENC GNSS, 7-10 Aril, Bordeaux, France

- Oscar Pozzobon, "State of the Art in GNSS Authentication and Opportunities for System Evolutions", International Technical Symposium on Navigation and Timing, ENAC, 16-17 Nov 2015, Toulouse, France

- P. Walker, CGI;V. Rijmen, University of Leuven; O. Pozzobon, QASCOM, I. Fernández-Hernández, L. Bogaardt, European Commision;G. Seco-Granados, Universitat Autònoma de Barcelona;J. Simón, European GNSS Agency;D. Calle, GMV; "Galileo Open Service Authentication: A Complete Service Design and Provision Analysis", ION GNSS 2015, 14-18 September, Tampa, Florida, US.

- Samuele Fantinato, Oscar Pozzobon ,Stefano Montagner, Giovanni Gamba, Andrea Dalla Chiara, QASCOM - Italy; Filippo Rodriguez, Telespazio - Italy; "Defending Critical Infrastructures from GNSS Interference", 21st Ka Band and communication conference, Bologna, Italy, October 12-14 2015

- Luca Canzian, Oscar Pozzobon, Giovanni Gamba, Samuele Fantinato, Stefano Montagner, Qascom - Italy, Francisco Amarillo Fernandez, Rigas Ioannides, Massimo Crisci, ESA/ESTEC – The Netherlands "On-Board Satellite-Based Interference Geolocation Using Time Difference of Arrival Measurements",21st Ka Band and communication conference, Bologna, Italy, October 12-14 2015

- Oscar Pozzobon et al "GNSS authentication for aeronautics applications", Helsinki, ENC GNSS 2016, 1/06/16

- Software Tool for the Assessment of On-Board Satellite-Based Interference Geolocation Techniques, L.Canzian, S.Fantinato, O.pozzobon, 3rd ESA Workshop on Advanced Flexible Telecom Payloads , 21-24 march, ESA ESTEC, Noordwijk, The Netherlands.

- Oscar Pozzobon, "State of the Art in GNSS Authentication and Opportunities for System Evolutions", International Technical Symposium on Navigation and Timing, ENAC, 16-17 Nov 2015, Toulouse, France

- Oscar Pozzobon, Samuele Fantinato, Andrea Dalla Chiara, Giovanni Gamba,Qascom S.r.l., Massimo Crisci, Pietro Giordano, Werner Enderle

- European Space Agency (ESA), Keplerlaan 1, 2201 AZ Noordwijk, The Netherlands,David Chelmins, Obed S. Sands, Carolyn J. Clapper James J. Miller,NASA, "GPS and Galileo developments on board the International Space Station with the Space Communications and Navigation (SCaN) testbed, Ka band conference October 2016, Cleveland, Ohio, US

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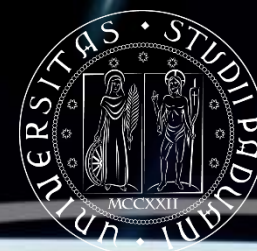
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Thank you!