Project HRRF

Data Recording Summary
Results and Analyses

Marc Troller
Skyguide, Swiss Air Navigation Services
Data Recording Summary

› 263 GB of compressed measurement data
› 156'594 flights processed
› 65'589 hours recorded
› 41'745 flight hours recorded, target: 40'000 flight hours
Distribution of Data Recording

Geographical Distribution of Measurements

Skyguide/TN-P/MT -- All Levels

measurements per km²
Flight Trajectory Analyses

Definition of flight paths and errors

- Desired Flight Path
- True Flight Path
- Total System Error (TSE)
- Flight Technical Error (FTE)
- Navigation System Error (NSE)
- Navigation System Flight Path
- RNP 0.3 environment during 95% of the flight
- 0.25 NM during 95% of the flight
- 0.3 NM during 95% of the flight
Assessment Routing
Inselspital - Interlaken

Route: "LSHI-EBBO"
Flight: 07.01.2017

95 flights recorded and analysed
Swiss Low-Flight Network

GNSS Low Flight Network (LFN) for HEL

- KY251
- KY252
- KY253
- KY256
- KY257

14 flights

RNP 0.3 and EGNOS required

Restricted Access (REF ENR 1.1).

103 flights

COR: new chart (WEF 17 AUG 2017)

© 2017 Swissair, CH 2004 WABER
Assessment LFN Routing

Route: KY253/252
# Flights: 4

[Diagram showing Swiss grid coordinates and track deviation from designed track for flights along LS110, LS201, LS202, LS203, LS204, LS205, LS206, LS207, LS208, LS209, LS210, LS211, LS212, LS213, and LS214, with deviations from designed track from LS209 to LS214 shown on the right side of the diagram.]
Statistical FTE Assessment

21 hours of flight time recorded under RNP 0.3 performance

Total System Error (TSE)
Navigation System Error (NSE) negligible

Histogram of FTE

- Mean = 0.0003 NM
- 95%(-) = -0.0134 NM
- 95%(+) = 0.0168 NM
- 99%(-) = -0.0419 NM
- 99%(+) = 0.0454 NM
- max(-) = -0.1662 NM
- max(+) = 0.1485 NM

Desired Flight Path
Flight Technical Error (FTE)
~ Total System Error (TSE)
True Flight Path
Navigation System Error (NSE) negligible
Analysis KY252 Southbound with GNSS Outage

Route: KY252 southbound without GNSS

GNSS switched off at LS202 (until LS212)
Flight time: 26 minutes
Approach Interlaken Hospital

Project: 5lives  Flight: 2 / 18.10.2017

Route: LS405 (IAF) - HKA01 - HKA02 - HK07I (IF) - LSHK (PinS/MAP) - HKM01 - HKM02 - HKM03 - HKM01 - LSHK - HK07F - HK07I - HKA02 - HKA

GNSS switched off at LSHK
RNP0.3 / 0.15 environment
Design Route "Thunersee"

Route: "Thunersee"
Flight: 21.05.2014
Procedure Design in Mountainous Areas

Primary Protection Area

Secondary Protection Area

RNP 0.3 en-route

RNP 0.1 RNP AR

0.3NM

0.2NM

0.1NM

1.45NM

MOC

CHIPS HRRF Project Results 04.10.2018
Protection Level Analyses

GNSS Protection level Concept

› Position of an aircraft usually not known
› Protection level provides a bound on the position error
› Horizontal protection level is the radius of a circle in the horizontal plane, with its center being at the true position, that describes the region assured to contain the indicated horizontal position
› Similar definition for the vertical protection level

Source: navipedia.net
Horizontal Protection Level Analysis

- 95%
- 99%

Horizontal Protection Level [m]

EC635 #1-13
EC145 #1-5
AW109 #1-11
Correlation Protection Level vs. No. Satellites Used

Example:
EC145
2276 flight hours
Summary and Conclusion

Data recording
› > 40'000 hours of flight data recorded - statistical significance reached

Flight track accuracy
› Track accuracy usually below 0.05 NM (95th percentile at 0.01 NM)
› Larger errors visible for manually steered flights
› RNP requirement achieved with large margin
› GNSS outages may soon cause an exceedance of the RNP requirement

Protection level assessment
› 99% of HPL 25-70 m for flight data analysed
› Slight correlation of HPL with flight height detected
› High protection level performance observed in the Swiss airspace