

Implementation and use of EGNOS in Germany

**MMIG46 TECHNICAL CONFERENCE
Bremen Airport**

11 October 2013



DFS Deutsche Flugsicherung

DFS Overview

- **Langen:** Headquarters, Academy, Systems House and R&D Centre
- **Control centres:** Langen, Bremen, Munich, Karlsruhe and DFS staff at the EUROCONTROL Centre in Maastricht
- **16 Tower locations**
- **AIS-C in Frankfurt-Rödelheim**



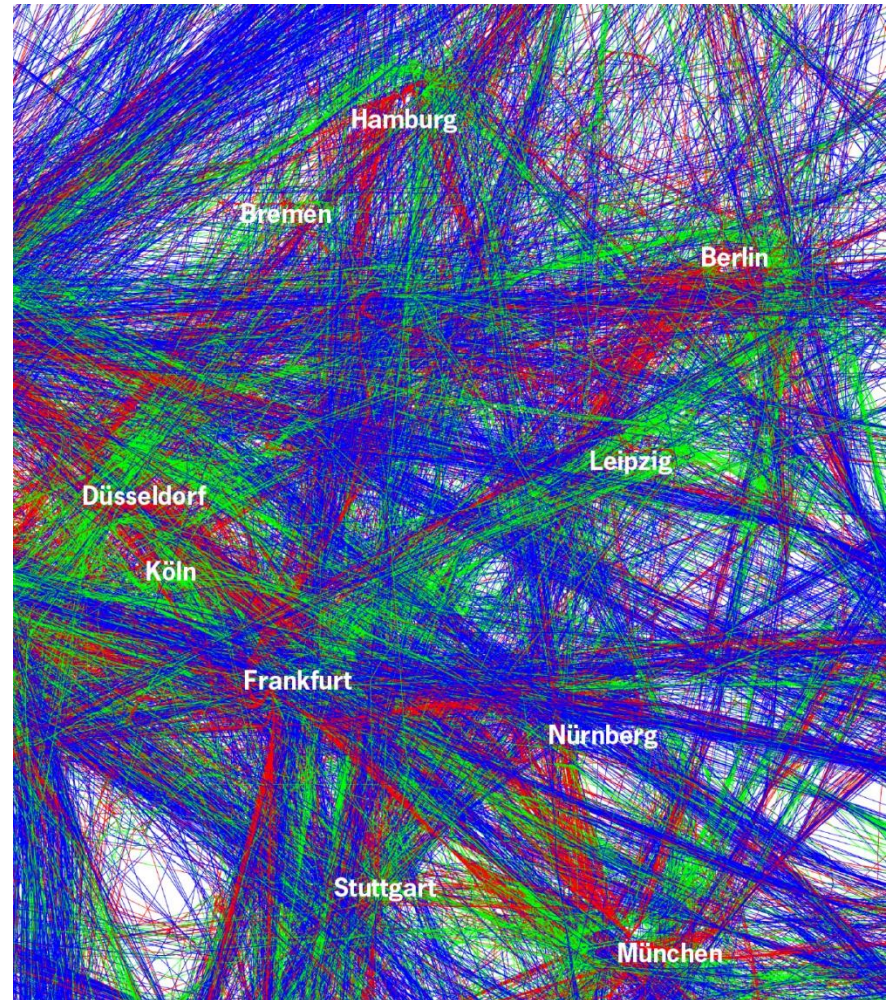
Aircraft movements in Germany

One day in January 2013

Climbs

Transit flights

Descents



Part I: TECHNICAL



Classification of satellite navigation systems

- **Constellations**

GPS (USA), GLONASS (Ru), Beidou/Compass (China), GALILEO (EU)

Global navigation satellite systems (“GNSS”), civil use possible

- **Aircraft-based Augmentation System (ABAS)**

On-board augmentation system to improve integrity (RAIM) or to improve integrity and availability through interaction with other sensors (AAIM).

- **Ground-based Augmentation System (GBAS)**

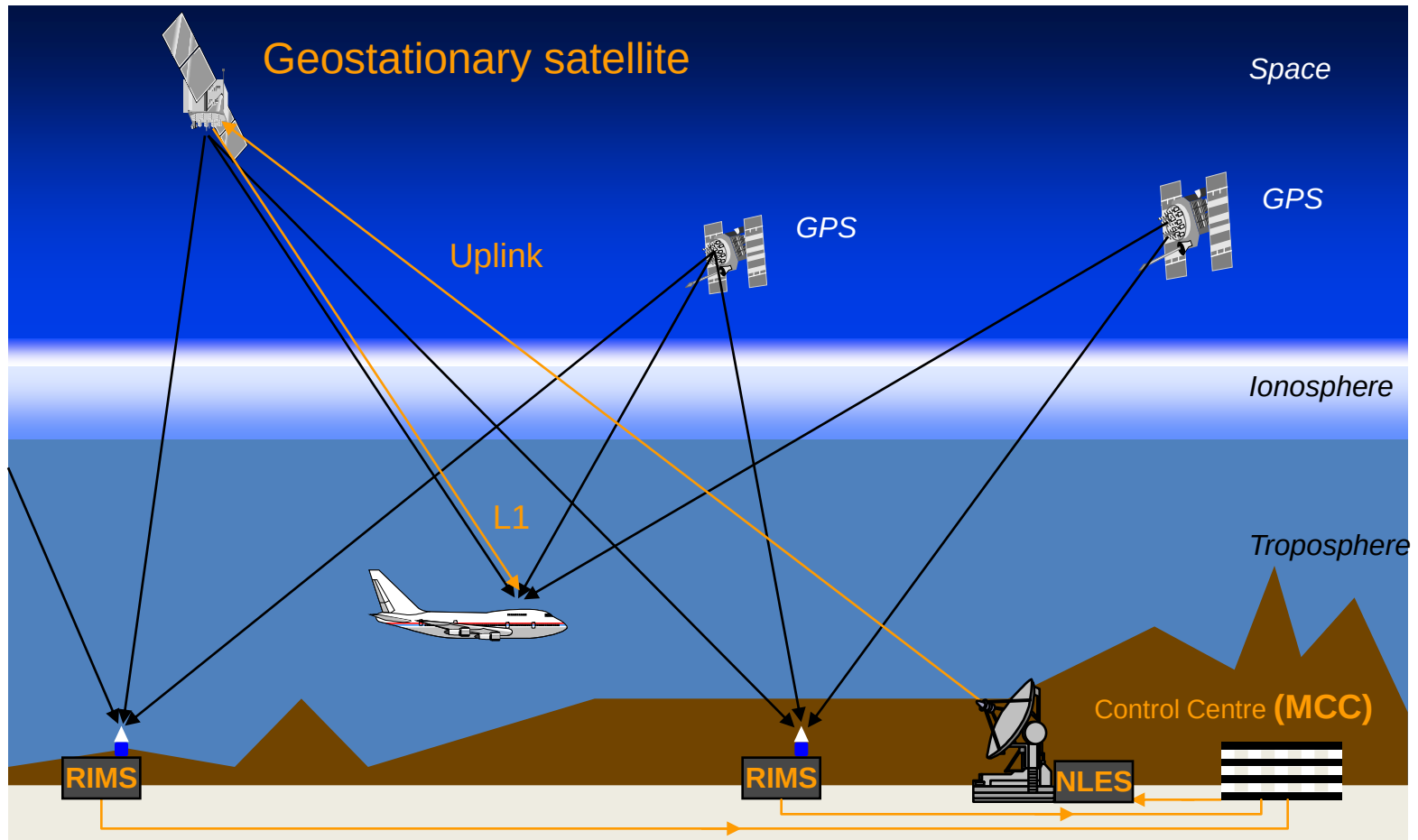
Augmentation system to improve availability, integrity and accuracy at one location (e.g. airport Bremen).

- **Space-based Augmentation System (SBAS)**

WAAS (USA), EGNOS (EU), MSAS (Japan), GAGAN (Indien), SDCM (Ru)

Augmentation system to improve availability, integrity and accuracy within a region (e.g. Europe).

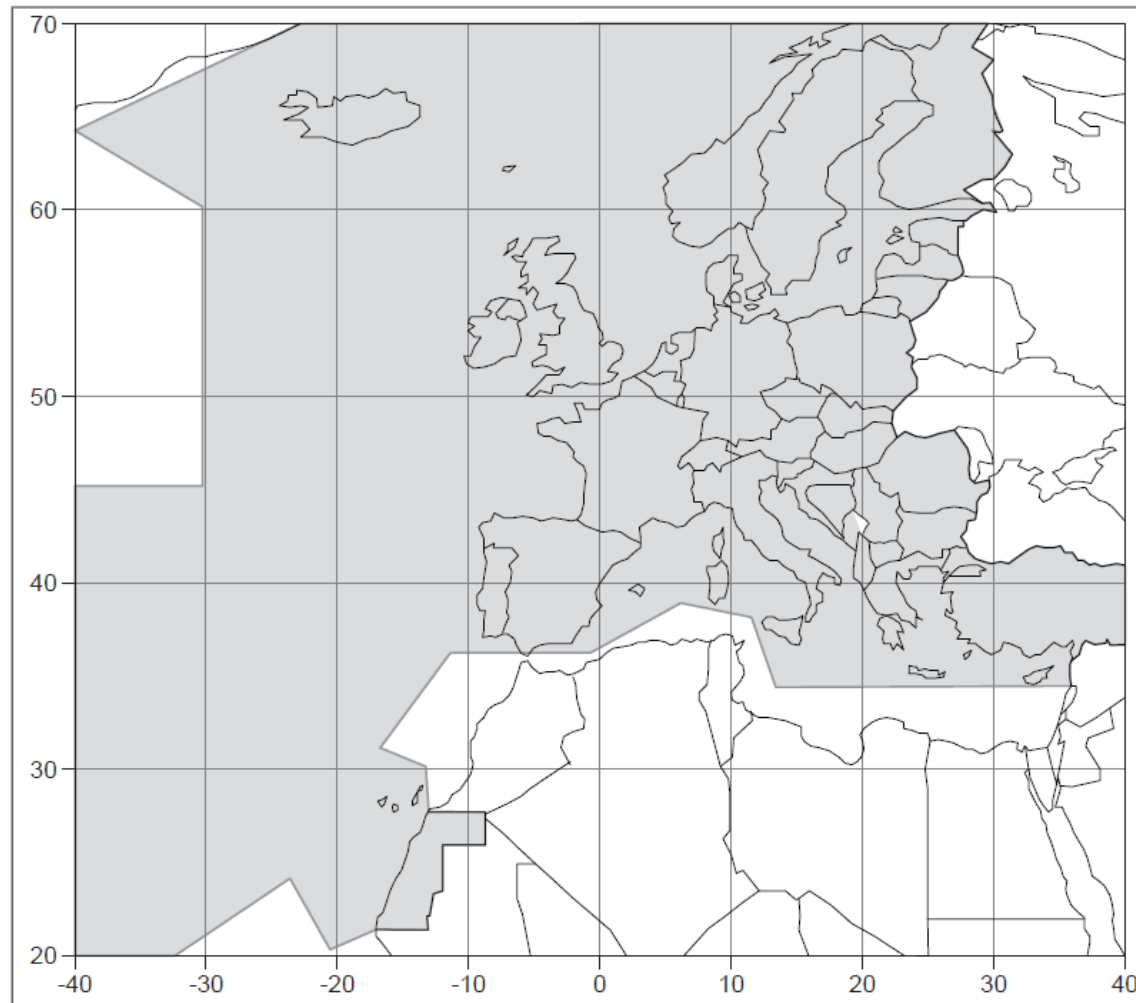
SBAS / EGNOS Principle of Operations



EGNOS Infrastructure Location

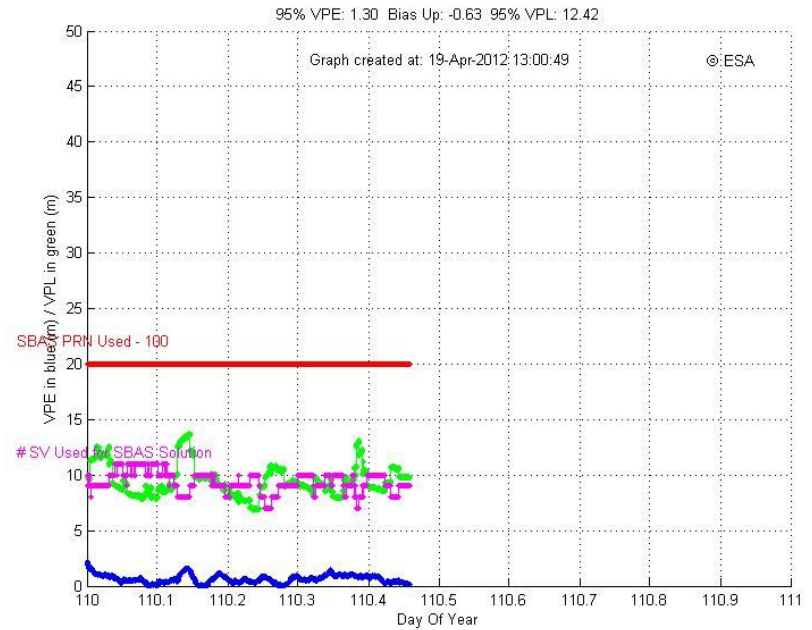
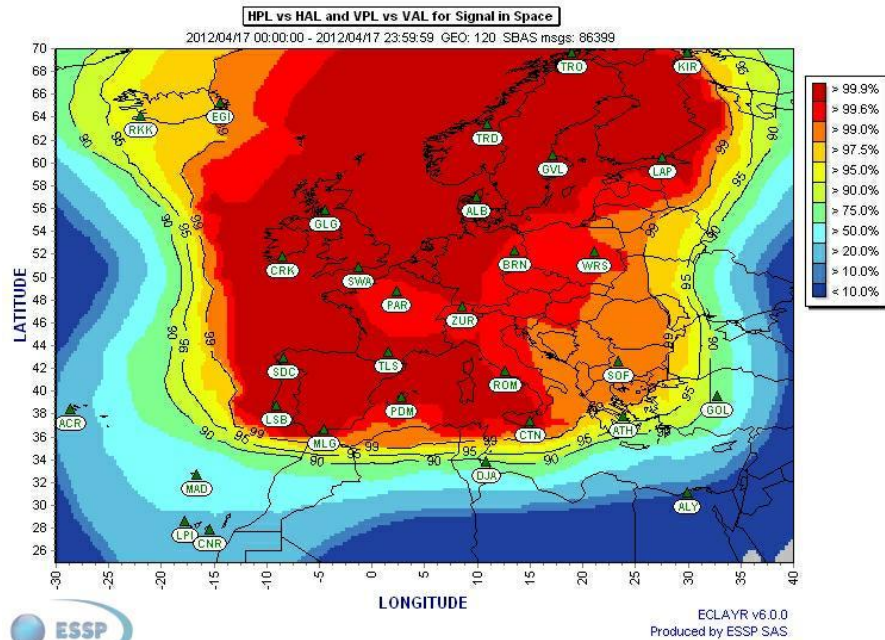


EGNOS Service Area



Source: EGNOS SoL SDD

EGNOS Performance



Sources: ESA

Accuracy	horizontal	NPA	APV-I	APV-II	CAT I
	95%	220 m	16 m	16 m	16 m
	vertical 95%	n/a	20 m	8 m	6 m to 4 m
Availability		0,99 to 0,99999	0,99 to 0,99999	0,99 to 0,99999	0,99 to 0,99999
Continuity		10 ⁻⁴ /h to 10 ⁻⁸ /h	1-8x10 ⁻⁶ /h in any 15s	1-8x10 ⁻⁶ /h in any 15s	1-8x10 ⁻⁶ /h in any 15s
Integrity	Integrity	10 ⁻⁷ /h	1-2x10 ⁻⁷ per appr.	1-2x10 ⁻⁷ per appr.	1-2x10 ⁻⁷ per appr.
	Hor. alert limit	556 m	40 m	40 m	40 m
	Vert. alert limit	n/a	50 m	20 m	15 m to 10 m
	Time to alert	10 s	10 s	6 s	6 s

- The European Commission owns the EGNOS system on behalf of the European Union since 1.4.2009
www.egnos-portal.eu
- ESSP SAS (F) is operator of EGNOS since 1.10.2009 and certified as ANSP since 12.7.2010
www.essp-sas.eu
- The Open Service of EGNOS is available since 1.10.2009
- The Safety of Life (SoL) Service is available for aviation in Europe since 2.3.2011
- In Germany EGNOS is officially usable for aviation since 15.12.2011
- Currently 43 airports in Germany have procedures usable with EGNOS (including Heliports)

EGNOS future development

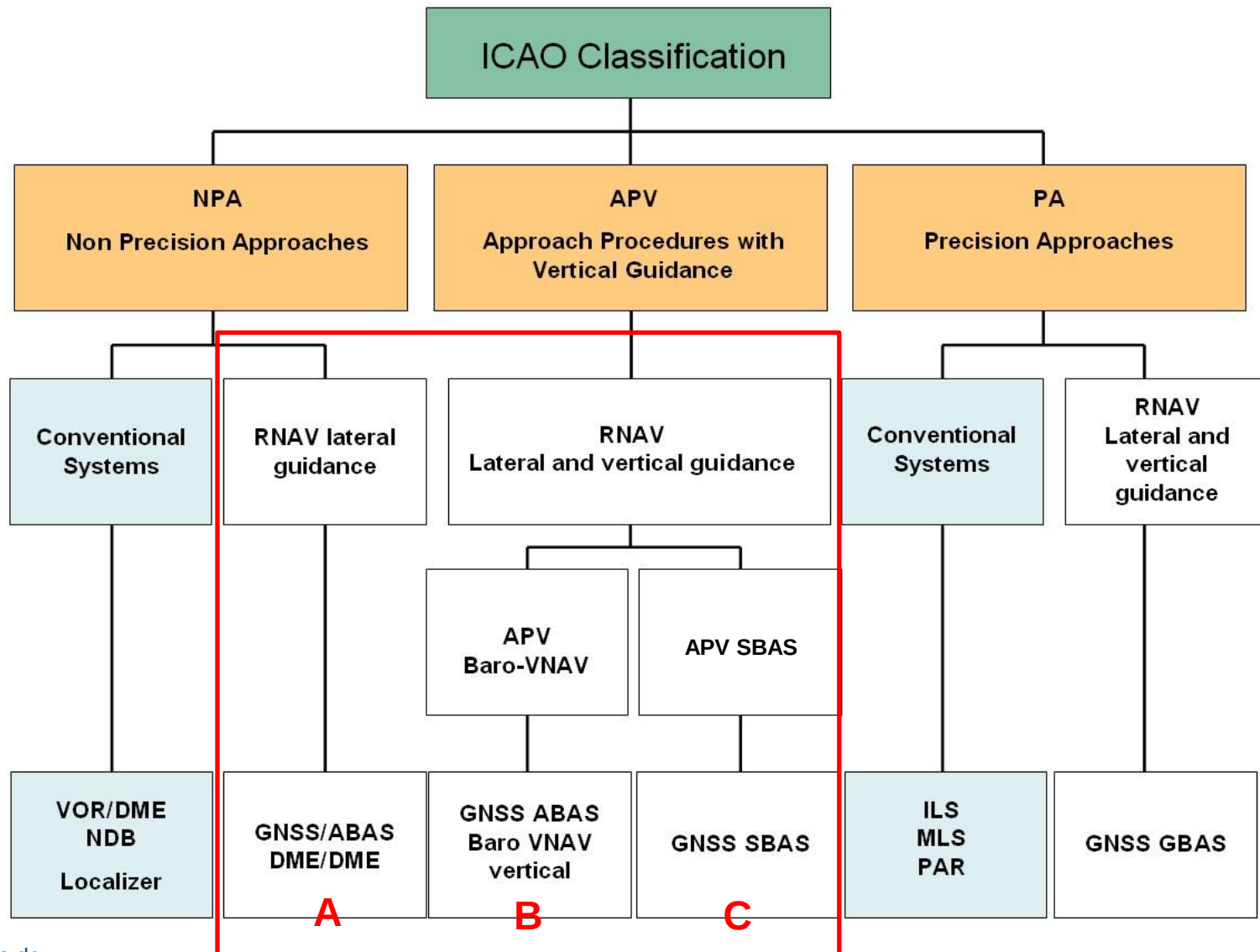
- Better performance for aviation
(LPV 200, possibly CAT I, CAT I autoland)
- Support of GALILEO
- Support of new frequencies
(L5, E1, E5a, E5b)
- Extension of coverage area
(northern Europe, eastern Europe, Africa)
- Services for other users
(maritime applications, rail and road traffic, precision farming, etc.)



Part II: OPERATIONAL



Approach Classifications in ICAO Annex 6



Use of EGNOS in Germany

NACHRICHTEN FÜR LUFTFAHRER

59. JAHRGANG

LANGEN, 15. DEZEMBER 2011

NfL I 209 / 11

Bekanntmachung über die Nutzung von EGNOS auf RNAV(GPS)-Anflugverfahren

Hiermit wird die Nutzung des europäischen Satellitenergänzungssystems (SBAS) „EGNOS“ für den Betrieb auf den in der AIP Abschnitt AD publizierten RNAV(GPS)-Anflugverfahren, sowohl für Nichtpräzisionsanflüge (NPA bis zum publizierten „LNAV“-Minimum) als auch für APV-Verfahren (APV baro-VNAV bis zum publizierten „LNAV/VNAV“-Minimum, APV-SBAS bis zum publizierten „LPV“-Minimum) freigegeben.

Voraussetzung zur Nutzung der Vertikalführung mit EGNOS auf APV baro-VNAV-Verfahren ist eine zugelassene SBAS-Avionik der Klasse 2, 3 oder 4.

Informationen zur Systemverfügbarkeit von EGNOS werden im Falle einer negativen Verfügbarkeit über NOTAMs publiziert. Ansonsten ist davon auszugehen, dass das System EGNOS betriebsbereit ist.

Weitere operationelle Nutzungsvoraussetzungen sind über entsprechende EASA-Publikationen geregelt.

Langen, den 23.11.2011
Bundesaufsichtsamt für Flugsicherung
BAF LFR/2.10.1/0024-001/11

ENR 1.5-12
12 JAN 2012

LUFTFAHRTHANDBUCH DEUTSCHLAND
AIP GERMANY

4. Nutzung von EGNOS auf RNAV(GPS)-Anflugverfahren

Die Nutzung des europäischen Satellitenergänzungssystems (SBAS) "EGNOS" wird für den Betrieb auf den im Luftfahrthandbuch, AD-Teil, publizierten RNAV(GPS)-Anflugverfahren, sowohl für Nichtpräzisionsanflüge (NPA bis zum publizierten "LNAV"-Minimum) als auch für APV-Verfahren (APV-Baro-VNAV bis zum publizierten "LNAV/VNAV"-Minimum, APV-SBAS bis zum publizierten "LPV"-Minimum) freigegeben.

Voraussetzung zur Nutzung der Vertikalführung mit EGNOS auf APV-Baro-VNAV-Verfahren ist eine zugelassene SBAS-Avionik der Klasse 2, 3 oder 4.

Informationen zur Systemverfügbarkeit von EGNOS werden im Falle einer negativen Verfügbarkeit über NOTAM publiziert. Ansonsten ist davon auszugehen, dass das System EGNOS betriebsbereit ist.

Weitere operationelle Nutzungsvoraussetzungen sind über entsprechende EASA-Publikationen geregelt.

4. Use of EGNOS on RNAV(GPS) Approach Procedures

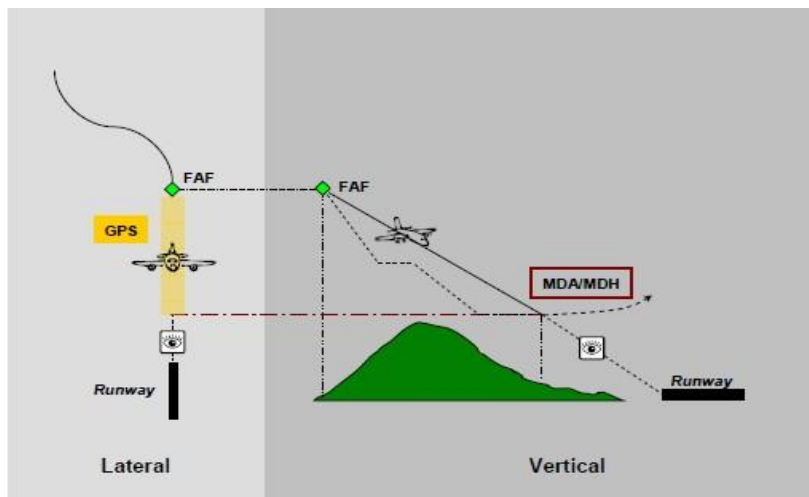
The use of the European satellite augmentation system (SBAS) "EGNOS" has been approved for operations on the RNAV(GPS) approach procedures published in the AD part of the AIP for non-precision approaches (NPA up to the published "LNAV" minimum) as well as for APV procedures (APV Baro-VNAV up to the published "LNAV/VNAV" minimum, APV-SBAS up to the published "LPV" minimum).

Class 2, 3 or 4 approved SBAS aircraft avionics are a requirement for the use of vertical guidance with EGNOS on APV Baro-VNAV procedures.

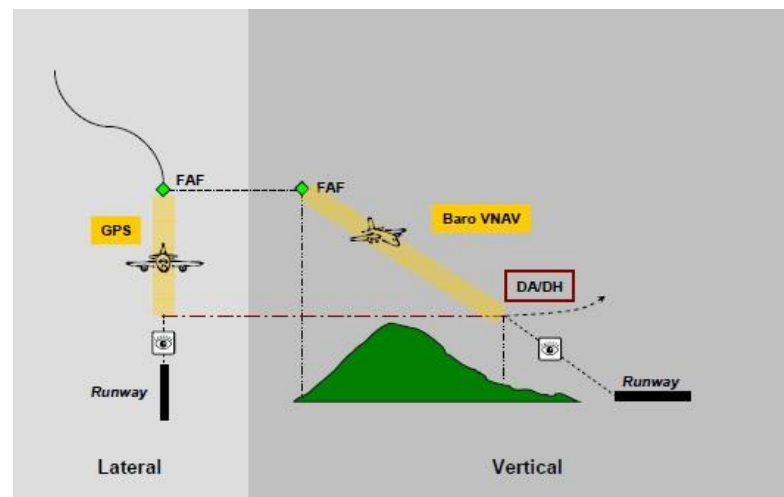
Information on the system availability of EGNOS will be published with NOTAM in the case of negative availability. Otherwise, it may be assumed that the EGNOS system is ready for operation.

Further operational requirements of use are specified in the relevant EASA publications.

RNAV(GPS) NPA, APV baro-VNAV, APV-SBAS

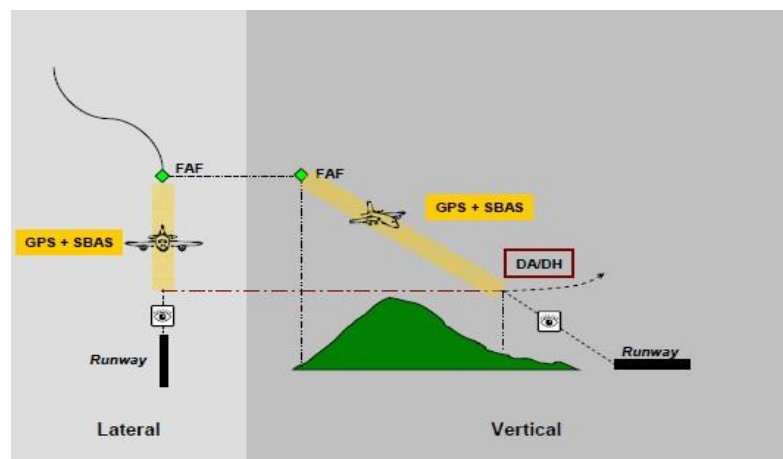


NPA down to
LNAV-Minimum



APV baro-VNAV down to LNAV/VNAV-Minimum
SBAS vertical guidance possible if:

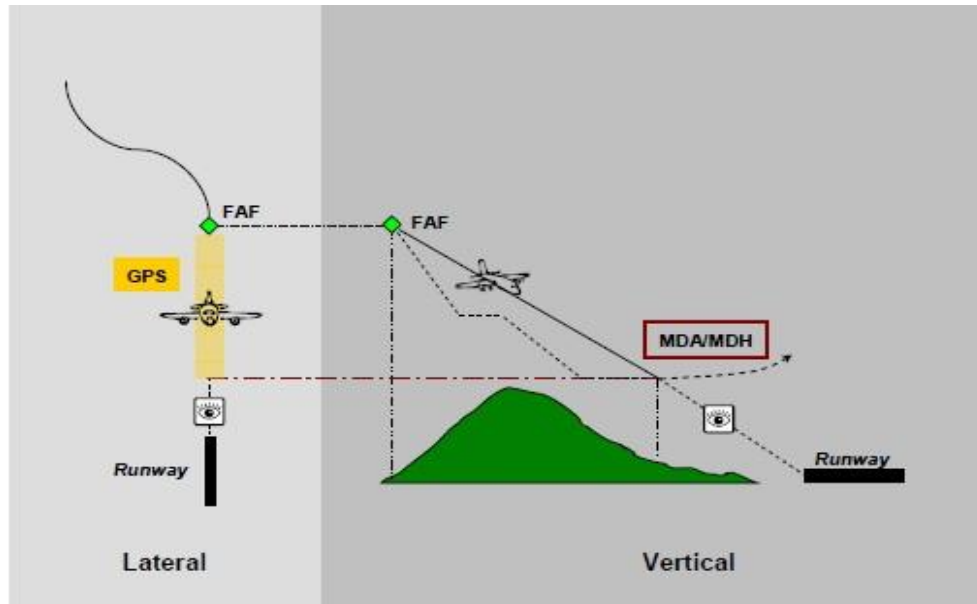
- Procedure Design adapted (in Germany YES)
- Avionic supports that mode



APV SBAS down to
LPV-Minimum

RNAV(GPS) NPA, APV baro-VNAV, APV-SBAS

A

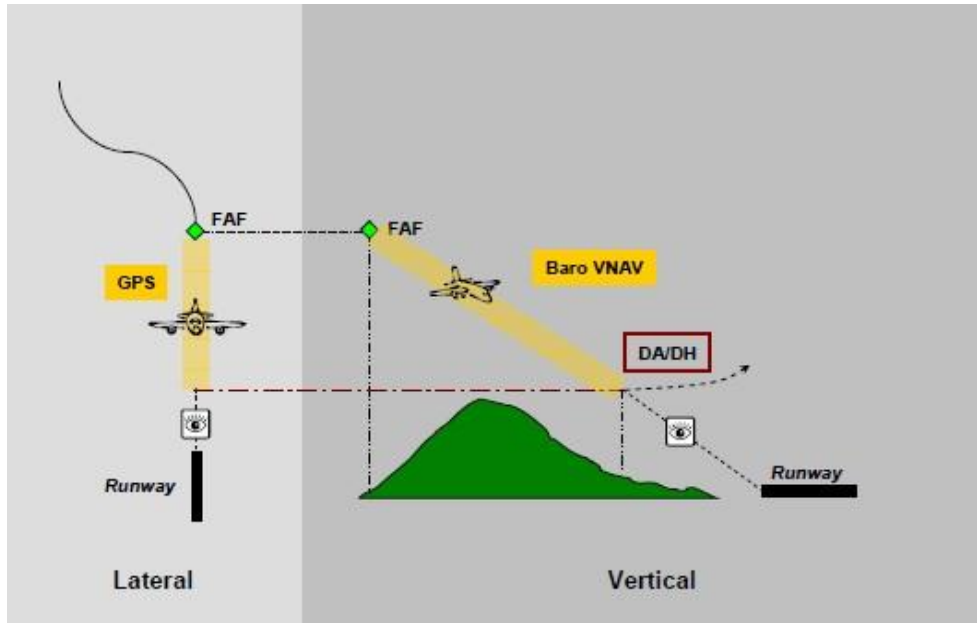


- Used Technology:
 - GPS
- Required Receiver(s):
 - TSO-C129(a)
 - TSO-C145/146/196 possible

- Supported Operation:
 - Non-Precision Approach to LNAV (Lateral Navigation) Minimum
 - No Vertical Guidance

RNAV(GPS) NPA, **APV baro-VNAV**, APV-SBAS

B

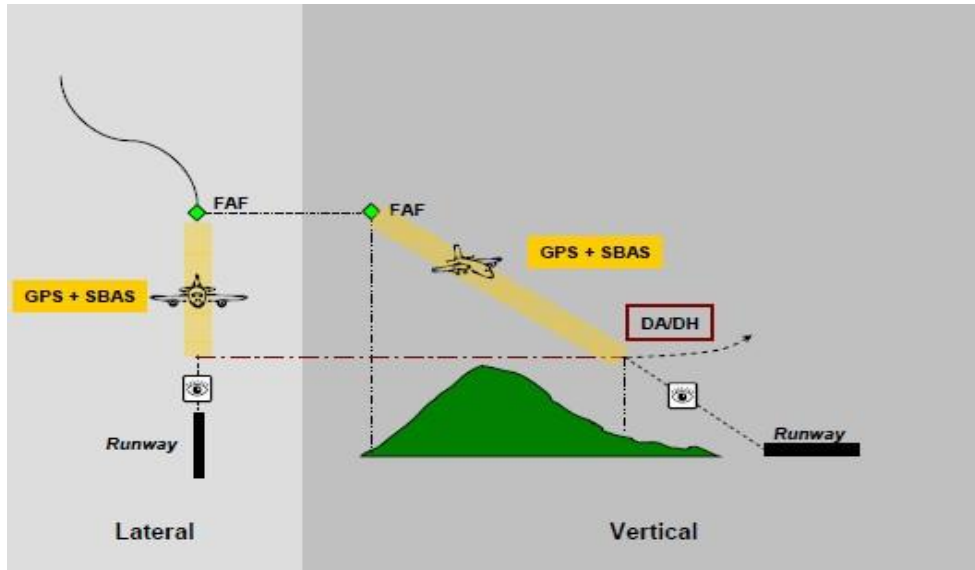


- Used Technology:
 - GPS + Baro provide **vertical guidance data** based on barometric altitude
- Required Receiver(s):
 - Baro-VNAV **approach system** with IFR-approved GPS

- Supported Operation:
 - Non-Precision Approach to LNAV/VNAV Minimum
 - SBAS vertical guidance possible if (i) procedure design adapted (in Germany YES) and (ii) avionics supports that mode

RNAV(GPS) NPA, APV baro-VNAV, **APV-SBAS**

C



- Used Technology:
 - SBAS provides direct **vertical guidance data**
- Required Receiver(s):
 - TSO-C145/146 („WAAS Receiver“)

- Supported Operation:
 - APV SBAS down to LPV (Localiser Performance with Vertical Guidance) Minimum

RNAV(GPS) NPA, APV baro-VNAV, APV-SBAS

Procedure type	Theoretically best possible <u>operational</u> Minimum (disregarding other conditions)	Remark
Localizer (with or without DME)	250 ft MDH	
SRA (finishes at 0,5 NM)	250 ft MDH	
SRA (finishes at 1 NM)	300 ft MDH	
SRA (finishes at ≥ 2 NM)	350 ft MDH	
VOR	300 ft MDH	
VOR/DME	250 ft MDH	
NDB	350 ft MDH	
NDB/DME	300 ft MDH	
VDF	350 ft MDH	
RNAV as Non-Precision Approach with LNAV Minimum	300 ft MDH	
RNAV as APV baro VNAV-Approach with LNAV/VNAV Minimum	250 ft DH	Minima ≤ 300 ft DH require a CAT I certified runway
RNAV as APV SBAS-Approach with LPV Minimum (APV I, APV II)	250 ft DH (APV I) [200 ft DH (APV II) not for EGNOS!]	Minima ≤ 300 ft DH require a CAT I certified runway
PA CAT I (ILS, MLS, GLS)	200 ft DH	
PA CAT II (ILS, MLS [GLS planned])	100 ft DH	
PA CAT III A (ILS, MLS [GLS planned])	< 100 ft DH	
PA CAT III B (ILS, MLS [GLS planned])	< 100 ft DH < 50 ft DH	Depending on Airport, Operator, Aircraft and Crew Training Approvals

Example APV Baro-VNAV

LUFTFAHRTHANDBUCH DEUTSCHLAND
AIP GERMANY

AD 2 EDDG 4-6-1
Effective: 27 JUN 2013

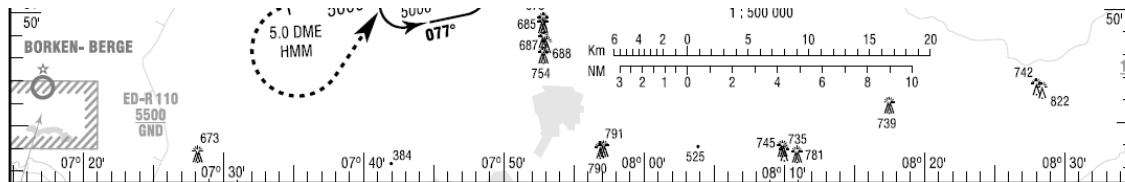
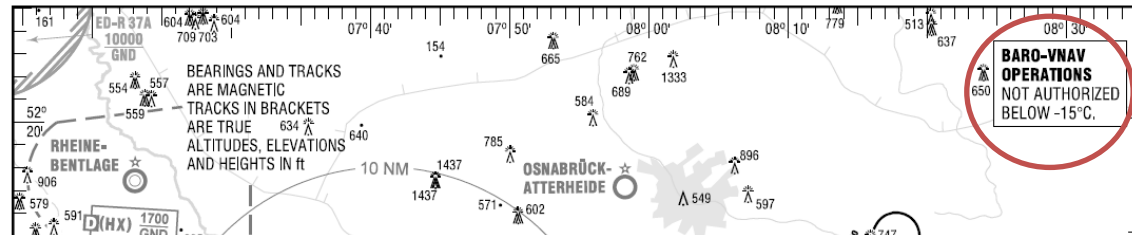
INSTRUMENT
APPROACH
CHART - ICAO

VAR 1° E

ELEV 160
OCH RELATED TO
THR 25 ELEV 159

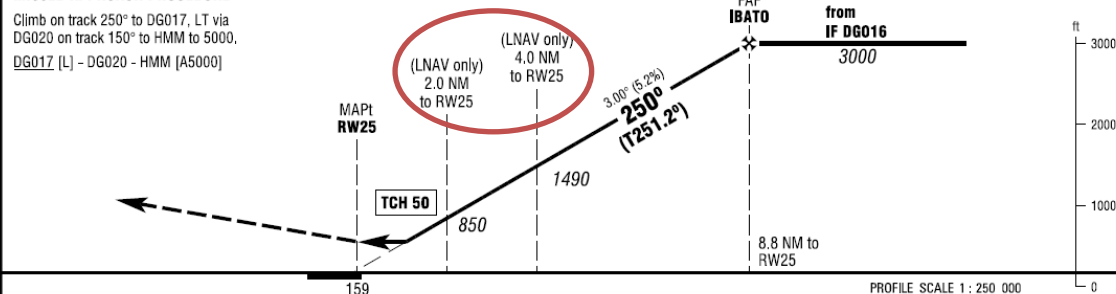
ATIS	127.175	MÜNSTER TOWER	129.800
LANGEN RADAR	129.300	MÜNSTER GROUND	121.875

MÜNSTER/OSNABRÜCK
RNAV (GPS)
RWY 25



MISSED APPROACH PROCEDURE

Climb on track 250° to DG017, LT via
DG020 on track 150° to HMM to 5000,
DG017 (L) - DG020 - HMM (A5000)



	A	B	C	D
OCA (OCH)	560 (400)	560 (400)	560 (400)	560 (400)
RNAV	530 (370)	530 (370)	530 (370)	530 (370)
RNAV / VNAV				

DIST THR / RW25	2	3	4	5	6	7	8
ALTITUDE	850	1170	1490	1800	2120	2440	2760

GS	kt	80	100	120	140	160	180
IBATO - RW25 (8.8 NM)	MIN:SEC	6:36	5:17	4:24	3:46	3:18	2:56
Rate of descent (5.2%)	ft / MIN	420	530	640	740	850	960

Implementation of APV SBAS (LPV) procedures

- Each IFR airport can request implementation of LPV procedures from DFS
- Costs for procedure design are borne by DFS
- Flight validation necessary (Signal to Noise, SBAS-Alarms) – but according to German regulations¹⁾ cost-neutral for the respective aerodrome operators

Issue

- Obstacle detection range much larger than for existing procedures
 - New/different obstacle detection campaign required
 - Costs are borne by the aerodrome operator !
 - Optional: APV SBAS, LPV Minimum same as LNAV-Minimum

¹⁾ § 3 LuftKostV of 19.08.2010

Example APV SBAS

EGNOS Channel Number SBAS Approach ID

AD 2 EDTY A-6-2
Effective: 13 DEC 2012

AIP GERMANY

Effective: 13 DEC 2012

AIP GERMANY

SCHWÄBISCH HALL
RNAV (GPS) RWY 10
EGNOS CH 82829 E10A

ATIS 133.875
LANGEN RADAR 125.050
INFO 129.225

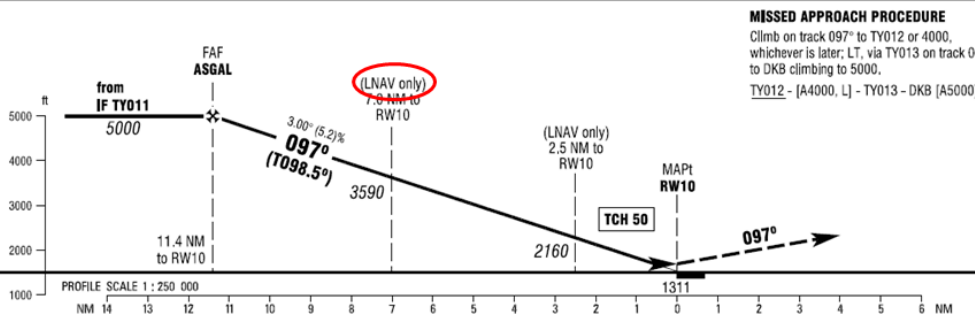
ELEV 1311
OCH RELATED TO VAR 2° E
THR 10 ELEV 1311

INSTRUMENT
APPROACH
CHART - ICA

SCHWÄBISCH HALL

WAY POINT LIST

BARO-VNAV OPERATIONS
NOT AUTHORIZED BELOW -15°C.



MISSED APPROACH PROCEDURE
Climb on track 097° to TY012 or 4000, whichever is later; LT, via TY013 on track 0 to DKB climbing to 5000.
TY012 - [A4000, L] - TY013 - DKB [A5000]

OCA (OCH)	A	B	C
RNAV	1760 (450)	1780 (470)	1830 (520)
RNAV / VNAV	1630 (320)	1630 (320)	1630 (320)
LPV	1760 (450)	1780 (470)	1830 (520)

DIST THR / RW10	11	10	9	8	7	6	5	4	3	2
ALTITUDE	4870	4550	4230	3910	3590	3280	2960	2640	2320	2000

Timing not authorized for defining the MAF.

GS	kt	80	100	120	140
ASGAL - RW10 (11.4 NM)	MIN:SEC	8:33	6:50	5:42	4:53
Rate of descent (5.2%)	ft / MIN	420	530	640	740

FAS Data Block Information

DATA FIELD	DATA
OPERATION TYPE	0
SERVICE PROVIDER IDENTIFIER	1
AIRPORT IDENTIFIER	EDTY
RUNWAY	10
APPROACH PERFORMANCE DESIGNATOR	0
ROUTE INDICATOR	
REFERENCE PATH DATA SELECTOR	0
REFERENCE PATH IDENTIFIER (APPROACH ID)	E10A
LTP/FTP LATITUDE	490708.9985N
LTP/FTP LONGITUDE	0094632.0725E
LTP/FTP ELLIPSOIDAL HEIGHT	+447.9
FPAP LATITUDE	490702.8820N
FPAP LONGITUDE	0094732.4075E
THRESHOLD CROSSING HEIGHT (TCH)	50
TCH UNITS SELECTOR (METERS OR FEET)	0
GLIDEPATH ANGLE (GPA)	3.00
COURSE WIDTH AT THRESHOLD	80
LENGTH OFFSET	0
HORIZONTAL ALERT LIMIT (HAL)	40
VERTICAL ALERT LIMIT (VAL)	50

CRC REMAINDER

20E92F4C

Airports with dedicated EGNOS procedures in Europe



Source: www.essp-sas.eu/

Thank you for your attention!

Questions... ?



DFS Deutsche Flugsicherung