

/ IMPLEMENTATION OF EGNOS BASED APPROACHES AT THE BORDER OF THE SERVICE AREA

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ISAVIA

OVERVIEW OF PRESENTATION

- / EGNOS ground segment in Iceland
- / EGNOS Working Agreement and EGNOS performance research
- / EGNOS precision navigation approval process and use in Iceland
- / Look at first EGNOS procedure designs in Iceland

EGNOS V2 RIMS OPERATIONS IN ICELAND - SINCE 2001



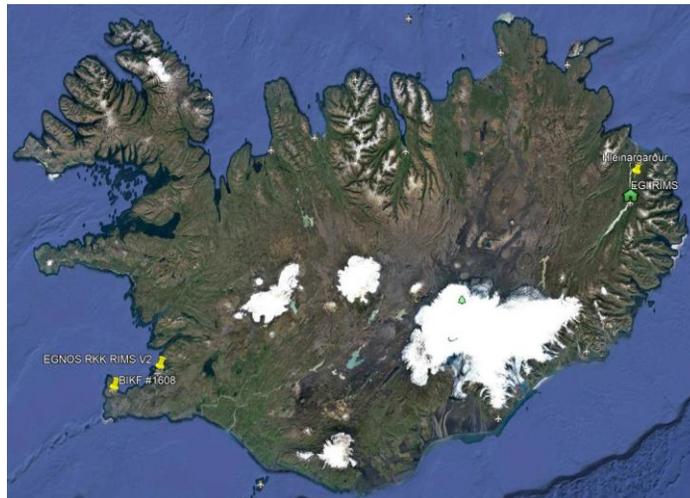
At Reykjavík and
Egilsstaðir airports.
Referred to as version 2

Isavia and ESSP cooperate
daily in RIMS operations



EGNOS V3 UNDER DEPLOYMENT IN ICELAND

- / Isavia is participating in GSA tender for deployment of EGNOS V3 RIMS (ground system upgrade).
- / Deployment is under way in Keflavik, a location on Iceland south-west peninsula.
- / Another location on east part of Iceland is being considered.

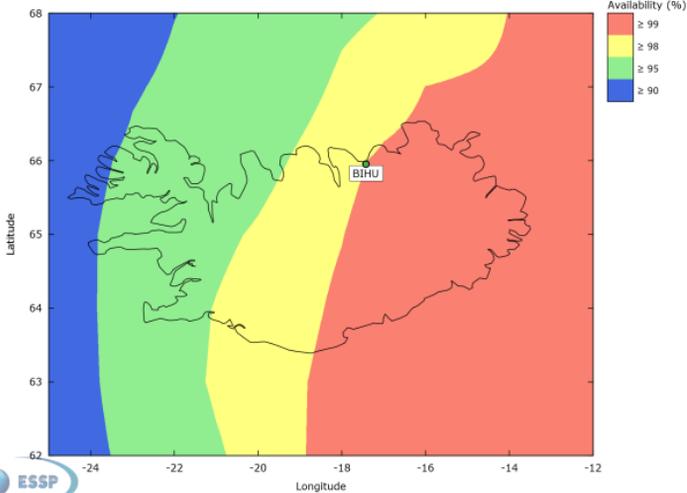


EGNOS WORKING AGREEMENT(EWA) AND PERFORMANCE RESEARCH

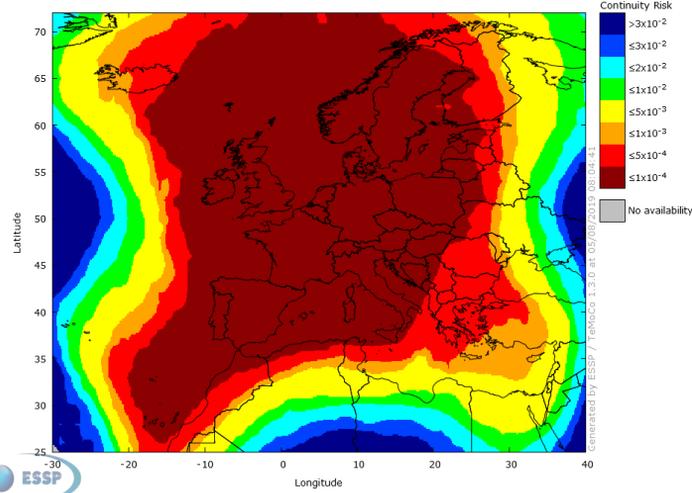
- / Cooperation was key in enabling EGNOS safety-of-life (SOL) service in Iceland.
- / Isavia and ESSP started negotiating the EWA in August 2017.
- / With inputs from EU, GSA and Icesetra, the Icelandic Aviation Authority, and Icelandic Ministry of Transport negotiations were concluded in August 2018.
- / EWA agreement between Isavia and ESSP was signed Desember 2018.
 - Key enabler to formalize EGNOS SOL service in Iceland.
- / Performance research very important at service volume boundary
 - Another key enabler for Iceland transport authorities to consider EGNOS LPV precision approach guidance in Iceland
 - Isavia and ESSP closely collaborated on initial EGNOS performance research.
 - And Isavia and GMV carried out further detailed EGNOS performance research.

APV-I – EGNOS LPV COVERAGE LIMITATIONS

APV-I Availability Map

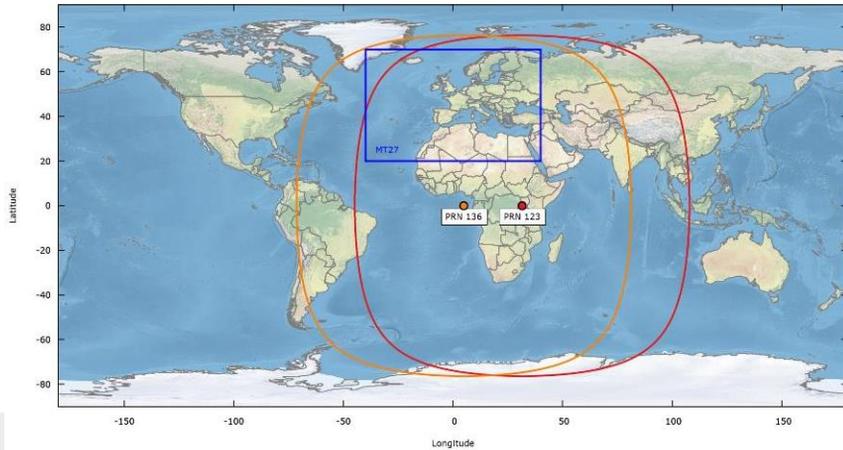


SIS Op - 01/07/2019 00:00:00 to 31/07/2019 23:59:59
APV-I Continuity Risk Map

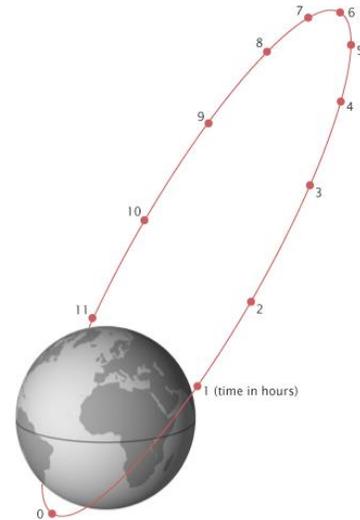
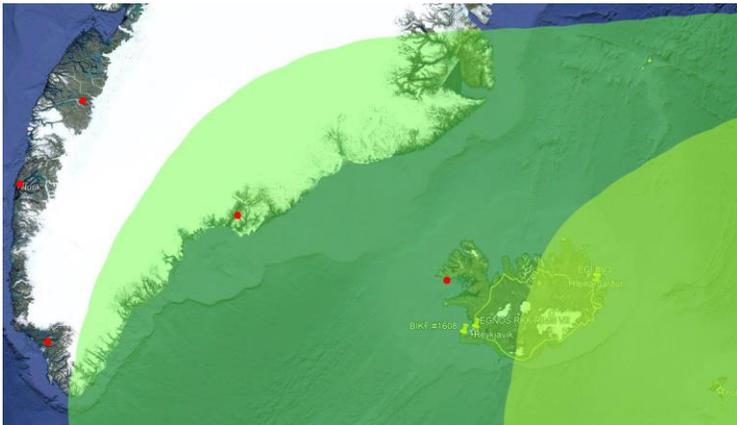


EGNOS SATELLITE LIMITATIONS

- / Low elevation of GEO-stationary satellites at northern latitudes
- / Out of constellation of 3 EGNOS satellites only two are of use in Iceland.
 - **Best is**: PRN 136 SES-5 (a.k.a. Sirius 5 or Astra 4B) L1 & L5, 5.0°E. Elevation angle from Iceland: **14,4°-15,9°** towards south-south-east.
 - **Very low**: PRN 123 Astra 5B L1 & L5, 31.5°E. Elevation angle from Iceland: **6,8°-7,4°** towards east-east-south
 - **Unusable**: PRN 126 INMARSAT 4F2 EMEA L1 & L5, 64.0°E. Elevation angle from Iceland below horizon.
 - **Best satellite was**: PRN 120 <decommissioned> Inmarsat 3-F2 (Atlantic Ocean Region-East) L1, 15.5°W. Elevation angle from Iceland was: 15,9°-18,2° towards south.



POSSIBLE SOLUTIONS TO EGNOS LIMITATIONS – PITCH OF IDEAS



High elliptical orbit (HEO) satellites

ICELAND APPROVAL PROCESS WITH EGNOS LIMITATIONS

- / Isavia and ESSP collected data from EGNOS RIMS and other ground receivers first quarter of 2016.
 - ESSP issued detailed performance reports with positive findings mid year 2016 with focus on Húsavík (BIHU) and Akureyri (BIAR) airports.
- / Based on ESSP findings Isavia issues early 2017 a safety study report of EGNOS APV-1 procedures in Iceland.
 - Accuracy and Integrity fulfilled, Availability and Continuity are affected by EGNOS limitations
 - Report referred to findings on SBAS in ICAO Annex 10, Attachment D:
 - 3.4.3.3: *[...] in the circumstances specified in the assessment, continuing to provide the [SBAS] service was safer than withholding it.*
 - 3.4.3.4: *For those areas where the system design does not meet the average continuity risk specified in the SARPs, it is still possible to publish procedures. However, specific operational mitigations should be put in place to cope with the reduced continuity expected.*
- / Key results for Iceland, using EGNOS increases safety even with it's limitations.

ICELAND APPROVAL PROCESS WITH EGNOS LIMITATIONS (2)

- / Icelandic Transport Authority (Icetra) authorizes EGNOS LPV/APV-1 procedures designs east of 19°W longitude in Q2 2017 with set of mitigating actions:
 - A NOTAM services for airports shall be in place to provide EGNOS performance status before flight
 - Before publications of APV-1 a region study of EGNOS signals-in-space quality shall be conducted.
 - The Iceland AIP shall clearly state the EGNOS signal limitations and aircrews shall assume alternative means of navigation in their flight planning.
- / Isavia fulfilled all mitigation steps for Húsavík and received approval from Icetra in March 2019 for publication
 - EWA allowed for EGNOS NOTAM proposals be provided from ESSP for Isavia's NOTAM and publication processes
 - GMV (in Spain) and Isavia cooperated on collecting local EGNOS data, and GMV produced detailed signals-in-space quality reports on EGNOS.
 - Isavia published AIC A012/2019 where aircrews are guided through the use of EGNOS APV-1 with it's local limitations.
- / First EGNOS LPV in Iceland at Húsavík (BIHU) became active May 2019.

USER EXPERIENCE WITH FIRST EGNOS LPV IN ICELAND

- / Primary operator to Husavik Airport is Eagle Air, an Icelandic domestic airline
 - Flown twice a day, every business day, to Husavik since LPV publication in May.
 - In the fleet, two Jetstream 31/32 aircraft are equipped for EGNOS LPV operations.
 - Up to 19 pilots within the company trained in use of EGNOS LPV on the Jetstream type. Number of active pilots depends on season.
- / Eagle Air's experience in use of EGNOS at BIHU
 - Most frequently use EGNOS LPV minima when in the Jetstream type.
 - Have not run into unavailability nor any complications with EGNOS signals performance at Husavik.
 - EGNOS gives benefits over earlier NDB and RNAV procedures in difficult weather.
 - Eagle Air is generally very pleased with EGNOS operations at Husavik.



APV-1 PROCEDURE PUBLISHED FOR BIHU

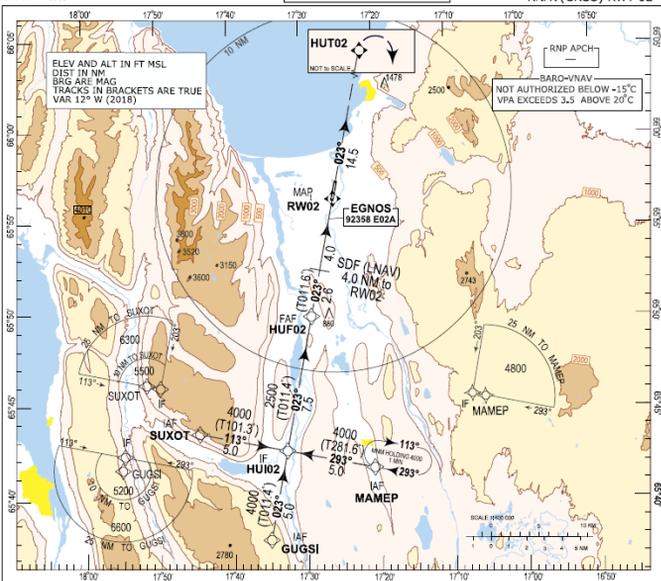
Husavik RNAV (GNSS) RWY 02 Instrument Approach Chart - ICAO

INSTRUMENT
APPROACH
CHART - ICAO

AERODROME ELEV 48

HUSAVIK AFIS	119.200
REYKJAVIK ACC	119.700/ 126.750

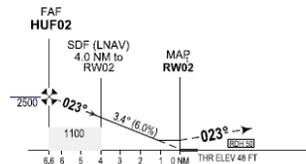
BIHU - HUSAVIK
RNAV(GNSS) RWY 02



CHANGES: Missed approach text

MISSED APPROACH:

Climb on track 023° to HUTO2, turn right direct MAMEP and hold at 4000.



TRANSITION ALT 7000

OCA (ft)	A	B	Remarks
LPV	240 (192)	250 (202)	
LNAV/NAV	500 (452)	510 (462)	
LNAV	670 (622)	670 (622)	
CIRCLING	670 (622)	670 (622)	ONLY WEST OF AD

DIST to RWY02 (NM)	1	2	3	4	5	6
ALT	462	826	1191	1555	1919	2283

Timing not authorized for defining MAP

GS	kt	80	100	120	140	160	180
HUF02-RWY02 (6.6NM)	MIN:SEC	4:57	3:58	3:18	2:50	2:28	2:12
Rate of descent (6.0%)	#/MIN	485	605	730	850	970	1090

Útgefið af Isavia ohf.
Published by Isavia Ltd.

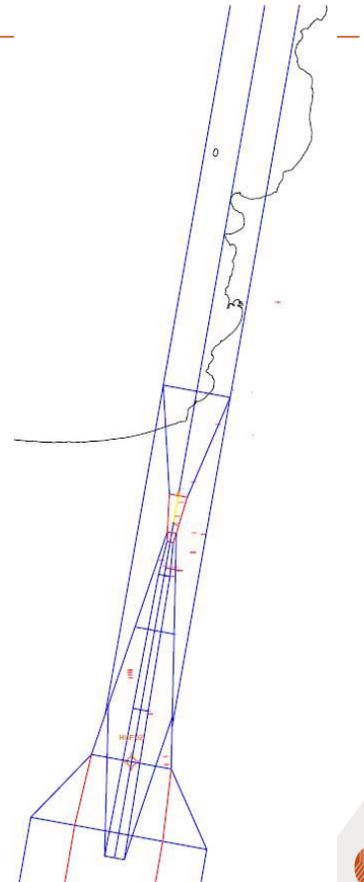
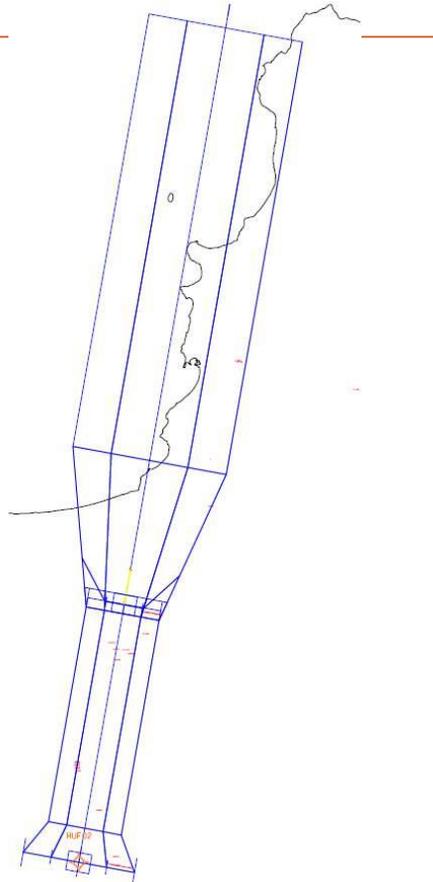
AIRAC AMDT 004 / 2019

BIHU EGNOS availability: 98.7%

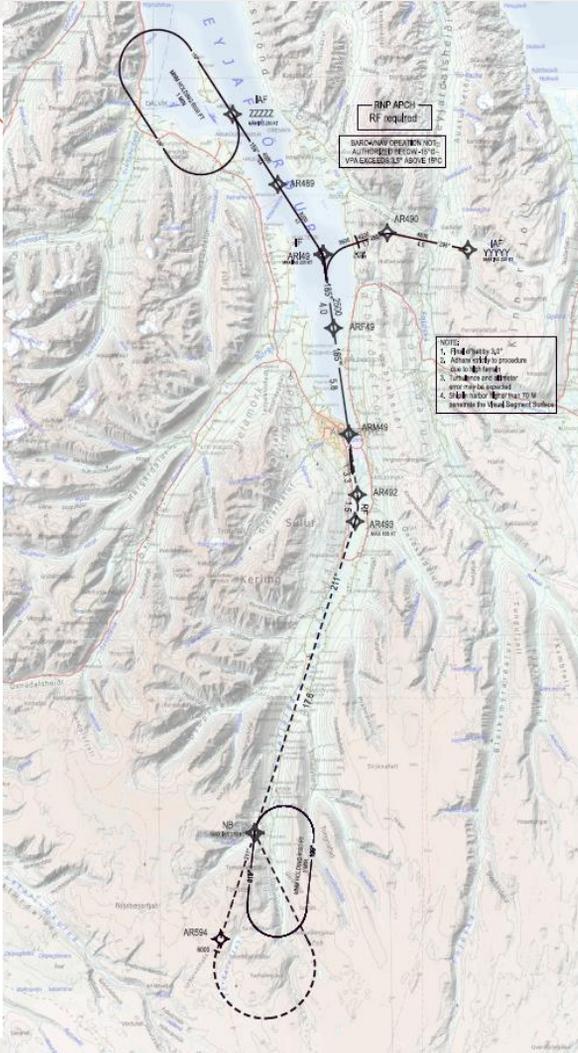
COMBINED(W/NDB)

GNSS/RNAV

EGNOS/LPV



AKUREYRI-EGNOS APPROACH DESIGN ONGOING

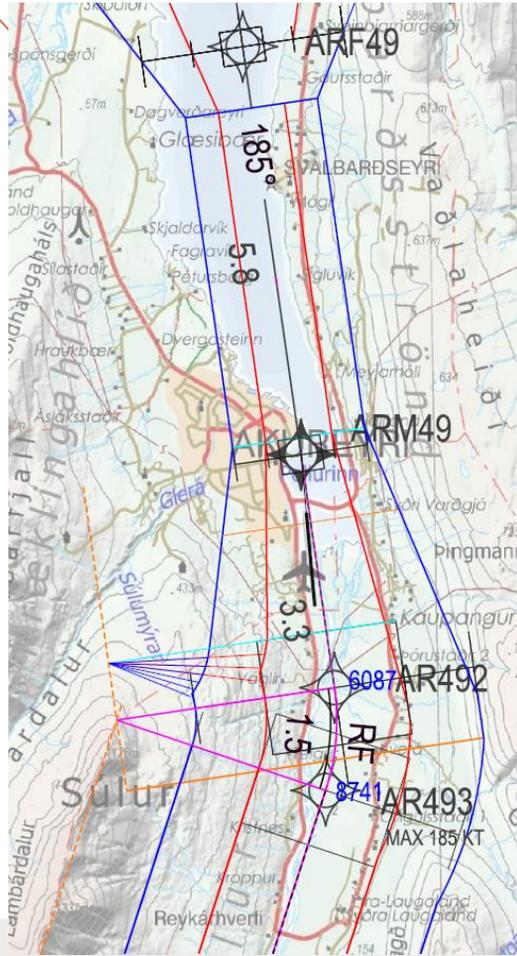


BIAR design estimates

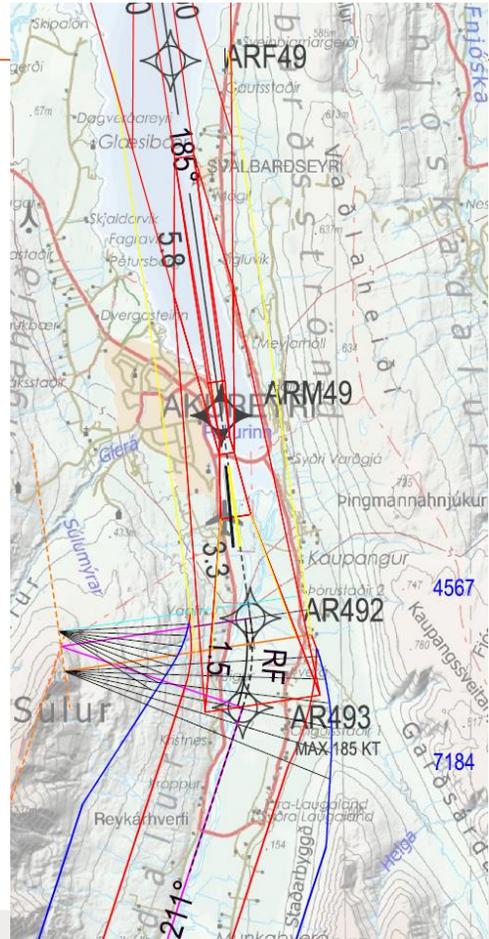
OCA	Climb Grad	CAT A	CAT B	CAT C	CAT D
LPV	2.5%	990	1000	1010	1020
	4.0%	480	490	500	510
LNAV/VNAV	5.0%	430	430	430	430
	2.5%	1050	1060	1090	1120
	4.0%	820	840	860	900
LNAV	5.0%	710	720	750	790
	2.5%	1310	1330	1350	1370
	4.0%	1100	1140	1180	1210
	5.0%	980	1020	1070	1110

BIAR EGNOS availability: 98.6%

GNSS/RNAV



EGNOS/LPV



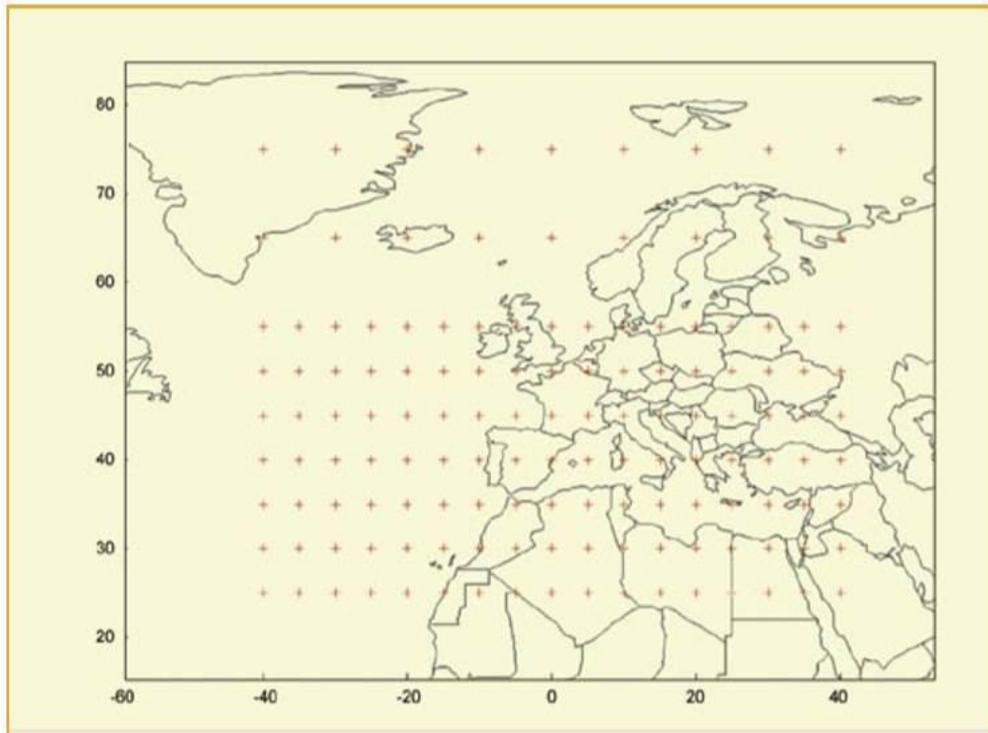
BIAR design

THANK YOU FOR YOUR ATTENTION – QUESTIONS?

/ Contact details

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ADDITIONAL SLIDES



EGNOS Ionospheric Grid Model

FOR OPERATOR CONSIDERATION

- / Multimode aviation receivers must be able to select correct SBAS service volume
 - F.ex switch correctly between EGNOS and WAAS service volumes
 - If service is selected outside service volume, causes increase in error budget.
- / Airframe configuration must be checked
 - i.e. effect of banking and signal blocking from parts of the airframe in an EGNOS procedure (satellites low on horizon).
 - Flight inspection and operator test flights must establish if any technical limitations exist for approaches, such as equipment capabilities and signal blocking (bank angles).

