



The role of EGNOS in the recapitalised DGNSS service of WSV - concept and implementation

Tamás Horváth¹, Michael Hoppe²

¹ Alberding GmbH

² German Federal Waterways and Shipping Administration (WSV)

EGNOS Annual Workshop, 3-4 October 2017, Athens, Greece

Outline



Alberding GmbH and WSV

WSV inland radiobeacon network

Recapitalisation based on the VRS concept

Alberding software solutions

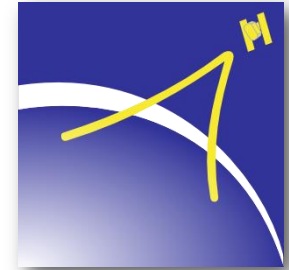
The role of EGNOS in the new WSV system

Summary and outlook

Alberding GmbH



- Independent German GNSS software and hardware development company
- Based in Wildau (near Berlin)
- Turn-key solutions for GNSS infrastructure operators and DGNSS/RTK service providers
- Maritime and inland waterway DGNSS systems (AT, DE, FR, HU, NL, PL, UK)
- SBAS-based DGNSS solutions since 2006



WSV

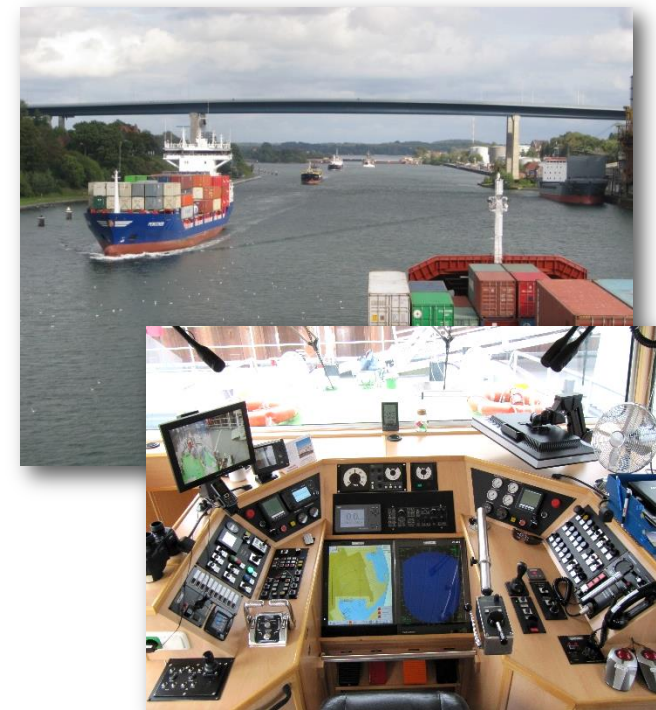


- German Federal Waterways and Shipping Administration
- Traffic Technologies Centre, Koblenz
 - System engineering and standardisation of RNAV systems
- 7.500 km of inland waterways in Germany → 4.500 km safety related waterways with commercial shipping
- To improve the safety of navigation WSV operates 7 IALA radiobeacon stations and a dense network of AIS base stations along inland waterways



WSV.de

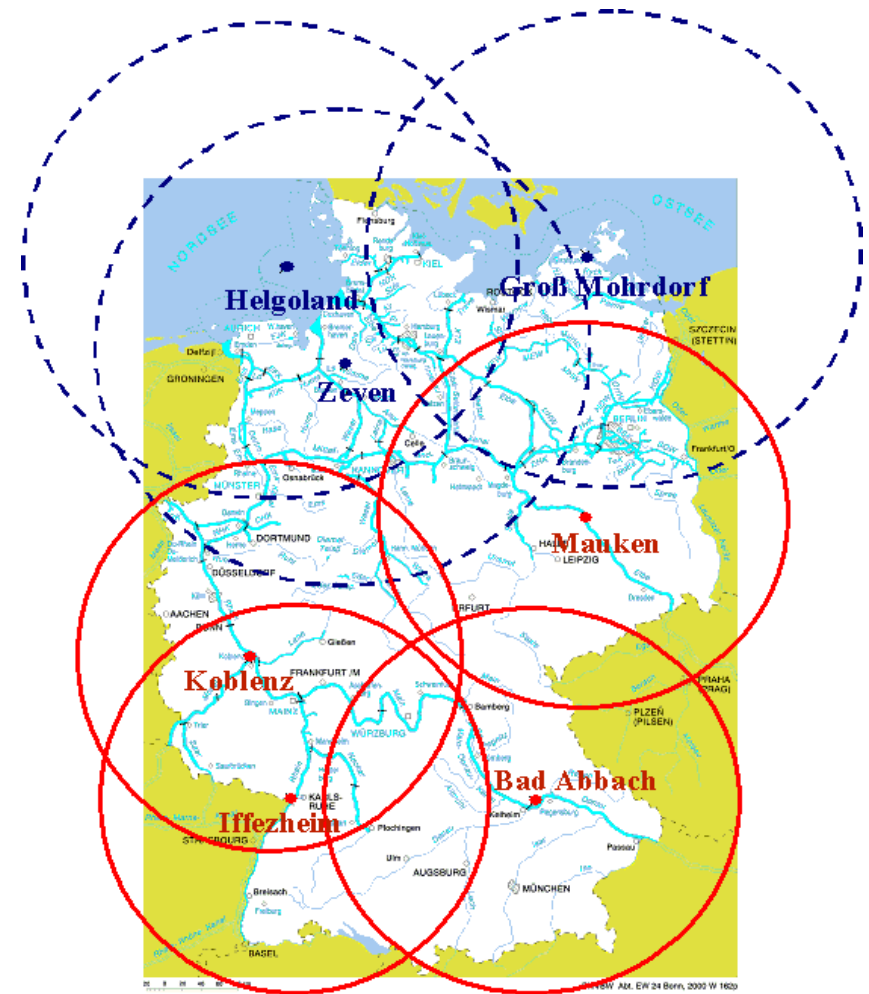
Wasser- und
Schiffahrtsverwaltung
des Bundes



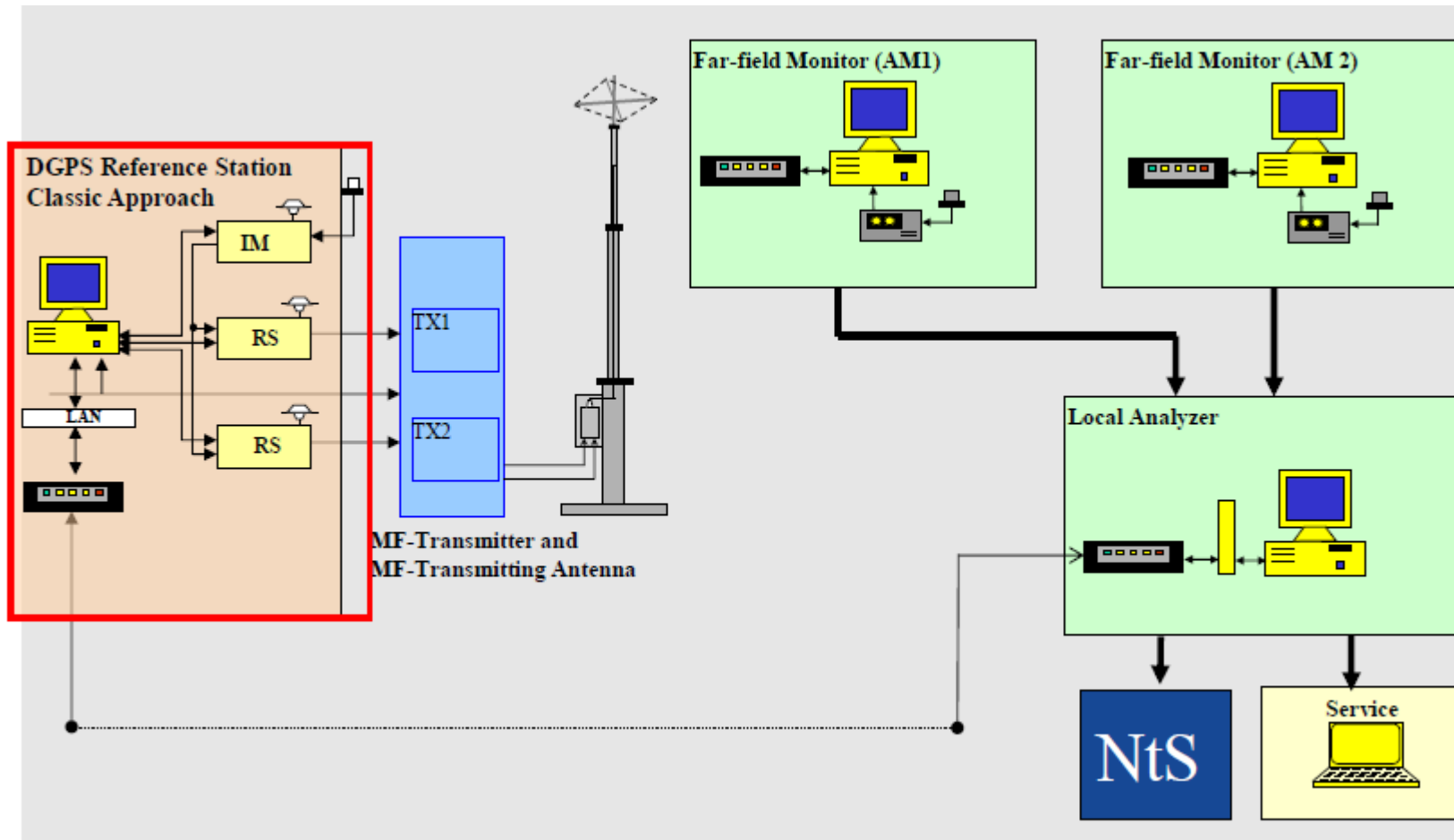
German radiobeacon network



- 3 IALA radiobeacon stations on the North Sea and Baltic Sea coasts since 1995
- 4 IALA radiobeacon sites for inland waterway navigation since 2003:
 - Bad Abbach (Danube)
 - Iffezheim (Rhine)
 - Koblenz (Rhine)
 - Mauken (Elbe)



Old system - decentralised architecture



Why recapitalise the infrastructure?



- The system became obsolete and difficult to maintain
 - hardware and software reached end of life time
 - no spare parts available
 - runs on old Windows NT OS
 - does not support the separation of correction generation from the means of transmission
 - no multi-GNSS correction generation
 - not possible to transmit AIS #17
 - not possible to transmit high accuracy corrections



VRS concept



- IALA Recommendations R-121, R-135 and Guidelines 1112 and 1060
- **Virtual Reference Station (VRS)** concept: corrections and integrity messages are computed at a **central site** using data from remote GNSS receivers
- VRS concept supports the **separation** of **correction generation** from the means of **data transmission**
 - central correction generation for any location within the coverage area
 - corrections can be transmitted via MF beacons, AIS service, VDES
- Input data from **existing GNSS reference stations** is possible
- VRS corrections provide **homogeneous accuracy**
- VRS corrections are **not affected by local effects** at the transmission sites (e.g., multipath, signal interference)
- Service availability depends on **communication links**

New WSV system requirements



- Data processing to be based on a centralised approach, using the Virtual Reference Station (VRS) concept
- Redundant computing centres at two physically separated locations
- Observation data of existing GNSS reference stations (GREF, SAPOS and WSV stations) to be used
- The 3 GPS receivers at each radiobeacon site to be replaced by a single multi-GNSS receiver to support Galileo in addition to GPS and GLONASS
- DGNSS corrections to be integrity checked before transmission (Pre-Broadcast Monitoring) in the VRS server
- Far Field Monitoring results to be sent back to the VRS server for centralised quality control
- **Local backup: EGNOS-based integrity checked corrections generated at the transmission sites**

Alberding software supports



Correction generation approach:

- Centralised
- Decentralised
- Hybrid

Data transmission link:

- IALA radiobeacons
- AIS/VDES base stations

User segment:

- Maritime navigation
- Inland waterway navigation



Beacon.net + Beacon Site Control



Alberding Beacon.net

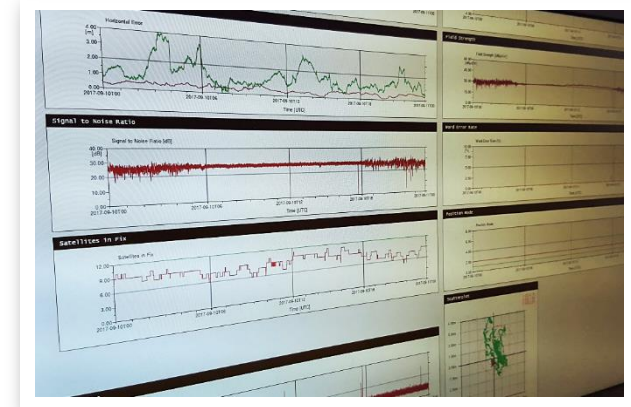
- Central data processing
- Scalable, modular DGNSS VRS software
- GNSS data input, VRS processing, integrity monitoring (PBM, FFM), data transmission (RTCM 2.x, #17, etc.)

beacon.net

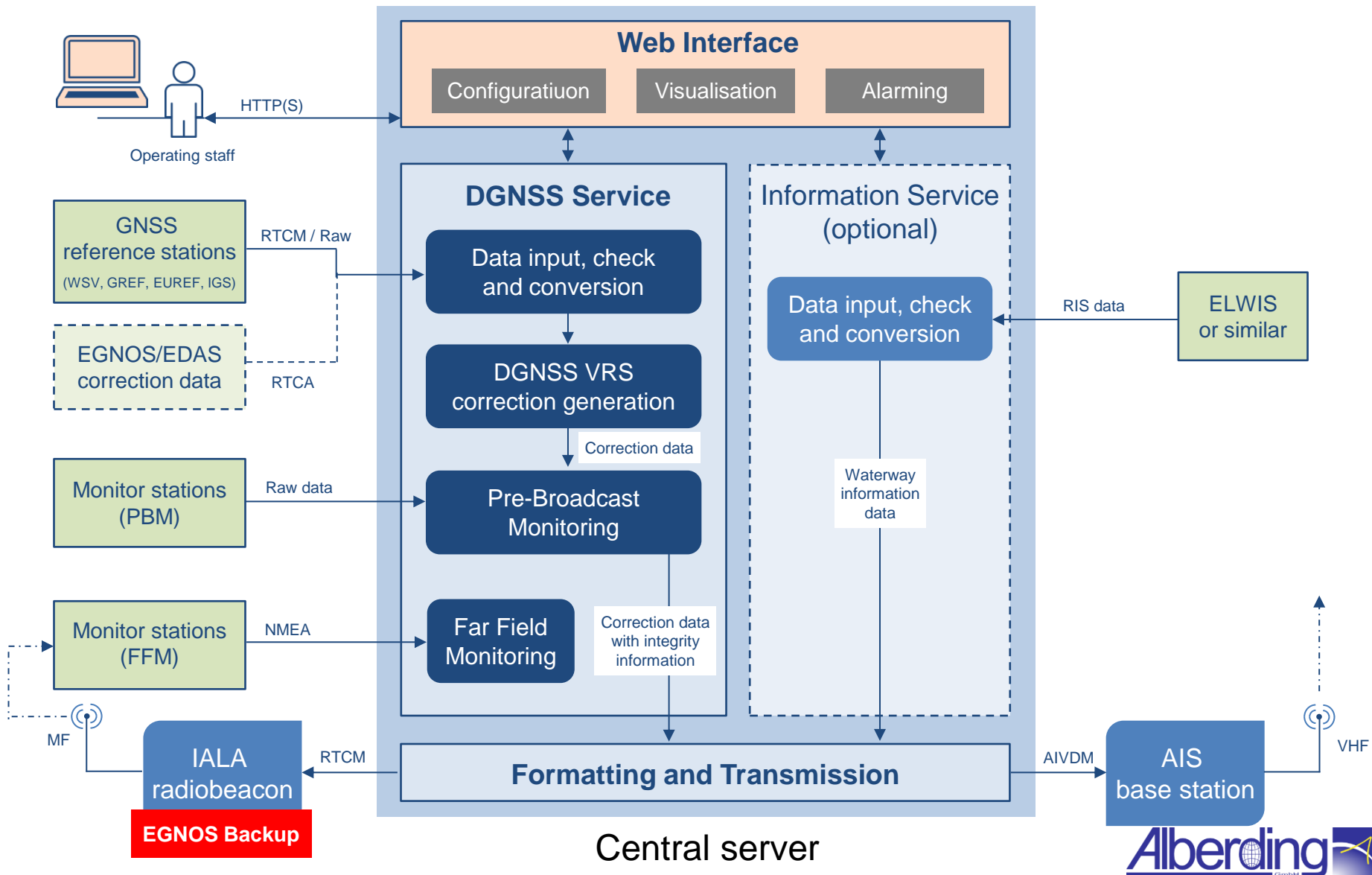


Alberding Beacon Site Control

- Decentralised processing – local backup
- EGNOS-VRS correction generation
- Pre-Broadcast Integrity Monitoring
- Correction selection for transmission



Alberding Beacon.net



Alberding Beacon.net



beacon.net
SUMMARY
MONITORING
SATELLITE SETTINGS
SETUP - SYSTEM
GET EURONET.CFG
SETUP - INTERFACE
LOG FILES

● EuroNet Process
● Beacon.net Cron
● HDD Available 4.4 GB

Summary
System Time : 08-09-2017 09:19:45 (UTC)

00:00:29 Stop

Confirm Status

Map

FFM Alert & Disruption

VRS_SEC_BA	VRS_SEC_IH	VRS_SEC_KO
VRS_SEC_MK		

Monitored Correction Outputs (PBM)

VRS_SEC_BA	VRS_SEC_IH	VRS_SEC_KO
VRS_SEC_MK	VRS_Sec_AIS_Ast	

VRS Correction Outputs

AIS_Asterstein_NoPBM	VRS_SEC_BA_NOPBM	VRS_SEC_IH_NOPBM
VRS_SEC_KO_NOPBM	VRS_SEC_MK_NOPBM	

VRS Networks

Binnenbereich

FFM Inputs

VRS_SEC_IH<-AMS_BG	VRS_SEC_IH<-AMS_BR	VRS_SEC_KO<-AMS_DO
VRS_SEC_BA<-AMS_KA	VRS_SEC_MK<-AMS_MS	VRS_SEC_KO<-AMS_NM
VRS_SEC_BA<-AMS_NS	VRS_SEC_MK<-AMS_WB	

Raw Data Inputs

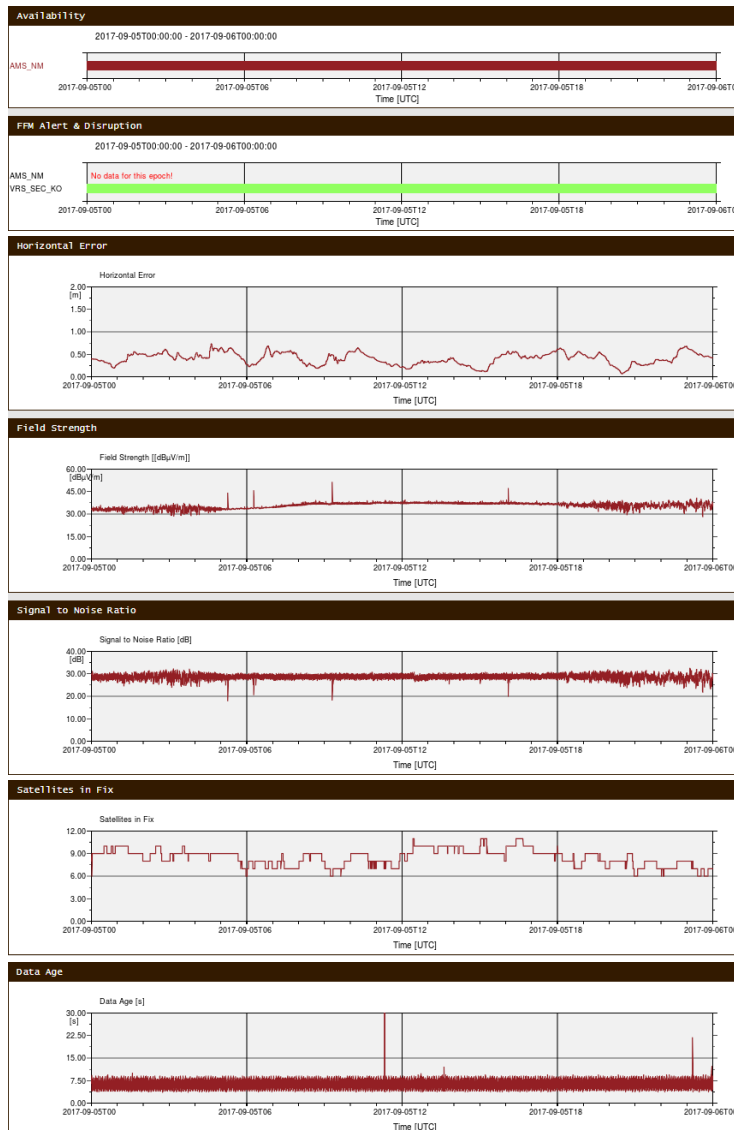
BORJ1	CLIB0	DGNSS_BA
DGNSS_IH	DGNSS_KO	DGNSS_MK
DIEP1	DILL1	EIJS0
ERLA1	GELL1	GOET1
GOR21	HELGI	HOFJ1
HOL21	HUEGO	KOS10
LDB21	LETJ1	MUEJ1
OBE40	SASS0	WARNO
WTZRO		

Others

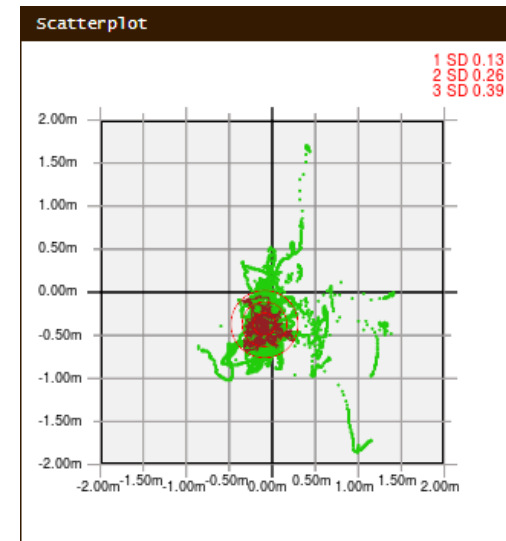
RTCM3EPH

Beacon.Net :: Alberding GmbH :: Schmiedestraße 2 :: 15745 Wildau :: info@alberding.eu :: +49 (0) 3375 / 52 50 370

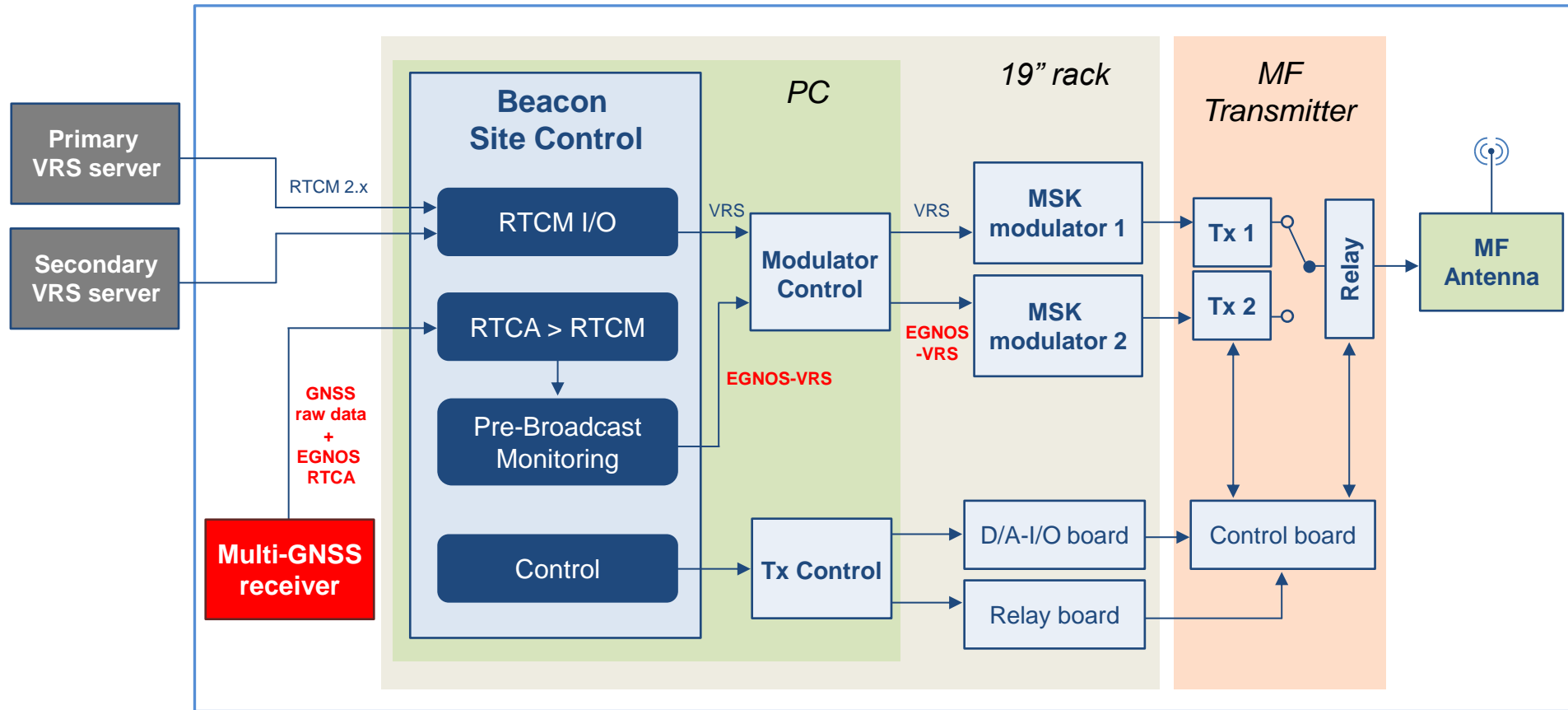
Web-based performance monitoring



Statistics					
VRS_SEC_KO<-AMS_NM					
	Min	Max	Avg	σ	2σ
North	-0.67	-0.04	-0.37	0.14	0.28
East	-0.33	0.25	-0.09	0.11	0.23
Horizontal Error	0.06	0.73	0.40	0.13	0.26
Data Age [s]	3.60	37.20	5.85	0.91	1.83
Satellites in Fix	6.00	11.00	8.51	1.09	2.18
Signal to Noise Ratio [dB]	18.00	32.50	28.64	0.86	1.72
Word Error Rate [%]	0.00	0.00	0.00	0.00	0.00
Field Strength [dBuV/m]	28.20	51.20	35.64	1.75	3.50
Horizontal Error of Monitor [m]	-	-	-	-	-
Availability [%]	G:100.00				
FFM Alert & Disruption [%]	0.00 (100.00)				
Baseline Length [km]	74.878				



Alberding Beacon Site Control



Transmission site

Alberding Beacon Site Control



BeaconSiteControl

Menu Receivers Correction Sources Correction Outputs Help

Receivers	Correction Sources	Correction Outputs
Name: DGNSS_MK Connection: ● Satellites in fix: 10G+7R Fix: ● Horizontal error [m]: 1.28 Height error [m]: -2.23	Name: VRS_EGNOS_MK Input connection: ● Number of satellites: 12G Health status: ● Last error: ● Last residual error: ● Name: VRS_PRI_MK Input connection: ● Number of satellites: 10G Health status: ● Name: VRS_SEC_MK Input connection: ● Number of satellites: 10G Health status: ●	Name: MODULATOR1 Output connection: ● Output source: VRS_PRI_MK Output netto datarate [bps]: 100 Name: MODULATOR2 Output connection: ● Output source: VRS_EGNOS_MK Output netto datarate [bps]: 100

SBAS Satellite Tracking Status

● 120 ● 123 ● 126 ● 136

Beacon.net FFM Status	TxControl Status
Name: VRS_PRI_MK Connection: ● Horizontal accuracy: ● Height accuracy: ● Age: ● Fix: ● Signal to noise ratio: ● Field strength: ● Word error rate: ●	Connection: ● Out_TX1Sel: ● Transmitted power [%]: 99.8 TX1OnAir: ● Reflected power [%]: 0.6 TX1Fault: ● Antenna current [A]: 4.5 Out_TX2Sel: ● Battery [V]: 20.2 TX2OnAir: ● Fault Detection [V]: 0 TX2Fault: ● Out_LowPower: ● ManualMode: ●

Alberding Beacon Site Control



BeaconSiteControl

Menu Receivers Correction Sources Correction Outputs Help

Receivers

Name: DGNSS_MK
 Connection: ●
 Satellites in fix: 10G+7R
 Fix: ●
 Horizontal error [m]: 1.28
 Height error [m]: -2.23

Correction Sources

Name: VRS
 Input connection: ●
 Number of satellites: 12G
 Health status: ●
 Last error: ●
 Last residual error: ●

Name: VRS
 Input connection: ●
 Number of satellites: 10G
 Health status: ●

Name: VRS
 Input connection: ●
 Number of satellites: 10G
 Health status: ●

SBAS Satellite Tracking Status

● 120 ● 123

Beacon.net FFM Status

Name: VRS_PRI_MK
 Connection: ●
 Horizontal accuracy: ●
 Height accuracy: ●
 Age: ●
 Fix: ●
 Signal to noise ratio: ●
 Field strength: ●
 Word error rate: ●

Source Configuration

Marker: WILEGNOS
 Type: EGNOS
 Receiver: WIL2BD_RAW

Coordinates

XYZ LLH

X/Latitude: 3796281.733
 Y/Longitude: 920751.615
 Z/Height: 5025146.310

Connection

Protocol:
 Server:
 Port: 0
 Mountpoint: WILEGNOS
 Username:
 Password:
 Device:
 Baudrate:

Pre-Broadcast Monitoring

Enable:
 Monitor: WIL2BD_RAW
 Max PRC (≤ 10000): 20
 Max RRC (≤ 4): 0.2
 Max PRC Residual (≤ 150): 5
 Max PRC Residual Delay/Timeout (5 ≤ delay ≤ 65): 5
 Max RRC Residual (≤ 10): 0.5
 Max RRC Residual Delay/Timeout (5 ≤ delay ≤ 65): 5
 Max Position Difference (≤ 100): 2.0
 Max Position Difference Delay/Timeout (5 ≤ delay ≤ 100): 5

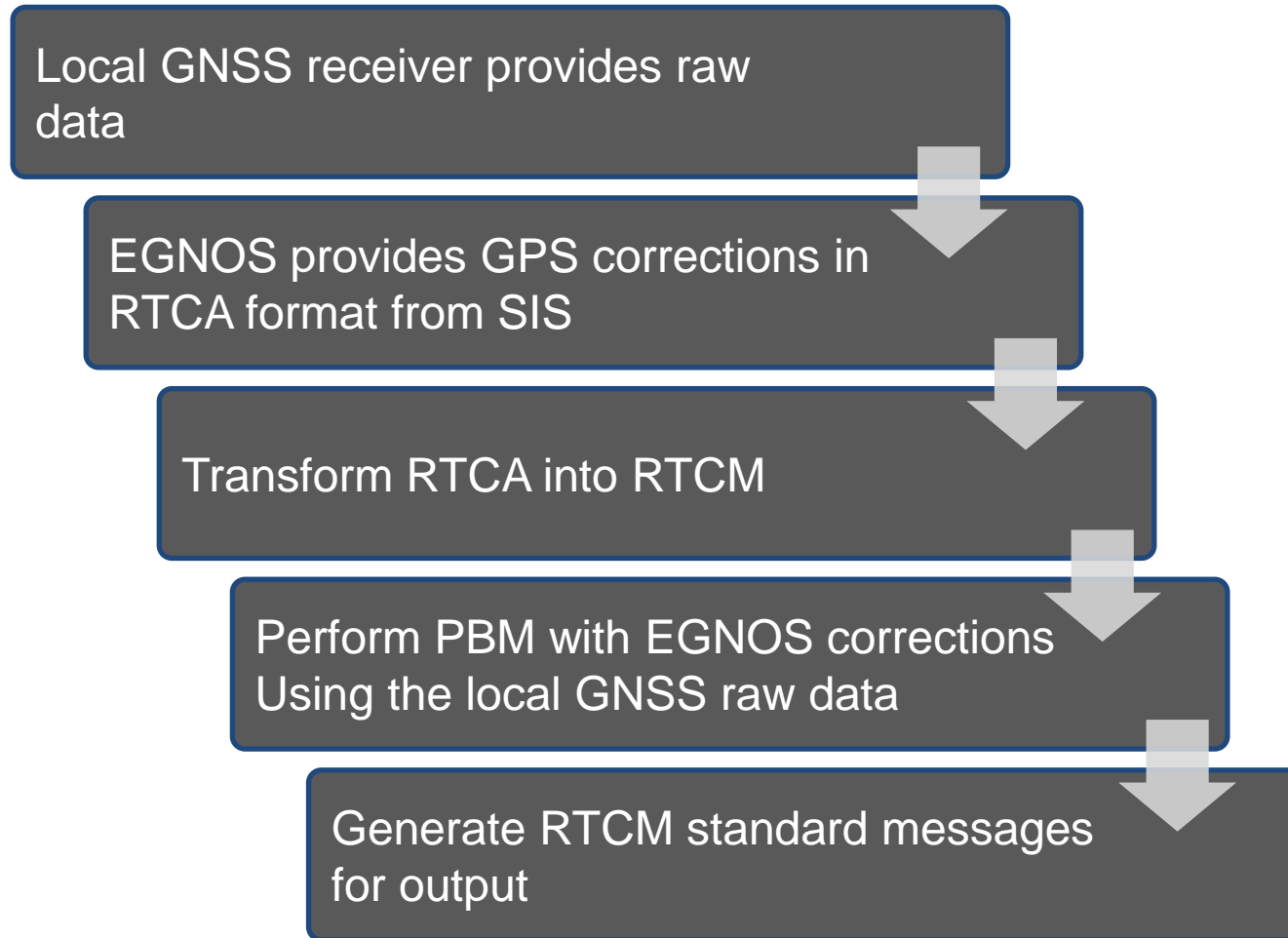
Message Type

Message Type	1	3	6	7	9/1	9/3	16	27	31	32	34/1	34/3	35	36
Schedule [s]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Station ID	0													
Brutto data rate [bps]	75													
Health	normal													

MT7 MT16 MT27 MT35 MT36

OK

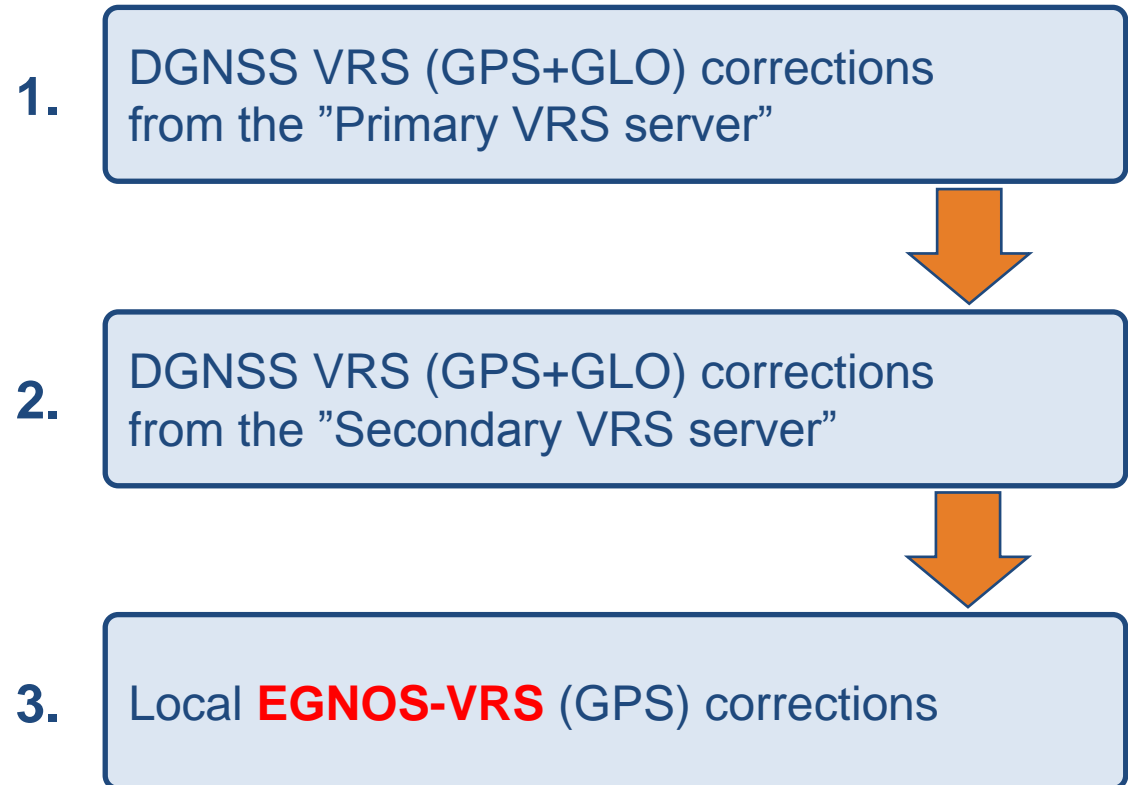
Local backup functionality



Correction selection hierarchy



Alberding Beacon Site Control Software



EGNOS-VRS performance example

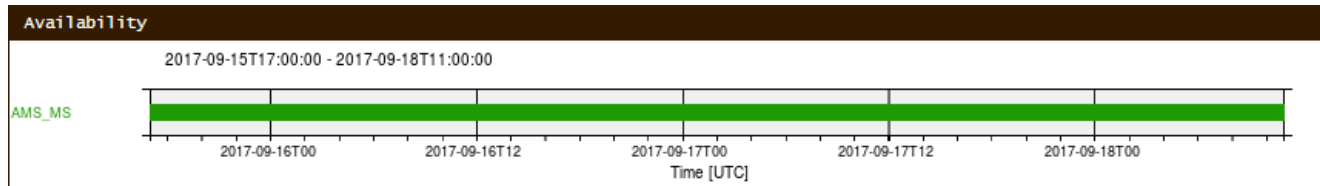


Beacon station: Mauken
51° 43' N | 12° 49' E

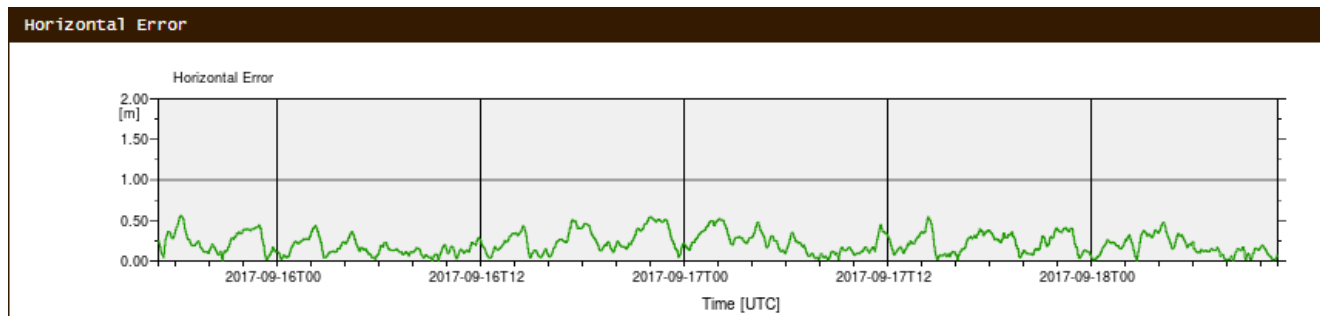
Far Field Monitor: Meißen
51° 10' N | 13° 29' E

Baseline length: 76 km

Availability

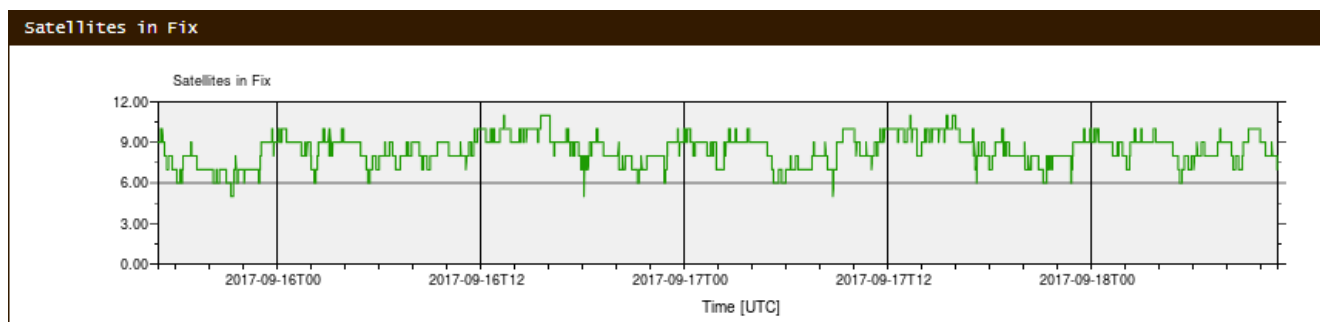


Horizontal error



Mean: 0.21 m
2σ: 0.26 m

No. of satellites



EGNOS-VRS performance example

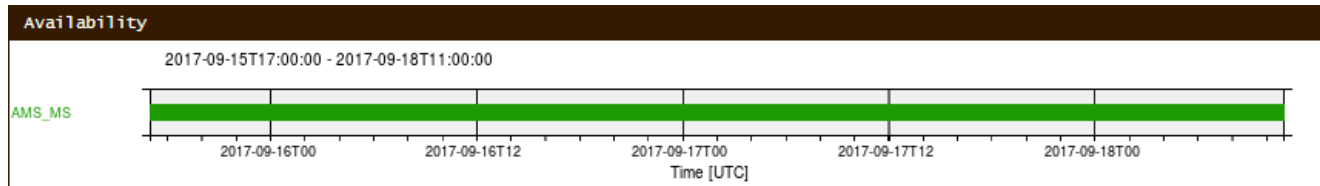


Beacon station: Mauken
51° 43' N | 12° 49' E

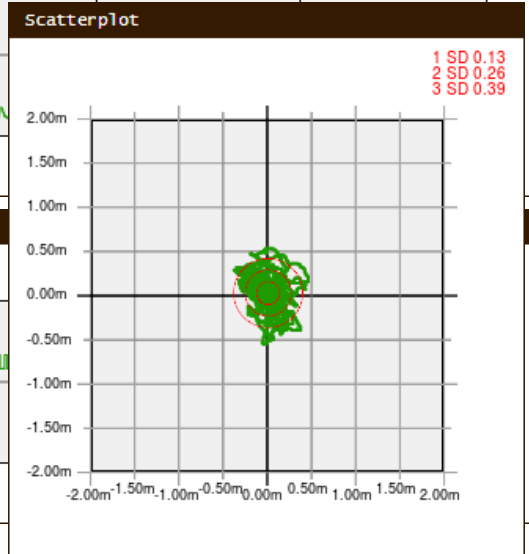
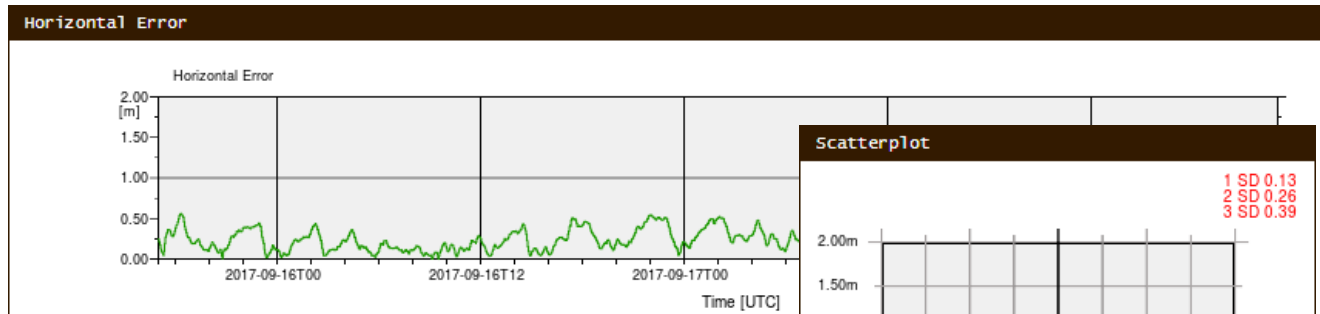
Far Field Monitor: Meißen
51° 10' N | 13° 29' E

Baseline length: 76 km

Availability

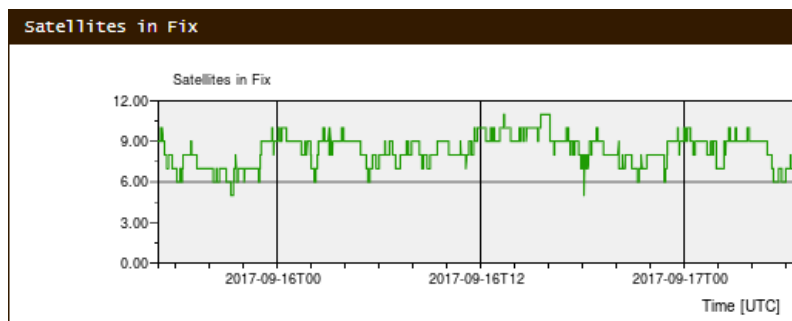


Horizontal error



Mean: 0.21 m
2σ: 0.26 m

No. of satellites

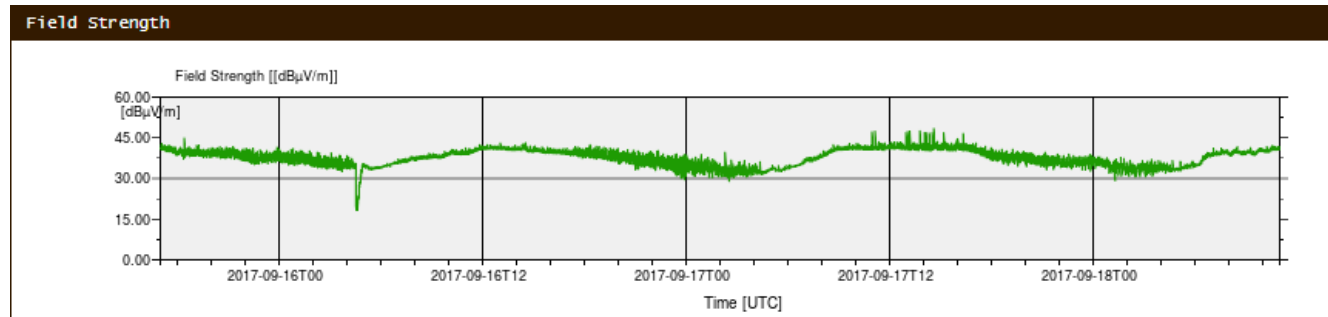


Horizontal scatter

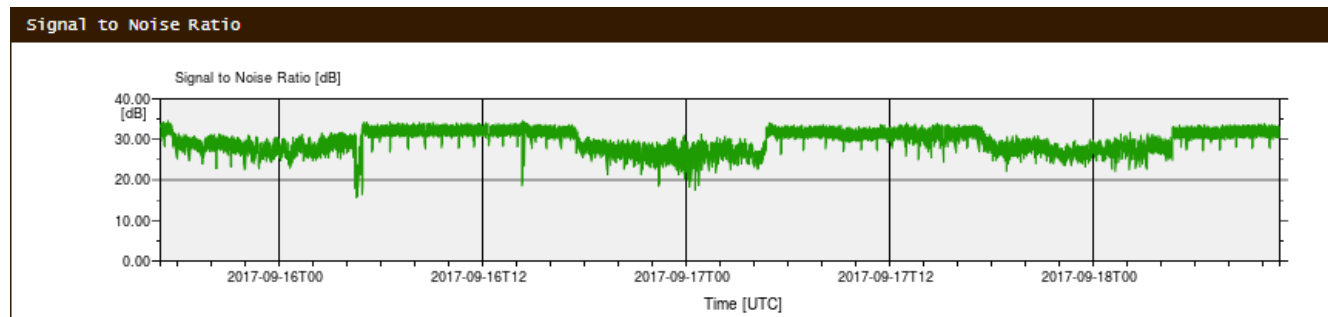
Radiobeacon signal quality monitoring



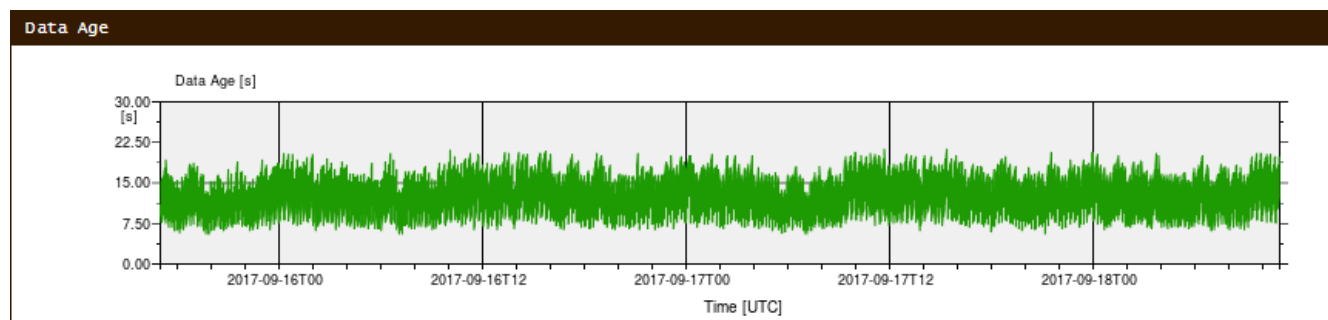
Field strength



Signal to Noise Ratio



Data age



EGNOS-VRS advantages



- Reduction of onsite infrastructure
- Independence of correction generation (EGNOS) from integrity checking (responsibility of the maritime authority) – IALA/IMO recommendation
- Quality of corrections not affected by local issues that could impact the beacon site (e.g. multipath, interference)
- Transparent for end users and compatible with deployed user equipment
- Transmission of EGNOS-VRS corrections via AIS #17 for IWW
- Generation of individual EGNOS-VRS corrections for each AIS base station location



GSA pilot project



GSA/OP/07/13 SC24 “Support to Maritime Service Providers for the transmission of EGNOS corrections via IALA beacons and AIS/VDES stations”

- Objective: analyse the technical and economic feasibility of the transmission of EGNOS corrections via IALA beacons and AIS/VDES
- Different potential architectures will be analysed in the frame of dedicated pilot projects
- Advisory board: maritime and IWW authority experts to define the pilot projects
- Working groups: execute the pilot projects
- Project duration: 17 months (Phase1 + Phase2)



We certify you're there.





Thank you for your attention!



Tamás Horváth

Alberding GmbH
Schmiedestraße 2
D-15745 Wildau

Phone: +49 3375 5250 370

Mobile: +49 151 1880 4899

Email: horvath@alberding.eu

Web: www.alberding.eu