EGNOS/EDAS based solution for the French DGPS network.


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Date 04/10/2017

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1.Context

✔ DGNSS guidelines and recommendations (IALA, IMO...) define main performances to be achieved

✔ French DGPS network becoming outdated therefore has to be replaced

✔ Recommendation IALA-R135: *«on the future of DGNSS»* clearly identify SBAS as potential source of maritime differential correction

✔ GSA works closely with stakeholders (EMRF, NMSP, IALA…) to foster EGNOS adoption in maritime

EGNOS/EDAS based solution for the French DGPS Network

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1.Context

7 stations metropolitan France and 1 station overseas (Guyane)
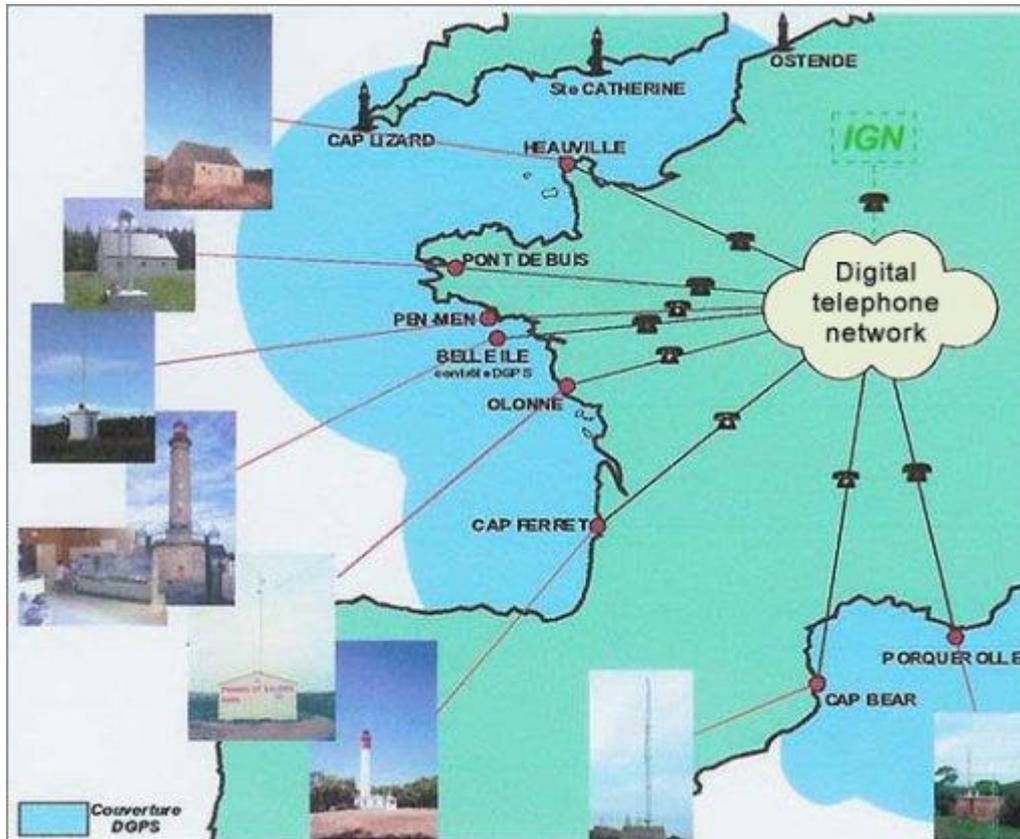
✔ Deployment about 15 years ago

✔ Central control station at Belle-île (Far-field monitoring)

✔ Remote control and survey using ISDN network

✔ Integrity-monitor at station allows only Post-Broadcast monitoring

EGNOS/EDAS based solution for the French DGPS Network

1.Context

DGPS Issues

- ✔ No redundancy (One couple RS/IM per station)
- ✔ Equipments are obsolete (regular failures)
- ✔ Lack of pre-broadcast integrity
- ✔ Service requirement no longer achieved (availability)

⬇

French Maritime Authorities instructed CEREMA to propose a short-term and cost effective solution for DGPS service maintenance

⬇

EGNOS/EDAS Based solution has been selected thanks to a promising preliminary study conducted by Cerema in 2016

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1.Context

Preliminary study results (Cerema 2016)

Position accuracy of 1.1 meters (95^{Percentile}) using either EGNOS SiS or RTCM converted from EDAS
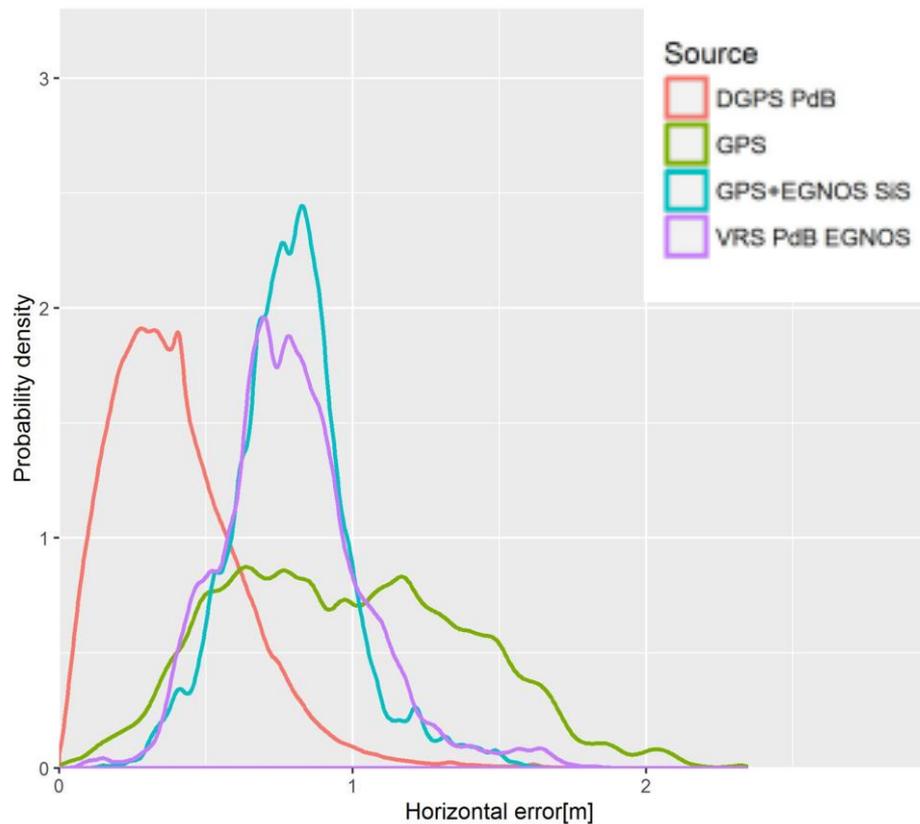
✔EGNOS VRS methods and DGPS measurement succeed to fulfil the requirements for coastal navigation (<10m)

✔Baseline 33 km (Distance from the VRS or beacon Station to the Rover)

✔ DGPS remain the most accurate method but only short baseline was studied

2.EDAS Centralized based architecture

Two Approaches for an EGNOS/EDAS based DGPS → Centralized or Local

Local	Centralized
✔ Independent of the network if SiS is used for collecting EGNOS Data ✔ Reduction of infrastructure on site compared to traditional DGNSS	✔ RTCA to RTCM software needed at the central facilities ✔ Significant reduction of material on the site (likely most cost effective) ✔ Dependant to a reliable network ✔ Mitigation of the jamming/local effects

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2.EDAS Centralized based architecture

Central server:

✓ A specific software is set-up in the central server generating RTCM V2.3 corrections from EGNOS RTCA for each beacon stations (EGNOS VRS Concept)

✓ GNSS raw data are collected at each beacon site in order to perform Pre-broadcast monitoring

✓ Data are sent to each beacon station over the network

Beacon Station:

✓ MSK Modulator

✓ GNSS Receiver collecting raw data

✓ Broadcast materials (transmitter, tuning unit, antenna...)

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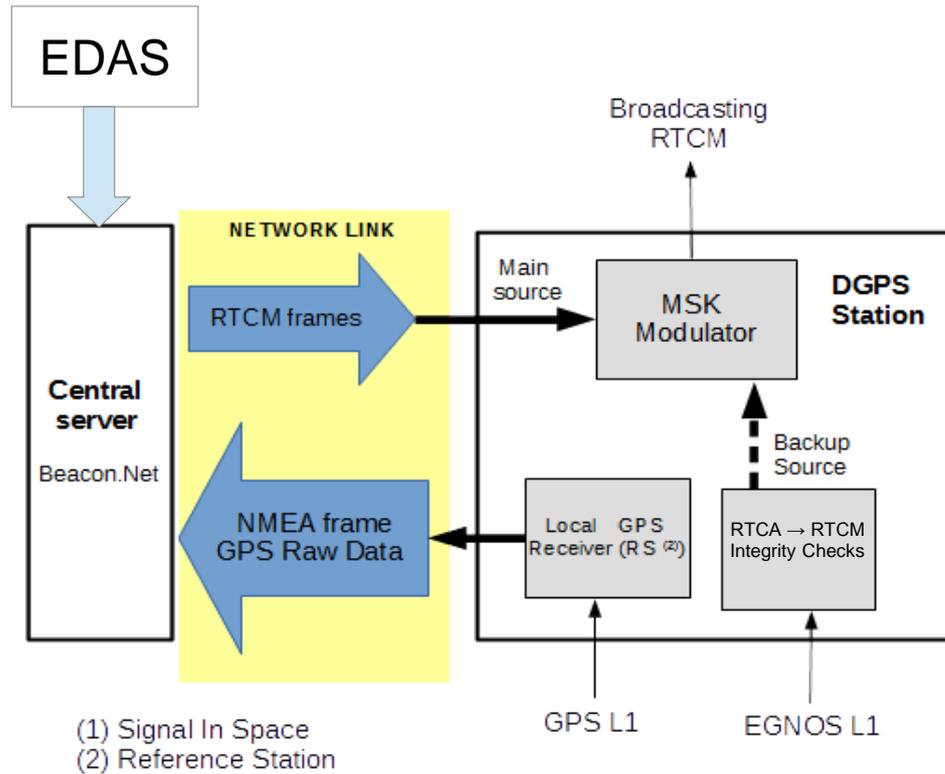
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3.Devices and software

Beacon.net:

- ✓ Provided by Alberding company (Germany)

- ✓ Provisions of Pre-Broadcast integrity (Position and SV domain)

- ✓ Monitoring of the data-flows (EDAS, VRS, GNSS Raw Data, Far-Field Monitors)

- ✓ Provision of reports for key parameters (Accuracy, availability, position precision…)

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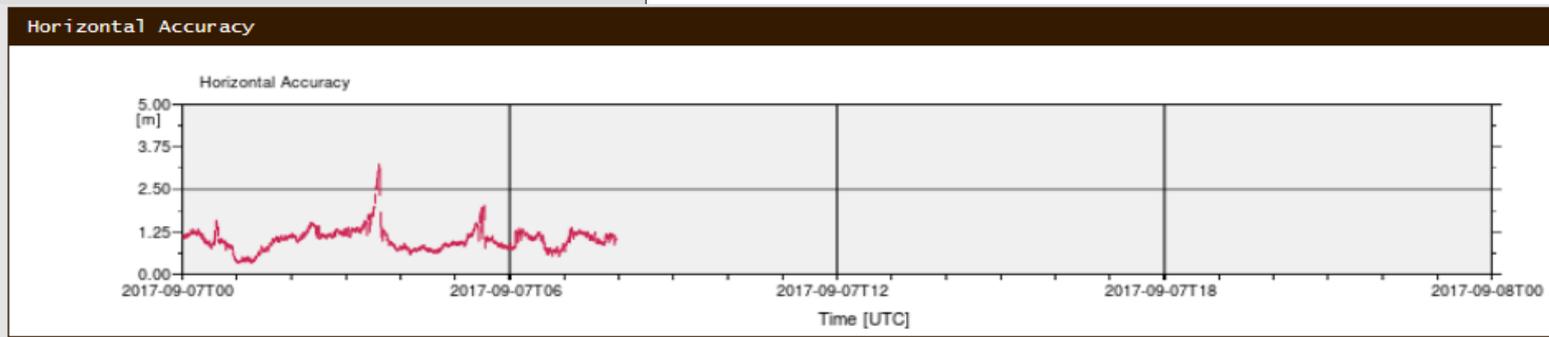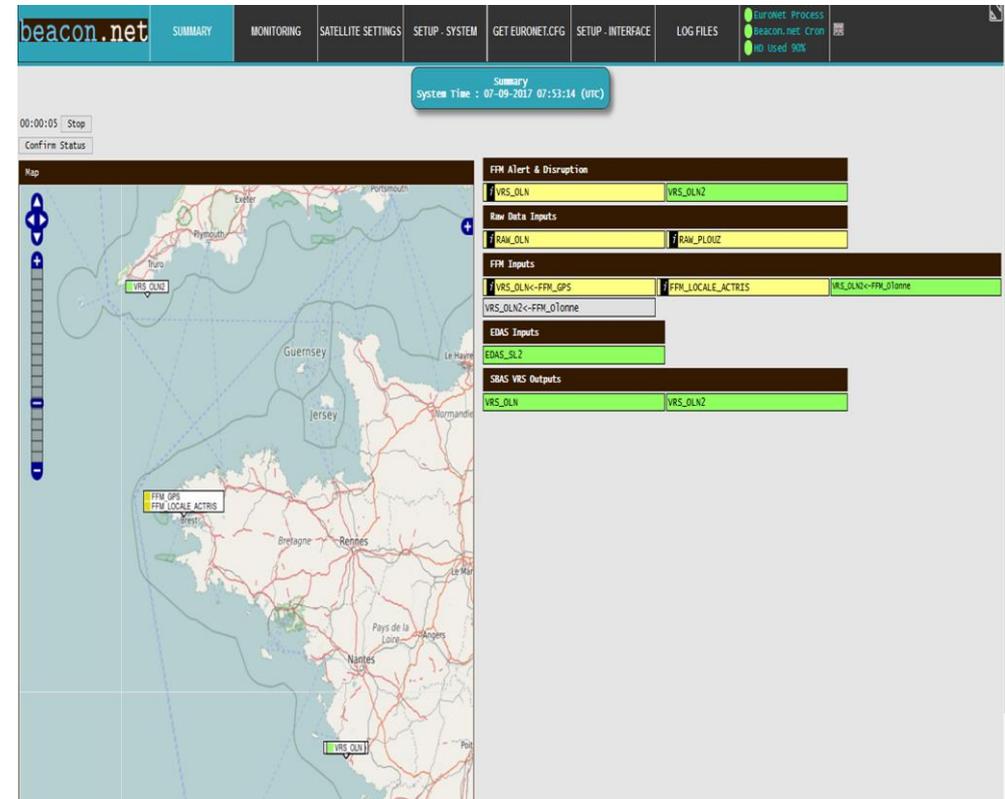
3.Devices and software

MSK Modulator:

Similar Products «off the shelves» are not usual in the market → Need of a specific development

EDAS

NETWORK LINK

RTCM frames

Central server
Beacon.Net

NMEA frame GPS Raw Data

Broadcasting RTCM

Main source

MSK Modulator

DGPS Station

Backup Source

Local GPS Receiver (R S (2))

RTCA → RTCM Integrity Checks

GPS L1

EGNOS L1

(1) Signal In Space
(2) Reference Station

Specifications for the call:

✓ IP enabled/remotely monitorable and configurable

✓ Broadcast a RTCM message type 6 with « Not operating » Flag if the station is not properly working

✓ Connected to two sources of RTCM in order to switch from one to another in case of defect (future backup)

✓ Fit with ITU M.823-3 (baud rate 25/50/100/200, frequency from 283,5 to 325 KHz...)

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3.Devices and software

MSK Modulator:

- ✓ Designed by ACTRIS Company (France, Brest)

- ✓ Included in a 2 Unit Rack

- ✓ Web access for monitoring

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3.Devices and software

MSK Modulator:

EGNOS Centralized architecture concept allows significant reduction of hardware on-site.

moniteur
Pc industriel
Routeur cxr rnis
Récepteur de référence RS
Moniteur intégrité
Ampli Kenta

Traditional DGNSS beacon site infrastructure

EDAS Centralized solution site infrastructure

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4. Test Campaign

Two main set of measurements:

[1] MSK Modulator validation in the laboratory:

- ✓ Laboratory scale tests without broadcasting
- ✓ The modulator output signal was attenuated and merged with L1 frequency
- ✓ Test duration was set to at least 12 hours

[2] Full scale tests

- ✓ The modulator was set-up in the beacon station of Olonne (307 KHz)
- ✓ The station was linked to the central server over the Inter-Administration-Network
- ✓ Marines were informed that signal provided is for testing purposes («Do not use it»)
- ✓ Test duration was between 24 hours to one week

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4. Test Campaign

[1] MSK Modulator validation in the laboratory (no broadcast):

The objectives was to validate that the modulation of the RTCM provided by Beacon.net does not affect the position accuracy
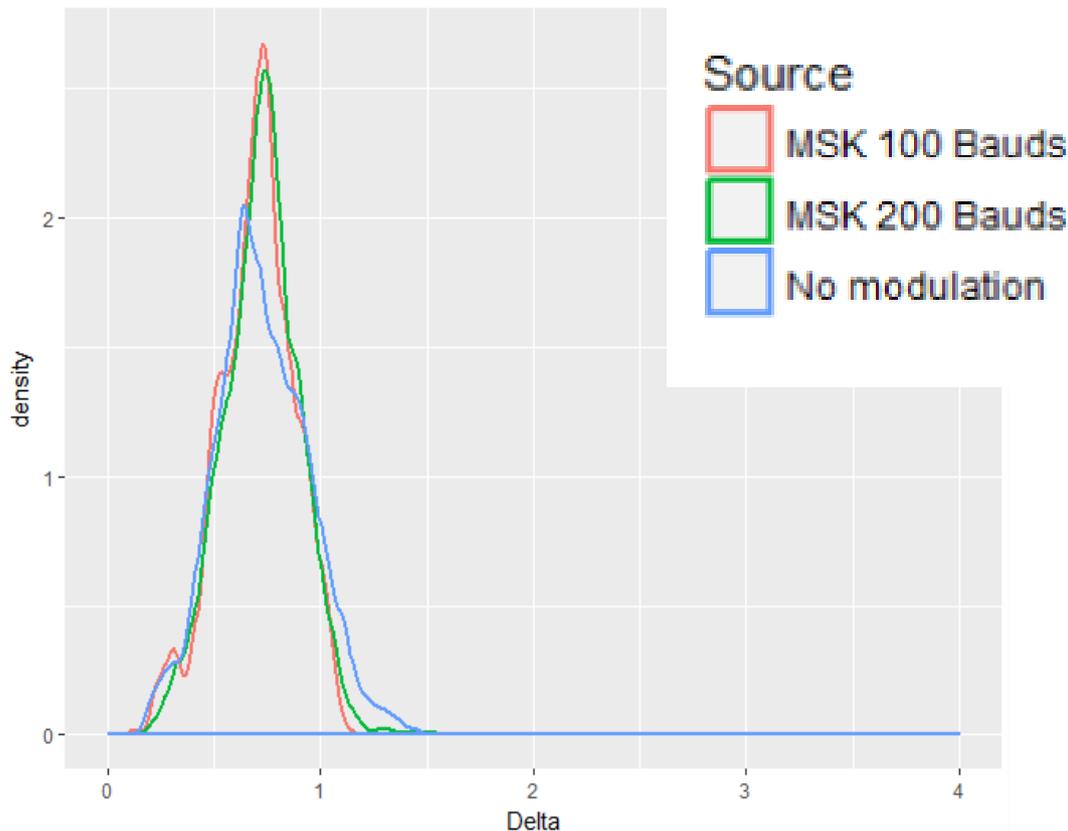

- ✓ The data has been collected in Plouzané and the VRS is defined in the location of Pont de Buis (baseline 33 Km)

- ✓ No significant difference was noticed between the three set of measurements

- ✓ Accuracy was 1.0 ± 0.1 m

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4. Test Campaign

[2] Full scale tests (Broadcast 307 KHz):

The objective was to assess the capability of the complete chain to fulfil the requirements particularly continuity and positioning performances within the defined coverage area
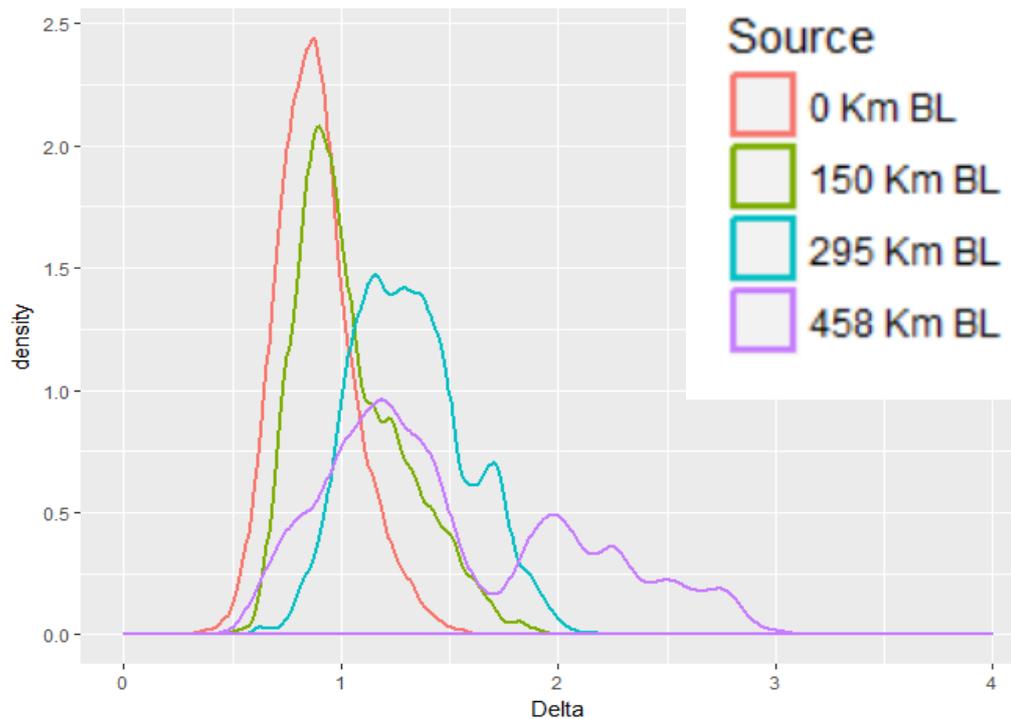
Baseline length	95[percentile] (m)
0	1.22
150	1.52
195	1.78
458	2.6

Note: Data collected using the same receiver and antenna at different epochs
Different VRS locations generated to simulate a wide range of rover baseline

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4. Test Campaign

Summary:

Accuracy requested for coastal navigation (10 m)

$y = 0,003x + 0,98$

Legend:
- EDAS/DGPS Cerema (2017)
- VRS ESSP Study (2016)
- VRS ESSP Study (2017)

French DGPS coverage
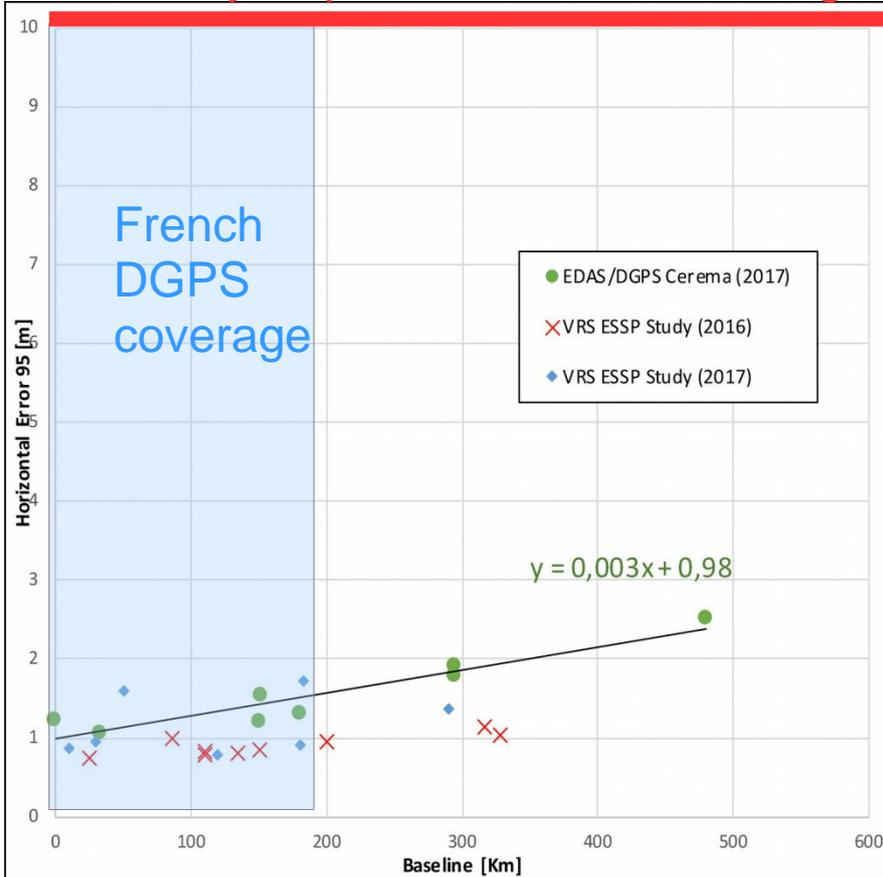
✓ Accuracy in the French coverage area remains below 2m (<<10m)

✓ Spatial decorrelation measured by Cerema ~ 30cm/100 Km → In line with standard DGPS[1]

✓ Accuracy (95%) at 0 Km baseline ~ 1 m → Typical EGNOS RTCA horizontal error[2]

1 - 0.22 m / 100km Monteiro(2005)
   0.5m / 100 km Canadian CG (2000)

2 - Extract from the EGNOS monthly performance report August 2017

Station	HNSE 95% (meters)
Aalborg	0.6
Athens	0.7
Berlin	0.7
Canarias	1.0
Cork	0.7
Catania	0.7
Djerba	0.8
Egilsstadir	0.7
Glasgow	0.7
Golbasi	0.9

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5. Cost based analysis

Cost based analysis for deployment (Cerema & ESSP):

	Cerema	ESSP CBA[1]
DGPS standard (no Redundancy)	150 K€	133 K€
Egnos-Centralized	20K€[2,3]	27 K€

Note 1: Values extracted from a specific cost base analysis delivered by ESSP to France
Note 2: taking into account the quantity discount for 7 stations.
Note 3 : Not taking into account the development costs of the modulator

The EGNOS centralized cost includes:

- License for the software with modules for: EDAS client, VRS, RTCA → RTCM, PB-monitoring)
- RTCM Modulator
- GNSS receiver for raw-data collection for PBM

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6. Conclusion & prospects

<u>Conclusion:</u>

✔Full scale tests confirm the capability of centralized solution based on EDAS converted to RTCM to fulfil the requirements for coastal navigation in real operation conditions.

✔A solution based on EGNOS SiS with integrity checks is a very promising way to set a backup at each beacon site independent of network.

✔Sharing interests and results with other maritime stakeholders to solve the last issues

✔2018 → To deploy the official service (based on EDAS) in at least two stations + design and test an EGNOS based backup solution

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Thank You

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