

# Assessment of User Performances of Current and Future Navigation Systems and Sensors using Computer Simulations

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## BIOGRAPHY

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Andrés Juez received his M.S. in Telecommunication Engineering from the "Escuela Técnica Superior de Ingenieros de Telecomunicación" (Politechnical University of Madrid). Since 2000 he has been working at GMV in several EGNOS and Galileo projects, and now he is Technical Responsible of Polaris software tool.

Theresa W. Beech has a B.S. in Physics from the University of Michigan, Ann Arbor and an M.S. in Atmospheric Physics from the University of Washington, Seattle. Before working at GMV, she worked at the Boeing Company in the Civil Space Division on a variety of projects including Teledesic, SeaLaunch and the Alpha module of the International Space System. She was deeply involved in the initial phases of the ground segment architecture definition of Galileo and the Galileo System Test Bed collaborating with both ESA and the European Commission. Theresa Beech is currently the Vice-President of Business Development of GMV Space Systems Inc. where she is responsible for overseeing all aspects of GMV's business development and industrial-institutional cooperation in the US, as well as coordinating GMV's business efforts.

## ABSTRACT

The use of additional sensors and systems with GNSS improves navigation performances and open the way for new mass-market and professional applications. The demonstration of the levels of performance that can be

expected using current and future positioning technologies will create new opportunities for industry. Before embarking on costly revisions to the existing navigation services it is necessary to know in advance what enhancements can be expected, and which may ultimately not lead to significant improvements. Using simulation tools from the very beginning of the feasibility phase allows performing trade-offs between different implementation options (e.g., positioning technologies to be used) and parametric analyses to support feasibility and cost-benefit studies.

Whilst many existing simulators are focusing on the GNSS global component, they do not allow simulating regional and local component contributions, not to mention the different sensors (like odometers) that can be frequently found in many mass-market and professional applications. Nevertheless there is a software tool, named **Polaris**, that allows the rapid performance assessment of navigation systems and sensors in low cost platforms (PCs and laptops) to support system and application design. Polaris allows the inclusion of GNSS (e.g. GPS and Galileo) and SBAS systems (e.g., EGNOS and WAAS) but also local augmentations (DGPS, pseudolites and radio mobile positioning, like UMTS) and sensors (e.g. odometers, gyroscopes, pedometers, etc.) The integration with a GIS facility and a 3D subsystem allows Polaris to evaluate applications in different environments, including 3D urban canyons, where satellite visibility is limited by surrounding buildings

This paper introduces how computer simulations can support application design from the early phases of system and application development. Actually computer simulations can not only support system and application design, but potential users surveying, market analyses and system/application promotion too. Using Polaris, the paper analyses the navigation performances for a typical application in an urban environment, showing results for different combinations of systems and sensors. Results are presented in a user-friendly and understandable manner

helping people without a background in navigation (as it is the case for many potential navigation users) to understand application potentials.

The paper finishes presenting the current status of the tool, projects and situation where it is being used and the future of Polaris.

## INTRODUCTION

New markets and professional applications are emerging to take advantage of the improvements in navigation performances that can be obtained by using complementary sensors and systems with GNSS. Before embarking on costly revisions to the existing navigation services it is necessary to know in advance what enhancements can be expected, and which may ultimately not lead to significant improvements.

For example, consider the case of a Bus Operator interested in tracking its vehicle fleet around a city, in order to provide real-time scheduling information to passengers waiting at bus stops. Would GPS receivers on buses provide not just the necessary level of accuracy, but more importantly sufficient availability? Would the addition of Galileo signals, or installing a low cost gyroscope and making use of the vehicle's odometer, improve performance? What grades of sensors would be needed to satisfy the required standards for the proposed positioning service? Even more, what would happen if the same navigation system was to be provided elsewhere, say, in a different type of urban environment? Could the service be adapted for use in other modes of transportation (such as trains, ships, or even by pedestrians), or would a somewhat different solution be more appropriate?

Sometimes the solution adopted is to develop prototypes or mock-ups of the system or application to be tested. These demonstrations are usually expensive since it may involve signal emulators, test beds and user equipment. In addition, demonstrations may be limited by the availability of data (e.g. navigation signal from the Galileo system) and/or infrastructures (e.g., clearance for the use of a highway to test a road application). In particular, this lack of availability limits applications to be demonstrated in a reduced number of operational scenarios in terms of:

- geographical location (specially for those systems, like GNSS or SBAS, for which user performances depend on geographical latitude)
- environments (e.g. urban canyon)
- user equipment characteristics (e.g., low/mid/high grade user receivers)

For instance, in case of the Galileo programme, there have been many pilot projects aimed at demonstrating (satisfactorily) the feasibility of certain mass-market and professional applications (see for instance [1], [2] and [3]). Nevertheless demonstrations can only be performed using GPS (with or without EGNOS). Extrapolation of results to scenarios involving Galileo can only be done through computer simulations.

The primary purpose of computer simulations is to validate the high level as well as the low level specifications. In addition, they also allow for specific design optimization and the analysis of critical design issues. A set of facilities supporting the overall development process of Galileo until the system is fully operational will be developed.

EGNOS has been using simulation since the preliminary design up to the deployment. In the initial phases Service volume simulators were used to define the service coverage scope and characteristics. Also simulators like Early Test System (ETS) were used for the dimensioning of the system and the determination of the achievable navigation performances.

In subsequent phases a wide set of simulation facilities were developed for RAMS and End To End Simulation. The detailed design of the EGNOS elements, the detailed definition of the final service, and the safety issues have been made using extensively these simulators. In fact, the EGNOS End To End Simulator (EETES) has been the benchmark over which the Central Processing Facility (CPF) operational algorithms, core of the control center, have been fully consolidated and developed. In parallel, the Service Volume, also fed by the EETES, has been used for the detailed characterization of all the Service Volume characteristics with the proposed choices of reference stations location. Finally, the deployment of the system is requiring a detailed EGNOS system simulation for the acceptance of the set up of each element in its final allocation. This task is being performed with Assembly Integration and Validation Platforms, which make extensive use of the already existing simulators used previously in system design.

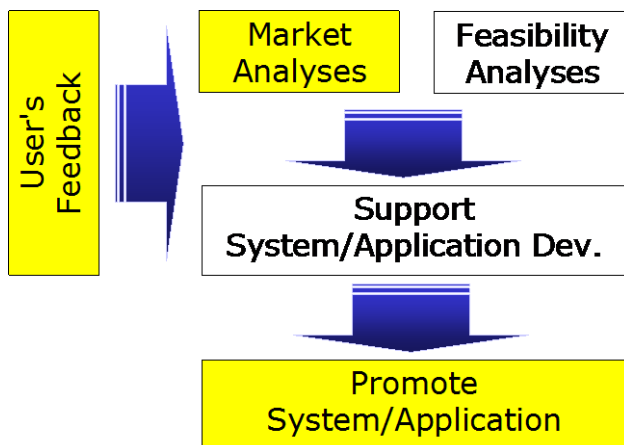
As far as computer simulation is concerned, the scenario in the Galileo case does not differ too much from the EGNOS approach depicted above. Service Volume simulators, like Elcano tool [5], have played a crucial role during Galileo initial phases. In addition to performance assessment, Elcano has allowed the analysis of the stability of navigation performances over time, constellation maintenance, in-orbit control strategy and constellation optimization.

The rapid penetration of navigation technologies in mass-market applications leads to new simulation needs. The

design of these applications has to be driven by user requirements that must be supplied by the future users so that it becomes what the users need. Using simulation tools from the very beginning of the **feasibility phase** allows users to provide **feedback** to system/application designers. Trade-offs between different implementation options (e.g., positioning technologies to be used) and parametric analyses support feasibility and cost-benefit studies.

Simulation tools are also of invaluable help in the **promotion of applications** (as well as the systems they are based on). The translation of application performances into user-friendly and understandable figures, graphs and even multimedia material helps non-experts to understand the benefits they can make from the proposed solution. Last, but not least, simulation tools are fundamental for computer aided learning (e-learning tools).

The situation is depicted in Figure 1, where simulation activities more specific (but not exclusive) of mass-market application development are shadowed in yellow.



**Figure 1: Purpose of Computer Simulations in Mass-market application development**

In summary, the potential users of this (new) kind of tools are:

- **Service Providers**, to support system and application design, establishing a link with potential users and promoting the applications being developed.
- **Navigation system engineers**, to demonstrate that navigation performances (at application level) meet user expectations.
- **Market analysts**, to support market research, showing to the users and service providers the benefits provided by using current and future positioning methods (e.g. Galileo).
- **Academic institutions**, used as means for computer aided learning

- **Public authorities**, to promote the use of navigation technologies and, in particular, systems (e.g. Galileo)

## SIMULATION TOOLS FOR MASS-MARKET APPLICATIONS

In the light of the discussion above about mass-market application needs, it is clear that new simulation tools are needed. As a minimum, they should have the following characteristics:

- **They should allow the evaluation of representative Figures Of Merit (FOM)** including, as a minimum, accuracy and availability of service. Continuity and integrity are not usual requirements for mass-market applications, despite they could be still interesting to assess **liability critical applications** (see for instance [4]).
- **They should allow the simulation of both navigation systems and sensors.** The use of additional sensors and systems will improve navigation performances and open the way for new applications such as safety of life services, fleet management, and environmental and agricultural monitoring.
- **Simulations should run “as fast as possible”,** but not to the detriment of achieving realistic simulation results. Simulations must not take several days to be prepared and executed. A special effort has to be devoted to optimize algorithms (achieving the level of precision required).
- **They should allow assessments of the applications in their working environments,** as, for instance, **urban canyons.**
- **They should run on low-cost and widely available HW platforms.** It should be possible to execute these tools on any standard PC or laptop running a Windows operating system.
- **They should include a user-friendly Graphical User Interface (GUI),** to assist users in the definition and execution of simulations, and the visualization of simulation results.

There are few tools available meeting these requirements. Existing (system) simulation tools are beyond what mass-market applications truly require. Many users do not have, neither need, a technical background on positioning technologies.

These necessities were already identified at the beginning of the Galileo programme. GMV’s Service Volume Simulator **Elcano** [5] was updated to allow assessment of performances in urban environments. Nevertheless it still

did not allow the inclusion of many systems used in mass-market applications (e.g. GSM/GPRS/UMTS positioning), nor sensors. Elcano modules were reengineered to a new software simulation tool, named **Polaris**, which was designed to meet the objectives stated before. A description of Polaris is provided in the next section.

## POLARIS

### Polaris Description

The objective of Polaris is to provide the tool needed in order to feed back requirements to the system and application design from a user point of view, and to support the market analysts in obtaining reliable inputs from users and service providers.

Polaris mission is therefore to allow **rapid performance assessments of navigation systems and sensors in low-cost platforms to support application and system design.**

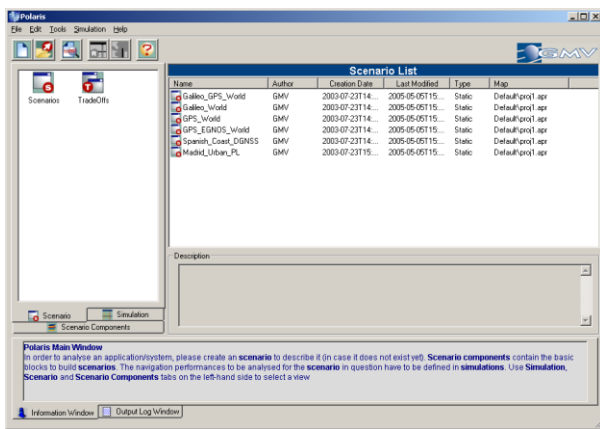


Figure 2: Polaris GUI (Main Window)

What Polaris actually does is evaluate a given set of navigation performances for a combination of navigation systems and sensors for certain (given) user environments.

Rapid means that simulations will run “as fast as possible”. Considering that Polaris runs in low cost platforms, i.e., standard PCs and laptops, simulation execution may take only a few seconds (trajectories) or minutes (service areas). Execution time depends mainly on the number of user locations or trajectories to be evaluated, number of satellite failures, etc.

Polaris is primarily focused on supporting mass-market application systems and sensors. Applications being evaluated can include not only **GNSS** systems, but also regional and local augmentations (**SBAS**, **DGNSS**, **pseudolites** and **GSM/GPRS/UMTS** positioning) and

sensors (**odometers**, **gyroscopes**, **accelerometers**, etc.). It also allows the evaluation of performances using map-matching techniques. Table 1 shows all the possible combinations of systems that can be constructed with Polaris. In addition, Polaris is able to simulate systems like **SISNeT** (see [6]), which provides SBAS differential corrections through a wireless network in real time.

NAV. SYSTEM COMBINATIONS										
GNSS										
SBAS										
DGNSS										
Pseudolites										
Radio Mobile										

Table 1: Combinations of Systems Allowed

In addition to the combinations above, when evaluating dynamic (i.e., non-static) applications it is also possible to include sensors and see their effect on navigation performances. The nature and combination(s) of the sensors allowed depend on the application domain (road, pedestrian, maritime or railway), and it is shown in Table 2.

		Application Domains			
		Road	Pedestrian	Railway	Maritime
Combinations	Odometer + gyroscope	Pedometer + Magnetic Compass	Odometer + Gyrocompass	Speed log + Digital Compass	
	Accelerom. + Gyroscope	Pedometer + Gyroscope	Odometer + Gyrocompass + Balises	Speed log + Gyrocompass	
	Differential odometer				
	Odometer + compass				
	Accelerom. + compass				

Table 2: Combinations of Sensors Allowed

Regarding the **Figures Of Merit (FOM)** to be computed for evaluating an application, Polaris supports the following analyses:

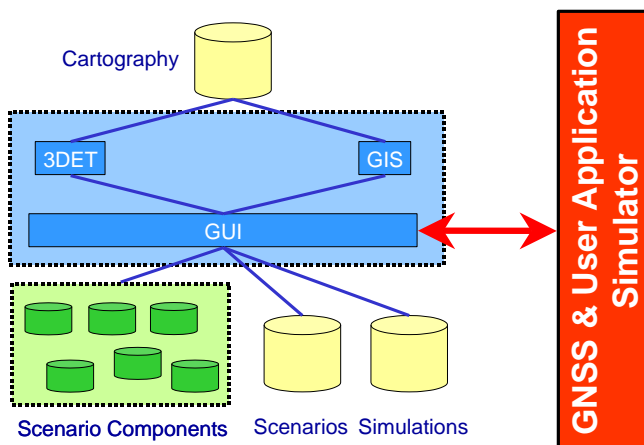
- **Accuracy** (horizontal, vertical, cross-track, long-track, etc.), DOP and number of satellites in view at given availability levels
- **Availability** and **continuity risk** of accuracy, DOP and number of satellites in view.
- **Protection levels**
- Other statistics like, for instance, the percentage of time with GNSS outages, with and without a navigation solution, etc.

The FOM available for a given scenario depend on the application domain. It is also very important to notice that Polaris allows the assessment of navigation performances also for the case of satellite failures.

Polaris has been designed to cope with different levels of expertise. Polaris includes a user friendly Graphical User Interface (GUI) to assist users in the definition of systems and applications, the FOM to be computed and visualization of simulation results.

In order to enable the evaluation of systems and application in real environments, the definition of user locations and ground entities is done using a **GIS** tool fully integrated in the MMI. Users can work with real environments provided that they have a GIS map of the area of interest. Polaris includes a tool to allow users to create 3D environments (**3DET** for short) starting from 2D GIS maps and, in particular, urban canyons. Future versions of the software will allow taking data from 3D digital cartography.

All these elements (MMI, GIS and 3DET) work together to build scenarios and simulations. It is a different subsystem, the **GNSS and User Application Subsystem (GNSS+UA)**, which is actually in charge of simulating the applications and providing the selected Figures Of Merit. It is worth mentioning the fact that there is no interaction between the GNSS+UA subsystem and the MMI, GIS or 3DET during simulation run. All the information required (like, for instance, visibility conditions) is generated “off-line” before the simulation is run. The **Core** subsystem gathers all the information and passes it to the GNSS+UA, which computes the FOM and generates simulation results files. The situation (high level architecture) is depicted in Figure 3, where the Core subsystem (which is the actual “glue” between all components) has not been represented for simplicity.



**Figure 3: Polaris High Level Architecture**

The parameters needed to define a simulation have to be well organized and easily accessible. A hierarchical organization has been constructed for the various scenario and simulation elements available for specification and users only need to specify elements up to the desired level of the hierarchy. Polaris logic of use is based on **repositories**. Applications (systems and sensors used, plus user locations and environment) are defined within **Scenarios**. **Simulations** consist of the scenario definition, plus the FOM to be computed and simulation conditions (time span, time step, satellite failures, etc.) Scenarios are built from **Scenario Components** (built-in or user defined). Scenario components are repositories that include definitions of all systems and sensors, plus user locations (service areas or trajectories).

### Algorithmic Approach

The simulation subsystem of Polaris, the GNSS+UA simulator (Figure 3) is a service volume simulator that computes a range of statistical parameters describing the performance of a given constellation of GNSS satellites. It replicates part of the least squares positioning solution that is carried out in a GNSS receiver. Instead of taking range measurements as an input, it considers the errors that would be present in those ranges. These error budgets, together with the defined positions of GNSS satellites, are used to construct a covariance matrix, which describes the precision of the estimated parameters (user position and clock offset). This covariance matrix is used as the basis of the performance analysis, allowing such parameters as DOP and co-ordinate accuracy to be evaluated.

This analysis is carried out at a single point in space and at a single epoch in time. To assess the performance over a selected coverage area and time period, the area of interest is divided into a number of grid points, and the performance at each grid point is assessed at regular intervals throughout the selected time period. Spatial and temporal statistics are then derived from the raw performance data at each grid point (Figure 4).

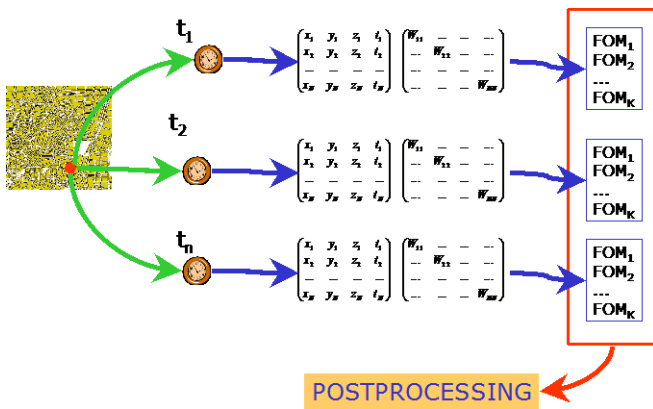


Figure 4: Assessment of Performances (Service Area)

The performance of a GNSS receiver traveling along a specific trajectory is assessed by computing the receiver's co-ordinates at regular intervals along the trajectory, and calling the assessment routines at those points.

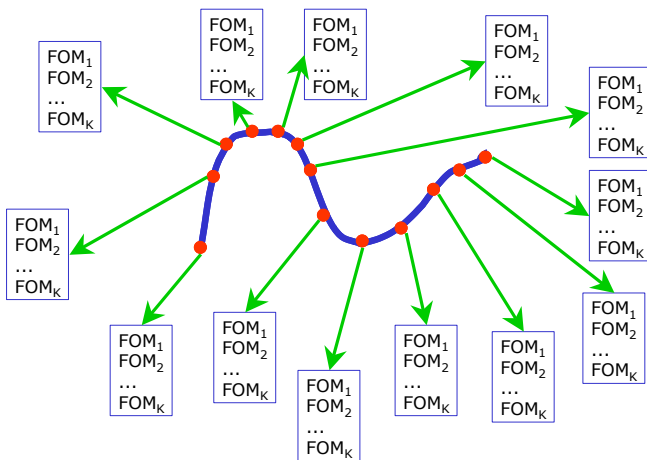


Figure 5: Performance Assessment along Trajectories

Depending on the trajectory start time the satellite positions (with respect to the user's location) differ, and therefore so do the navigation performances. Therefore it is necessary to evaluate the navigation performances for different time periods and then interpret all of the results.

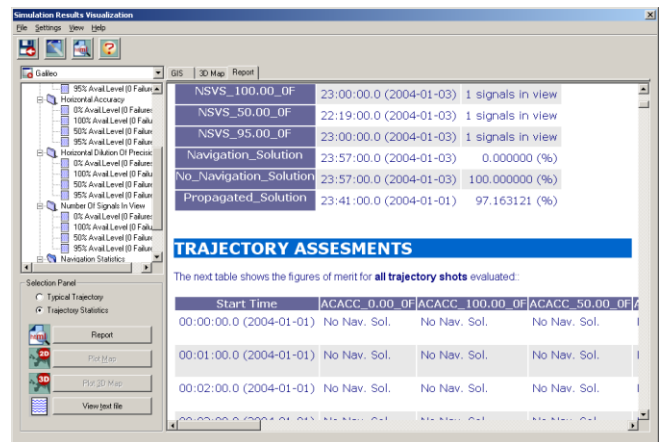
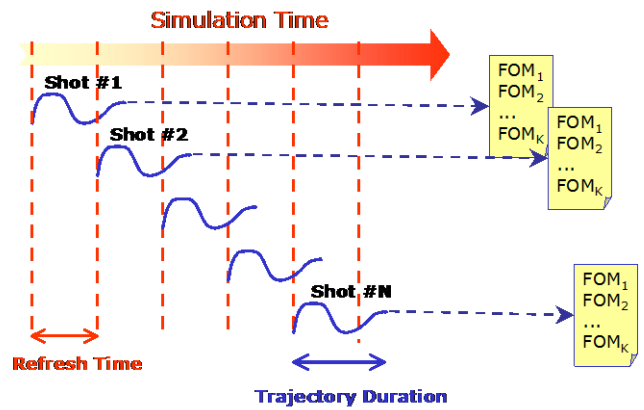


Figure 6: Performance Assessment of Trajectories considering different Time Windows and Polaris screenshot

In Polaris, GPS, Galileo and GLONASS constellations are defined in terms of satellite positions and the **error budget for range measurements**. The error budget varies depending on satellite elevation and the selected operating conditions. 3-D models are used to identify the satellite signals that would be received at any user location.

GNSS augmentation systems, such as local ground based augmentation systems (**GBAS**) or regional space based augmentation systems (**SBAS**), such as EGNOS, provide correction data to remove or reduce some of the error components of a GNSS ranging signal. The GBAS and SBAS models in Polaris, both apply reductions to individual components of the basic GNSS error budget based on the user's location relative to reference stations. In the case of SBAS, each GEO satellite also provides an additional ranging signal.

The use of **Pseudolites** and **GSM/UMTS** positioning are simulated in Polaris by adding extra ranges, with

appropriate error budgets, to the GNSS positioning solution. If enough ranges are provided by either of these systems, they can also provide a completely independent position solution, i.e. without any signals from space.

The performance of GNSS services and additional systems which reduce the errors in satellite ranges, provide additional range measurements, or both, is evaluated on a single epoch basis to produce a covariance matrix of the estimated user position. This is described in Figure 7 as “extended” GNSS processing.

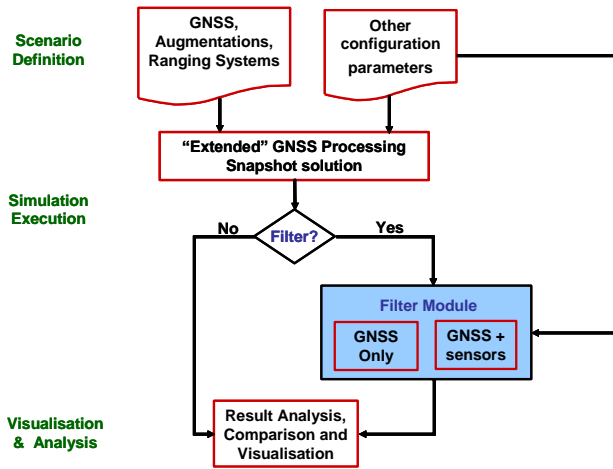


Figure 7: Overview of Polaris Processing Logic

To simulate realistic navigation systems, Polaris also considers the affect of applying a filter to successive single epoch position estimates. In a GNSS-based navigation system, a Kalman filter would almost invariably be applied. A filter can improve both the accuracy and availability of a navigation solution by exploiting previously recorded information and knowledge of the receiver motion. A filter also provides a means to integrate measurements from a variety of different systems and sensors.

In periods when sufficient ranges are available to compute a GNSS-based position, Polaris estimates the amount by which a typical filter would improve the accuracy of snapshot position estimates. In reality, this level of improvement depends on factors including the predictability of the vehicle motion, the degree of correlation in the measurements, and the effectiveness of the filter design. Polaris assigns values to each of these parameters depending on the scenario being simulated. During GNSS outages, the accuracy of a filtered solution is simulated by continuing to estimate the vehicle position based on the last measured position, speed and heading, and then differencing these position estimates from the corresponding points in the reference trajectory.

Polaris can also estimate the performance of a GNSS-based navigation system combined with complementary sensors in a user terminal. By combining sensors which measure heading and speed, a dead reckoning solution can be applied during GNSS outages. A range of sensors, appropriate to the various application domains, have been characterized in Polaris allowing the user either to select sensors of a standard grade, or to define their own specifications. As Polaris is focused primarily on GNSS-based solutions, the sensors which are included are typically “bridging” sensors, i.e. they can provide a usable navigation solution during limited periods of GNSS outage. During periods in which a GNSS solution is available it is assumed that GNSS data is used to calibrate dead reckoning sensors and that bridging sensors will not significantly improve upon the filtered GNSS position solution.

In addition, Polaris also allows simulating how does the application of map-matching algorithms affect navigation performances.

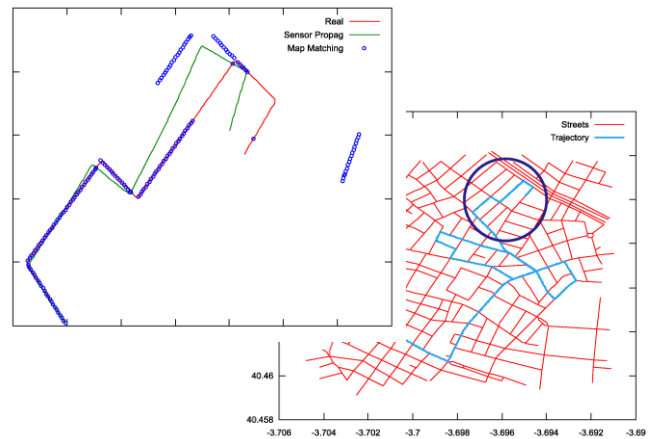
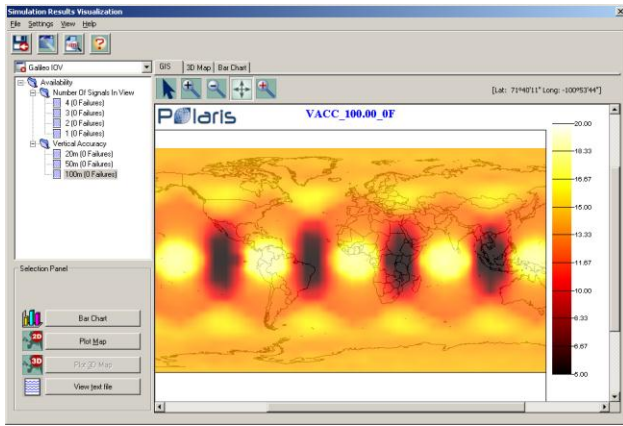


Figure 8: Map-matching

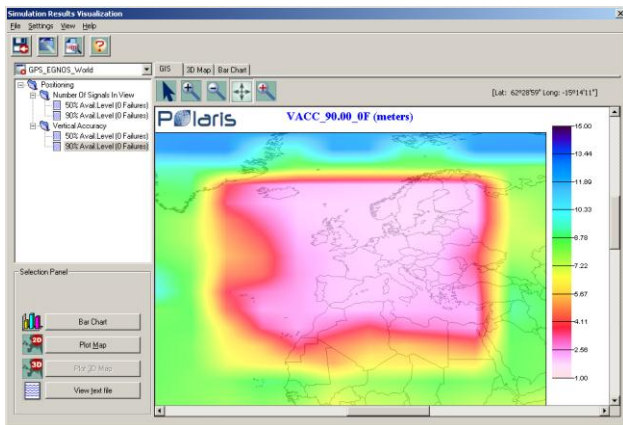
## EXAMPLES

Polaris can be used for assessing performances both at system and at application level. At system level, Polaris is a powerful Service Volume Simulator that has been (and is being) used in the frame of the Galileo programme. For instance, Figure 9 shows (visualization results) the availability of vertical accuracy lower than 100 m for the Galileo In Orbit Validation phase constellation. This is to say, for each user location, the percentage of times that instantaneous vertical accuracy is better (lower) than 100 meters. Notice that it is possible to define any GNSS constellation, as long as satellite positions (at a given epoch) and service error budgets are known.



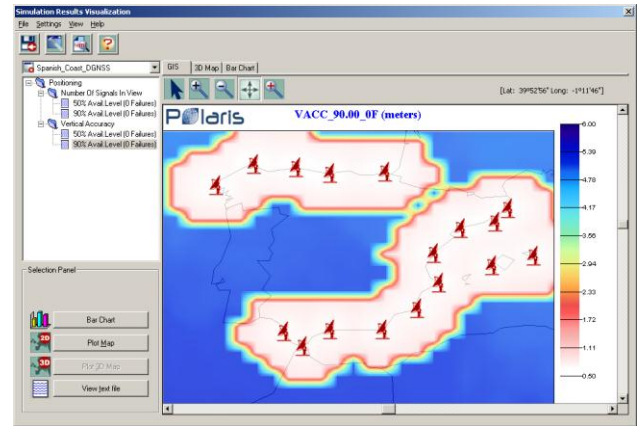
**Figure 9: Assessing the Galileo IOV constellation performances**

SBAS systems (as WAAS or EGNOS) can be analyzed too. Figure 10 shows a screenshot of the assessment of vertical accuracy values (90th percentile) of GPS+EGNOS. Polaris allows users to define SBAS reference station locations (performances are computed accordingly). This feature has allowed GMV engineers to analyze extensions of the EGNOS system to other regions in the world.



**Figure 10: Assessment of Vertical Accuracy values (90<sup>th</sup> percentile) of GPS+EGNOS**

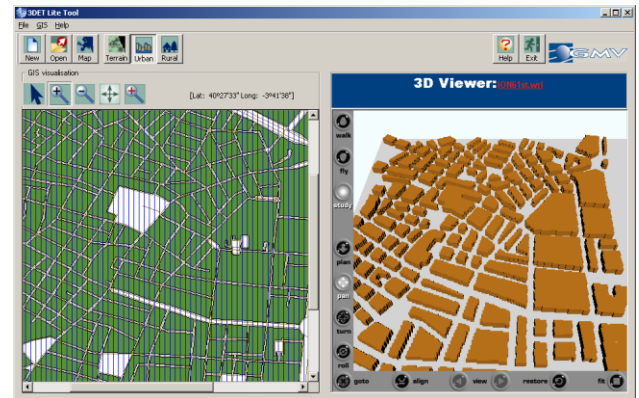
Differential GNSS performances can be analyzed too. Figure 11 shows the vertical accuracy values (90th percentile) for a Galileo + GPS constellation using the DGNSS network of the Spanish Port Authority.



**Figure 11: DGNSS**

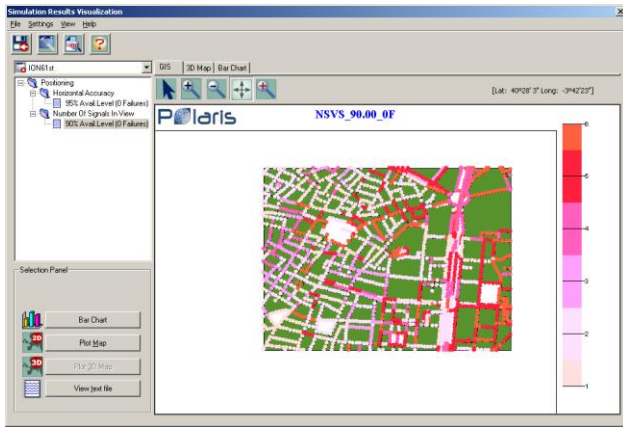
The most important added value of Polaris is its capability to assess application performances in low visibility conditions (e.g. urban canyons).

In the next examples, we have defined 3D information in an area of Madrid (Spain), starting from a 2D GIS map and using the 3DET tool (Figure 12).



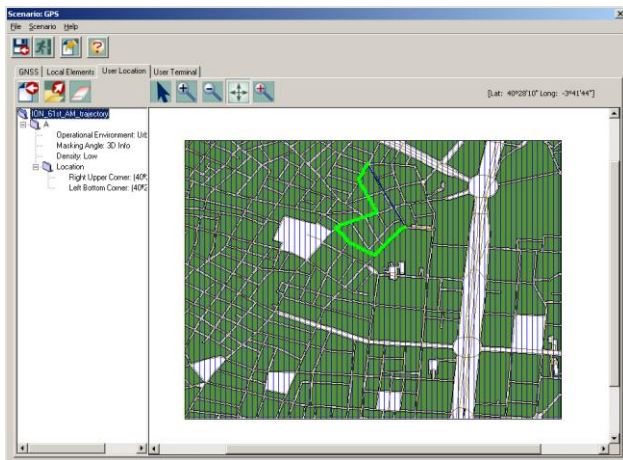
**Figure 12: 3DET Screenshot**

We could, for instance, analyze the number of GPS satellites in view (90th percentile) in the area (Figure 13).



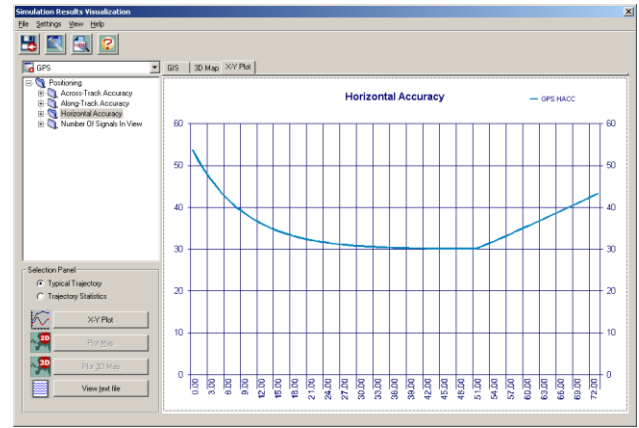
**Figure 13: GPS visibility in an Urban Area**

We can also analyze trajectories. The trajectory in Figure 14 (light green line) has been generated with Polaris' GIS facility, which includes a shortest-path algorithm.



**Figure 14: Generating Trajectories with Polaris GIS' Facility**

The trajectory (starting at a given epoch) has been analyzed and horizontal accuracy values are shown in Figure 15.

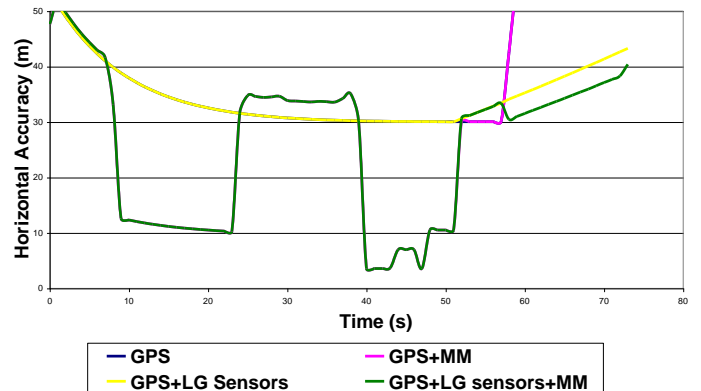


**Figure 15: HACC Values obtained with GPS for the Trajectory in the Example**

The following scenarios have been analyzed too:

- GPS alone
- GPS plus low grade distance and heading sensors
- GPS with map-matching
- GPS with low grade sensors (same as above) and map-matching

Polaris allows creating and running trade-offs with different scenarios. Simulation results for horizontal accuracy are shown in Figure 16. Notice that the scale in the vertical axis falls within 0 and 50 meters. When using GPS alone there is a GPS outage leading to a degradation to performances. The use of sensors allows keeping performances within "acceptable" margins.

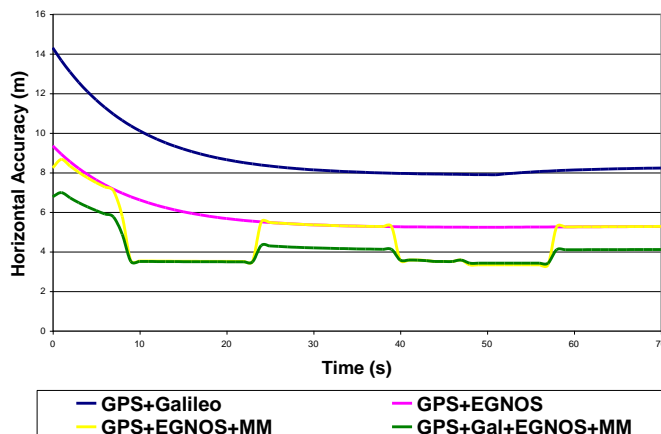


**Figure 16: Comparing Different Scenarios with GPS**

Several scenarios (trade-off) involving Galileo and/or EGNOS have been analyzed too (Figure 17):

- GPS + Galileo
- GPS + EGNOS

- GPS + EGNOS + Map Matching
- GPS + Galileo + EGNOS + Map Matching



**Figure 17: Comparing Different Scenarios with GPS, Galileo and EGNOS**

The detailed analysis of the results in the simulations presented before is beyond the scope of this paper. They are aimed at presenting the capabilities of Polaris in terms of simulation results.

Polaris has been (or is being) used in different projects, among which we can mention:

- **Galileo B and C/D/E1 phases**, as a Service Volume Simulator for navigation performances assessment
- **Extension of SBAS systems** (EGNOS) to South-America and North-Africa, in the frame of the GEM project (under EC contract)
- **Feasibility studies**, like ARMAS [7] (under ESA contract) and ADvantis [8] (under EC contract)
- **Promoting Galileo**, as in the GRAS project (led by ARC and aimed at demonstrating the benefits of a combined GPS+Galileo solution in a urban environment).

## CONCLUSIONS

The rapid penetration of navigation technologies in mass-market applications has motivated new requirements for simulations. New software tools are needed to allow demonstrating the benefits to be gained with GPS+Galileo combined solutions, with or without other systems and sensors.

The Polaris SW tool was designed to cope with this necessity. It allows rapid performance assessments of navigation systems and sensors to support application design, market surveying and e-learning processes, among

others. Several examples of use have been presented in this paper.

## REFERENCES

- [1] GJU Web site (5<sup>th</sup> FP Pilot Projects): <http://www.galileoju.com/page.cfm?voce=s3&idvoce=54&plugIn=1>
- [2] GJU Web site (6<sup>th</sup> FP Pilot Projects, 1<sup>st</sup> call): <http://www.galileoju.com/page.cfm?voce=s3&idvoce=53&plugIn=1>
- [3] ESA Navigation Projects web site: [http://www.esa.int/esaNA/SEM89KMKPZD\\_index\\_0.html](http://www.esa.int/esaNA/SEM89KMKPZD_index_0.html)
- [4] Beech, T. W. et al., *Integrity: a Key Enabler for Liability Critical Applications*; published in the proceedings of the ION 61<sup>st</sup> AM (Cambridge, MA), June 2005.
- [5] Ballester-Gúrpide, I., et al, *Future GNSS Constellation Performances inside Urban Environments*, published in the proceedings of the ION-GPS 2000 Conference, September, 2000.
- [6] F. Torán, et al. *Position Via Internet*, GPS World, April 2004
- [7] ARMAS project web site: [www.armasii.skysoft.pt](http://www.armasii.skysoft.pt)
- [8] ADvantis project web site: [www.galileo-advantis.com](http://www.galileo-advantis.com)