GISCAD-OV: CLGE joins the efforts to use Galileo in Property Surveying

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2018 schloss sich CLGE einem Konsortium unter der Leitung der italienischen Unternehmen GeoWeb und SOGEI an, mit dem Ziel, einen Projektvorschlag für das Horizont-2020-Programm «Space-EGNSS» einzureichen. Die ursprüngliche Idee zur Teilnahme an dieser Bewerbung kam vom italienischen CLGE-Mitglied CNGeGL über seinen Generalsekretär Enrico Rispoli. Das Konzept bestand darin, ein auf Galileo basierendes Projekt zu entwickeln, um das Tagesgeschäft der Immobilien- und Katastervermessung in Europa zu verbessern. Nach einer Periode intensiver Arbeit in den letzten Monaten des Jahres 2018 und im ersten Trimester 2019 wurde der Vorschlag pünktlich Anfang März eingereicht. Am 14. August 2019 wurde unser Projekt mit dem Titel «Galileo Improved Services for Cadastral Augmentation Development On-field Validation» oder GISCAD-OV von den europäischen Behörden genehmigt. Das Projekt begann Ende 2019 und hat eine Laufzeit von drei Jahren. GeoWeb wird der Projektkoordinator für GISCAD-OV sein, während SOGEI die wissenschaftlichen und technischen Bemühungen leiten wird. CLGE spielt eine wesentliche Rolle, vor allem bei der Definition der Benutzeranforderungen, den Pilotprojekten und der Verbreitung der Ergebnisse. Neben diesen Hauptakteuren haben sich dem Konsortium eine Reihe weiterer renommierter Organisationen angeschlossen: Geo++, Exagone (Teria), die Universitäten von Delft, Padua und York (CA), um nur einige zu nennen. CLGE hofft, dass seine Mitglieder diese Gelegenheit nutzen werden, um an einem grossen europäischen Projekt mitzuarbeiten.

En 2018, le CLGE a rejoint un consortium initié par les entreprises italiennes GeoWeb et SOGEI, dans le but d'introduire une proposition de projet dans le programme Horizon 2020 «Space-EGNSS». L'idée originale de participer à ce projet est venue du membre italien du CLGE, le CNGeGL, via son secrétaire général, Enrico Rispoli. Le concept était de développer un projet basé sur la technologie Galileo pour améliorer le travail quotidien des géomètres et des cadastres en Europe, grâce notamment au nouveau service HAS (High Accurancy Services de Galileo. Après une période de travail intense, durant les derniers mois de 2018 et le premier trimestre de 2019, la proposition a été déposée début mars. Le 14 août 2019, notre projet intitulé «Galileo Improved Services for Cadastral Augmentation Development On-field Validation» ou GISCAD-OV a été approuvé par les autorités européennes. Le projet a débuté le 1er décembre 2019 et durera 36 mois. GeoWeb coordonne le GISCAD-OV, tandis que SOGEI dirige les efforts scientifiques et techniques. Le CLGE joue un rôle essentiel, principalement dans la définition des besoins des utilisateurs, les projets pilotes et la diffusion des résultats. A côté de ces acteurs centraux, des noms prestigieux ont rejoint le consortium: Geo++, Exagone (Teria), les universités de Delft, Padoue et York (CA), pour ne citer que quelques exemples. Le CLGE espère que ses membres sauront profiter de cette opportunité qui leur est offerte de collaborer à un projet européen d'envergure.

** G.I.S.C.A.D: Galileo-Improved Services for Cadastral Augmentation Development*
The consortium of organisations structured to implement the project is coordinated by Geoweb SpA (IT), and composed of Exagone-Teria (FR), SOGEI SpA (IT), National Centre for Geographic Information - CNIG (ES), University of Padua - UNIPD (IT), Geo++ (DE), NovAtel (CA), University of York (CA), Geoflex (FR), Delft University of Technology (NL), Telespazio (IT), Research Institute of Geodesy, Topography and Cartography - VÚGTK (CZ), Liaison Committee of European Surveyors - CLGE, and University of Rome 3 - UNIROMA3 (IT).

The Consortium and CLGE's central position

The main scope of GISCAD-OV is the exploitation of new business opportunities in the field of Property and Cadastral surveying, using correction services of the brand-new Galileo High Accuracy Services (HAS).
The project Consortium including 14 members, represents the whole value chain of the cadastral and property surveying sector including National Mapping and Cadastral Agencies (NMCA's), Property and or Cadastral Surveyors, manufacturers, service providers, academics and research centers.
Institutional partners and national representatives of the European Cadastral domain are directly involved in the project both as Project Partners and End Users.
The structural involvement of End Users (e.g. Institutional and private Surveyors) has been considered as a core action. A project internal Advisory Board (AB) has been set-up within the governing structure of GISCAD-OV.
At proposal stage 10 organizations have expressed their support and interest in being involved in the above AB (International Federation of Surveyors FIG, Eurogeographics, RTCM, Land Board of Republic of Estonia, Swiss Topo, Spanish Directorate General for Cadastre, Belgium National Geographic Institute, the Working Committee of the Surveying Authorities of the Länder of Germany, the Estonian surveyors association and the Geodetic State Administration of Croatia).
The AB will work as an open consulting group throughout the entire project duration.

It has to be stressed that at the European level, CLGE is a very relevant active member of the project, representing the whole geodetic surveying community of our continent.
The Consortium also includes two Canadian partners (NovAtel Inc. and York University). NovAtel, which is part of the European Hexagon group, will contribute to the project by tracking and decoding the HA-CS data broadcast on E6B via their commercial professional receivers.
York University will contribute bringing its sound expertise, especially in PPP GNSS measurement processing engine, ionospheric modeling to constrain PPP and PPP-AR solutions.
GISCAD-OV will develop a solution to exploit the HAS correction services in the field of Property and Cadastral Surveying. It will conduct a Europe-wide Pilot Project campaign for validating the implemented solution, applying single Countries Cadastral Regulations.
GISCAD-OV's business model will be updated during the project implementation. Sound dissemination and exploitation activities will be carried out. Again, CLGE will play an essential role in this field.
A central piece will be the creation of the GISCAD-OV Control Centre. Figure 1 is a schematic overview of the GISCAD-OV architecture.

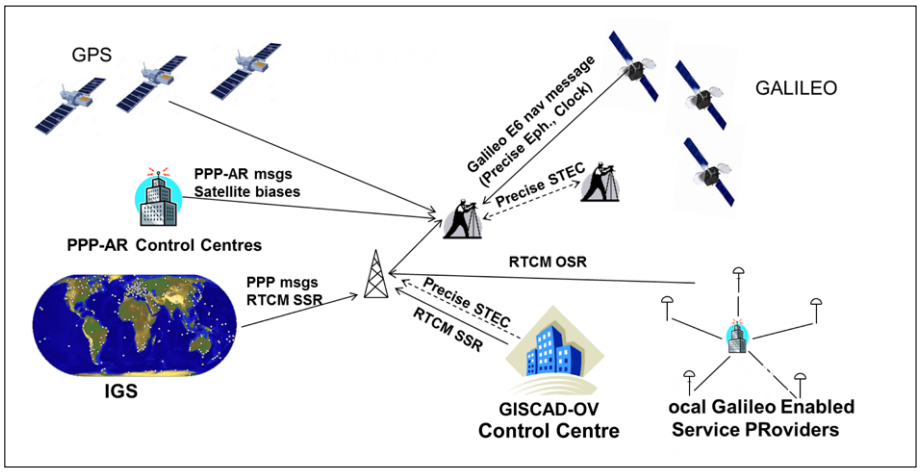

Fig. 1: Schematic overview of the GISCAD-OV architecture.

GISCAD-OV and the important role of the Pilot projects

GNSS measurements are largely used in Cadastral surveying and mapping. GNSS features' attractiveness vs the conventional methods and techniques are well known.
Nonetheless, at the current stage, Cadastral surveying operations carried out through GNSS are limited by several factors such as the cost of the Augmentation service (e.g. number of Reference Stations to be installed, maintenance costs, software licensing), the cost of professional GNSS receivers, the not easy-to-use services and the lack of customer care and supporting services.
The main scope of the GISCAD-OV project is to design, develop and validate an innovative and cost-effective High Accuracy Service for Cadastral and Property Surveying applications, based on GPS and Galileo High Accuracy Services (HAS) and advanced techniques of Precise Point Positioning- Ambiguity Resolution quick convergence (PPP-AR).
The project aims also to set up a GISCAD-OV Service Operator Centre, able to fully integrate the existing Augmentation and National infrastructures for improving Cadastral operations efficiency and effectiveness, reducing Cadastral procedures' time for the benefit of the citizen. Furthermore, an efficient Cadastral System update process will improve the data reuse interoperability with other applications (Infrastructure Monitoring, post-disaster management). A Europe-wide Pilot Project campaign will be carried out for validating the implemented solution, applying single Countries Cadastral Regulations.
GISCAD-OV services will achieve the following objectives:

- Reduction of Local Augmentation Service fees for Cadastral Surveyors;
- Reduction of Local Augmentation maintenance costs (namely through the reduction of the number of Reference Stations);
- Resizing of Local Augmentation Services: from raw measurement and corrections to PPP-RTK: precise estimation and broadcasting of STEC (Slant Total Electron Content) and ZTD (Zenith Tropospheric Delay) and optionally relevant gradients;
- Adoption of low-cost receivers for Cadastral Surveying;
- Implementation of crowdsourcing approaches for the exchange of local error for quick PPP-RTK;
- Preliminary testing of Cloud Services for Infrastructural Monitoring also paving the way to 3D Cadaster based on fully Galileo HAS.

The Project is split in 7 Work Packages and CLGE has a important role in nearly all of them. For two Work Packages, CLGE is leading the efforts:
WP 1: Project Management
WP 2: User Requirements, WP Leader
WP 3: Architecture design
WP 4: Pilot Projects, WP Leader
WP 5: Validation
WP 6: Standardisation & Regulation
WP 7: Business Development & Dissemination

With WP 2, it will be important to gather the functional and non-functional user requirements from all the partners in the value chain (NMCA's, Manufacturers, Service Providers, Standard Setting bodies, property and cadastral surveyors).
WP 4 is a very important one for CLGE and is based on its impressive network in Europe.

As explained above, the technique developed during GISCAD-OV will be tested via Pilot Projects established in 7 CLGE Member states: Croatia, Czech Republic, Estonia, France, Germany, Italy and Spain. If need be, the list of this Pilot Countries can still be adapted.

Naturally, CLGE will coordinate the Pilot Projects throughout their lifecycle. In each of the Pilot Countries, some volunteering Property Surveyors will have to perform a series of surveys using their traditional methods and repeat these surveys with the newly developed technique. The aim is to compare the results and to assess if and how both approaches meat the national regulations in the field of cadastral and property surveys.
A special type of Novatel Receivers will be set up and enable local property surveyors to perform property and or cadastral surveys, following the national applicable rules. They will use the conventional RTK of NRTK approaches but, in the same time, perform the survey based on the signals provided by the GISCAD-OV Control Centre, based on a sparser set of reference stations.

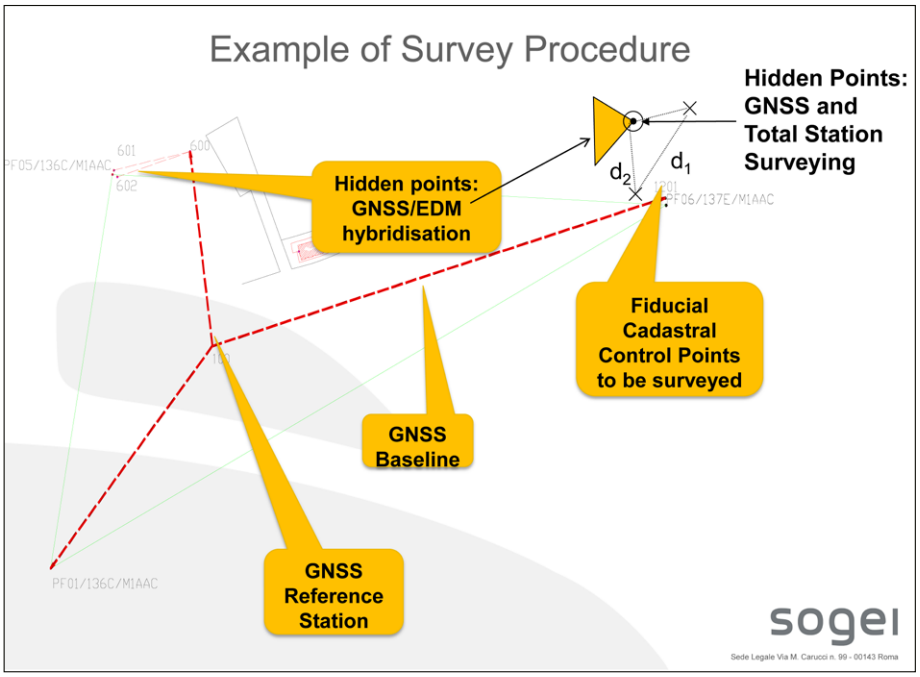

Fig. 2: Example of Survey Procedure.

Technical background of GISCAD-OV

High Accuracy positioning has been called for by the mapping and surveying community ever since GPS's initial adoption. Carrier Phase measurements are needed for achieving centimeter level accuracies. This implies fixing the relevant ambiguities (number of unknown initial integer number of wavelengths in the Tracking loop at the moment of satellite lock).
Fixing carrier phase implies the reduction of measurement errors. For this scope, differential techniques have been the basic source for cancelling common mode errors and implementing RTK (Real-Time Kinematics) and Network-RTK techniques for decades. Spatially correlated errors limit the minimum distance between receivers to 70 Km, through NRTK, while 30 Km for single stations dual frequency RTK.
Such techniques are limited to local services. Service Operators need to deploy and maintain dense networks of GNSS Reference Stations for providing raw measurements or error corrections to the rover receivers and allowing it to fix ambiguities and achieve centimeter level positioning.
Furthermore, both Reference Stations and rover receivers for High Accuracy provisioning have been provided to the users at a quite high cost.

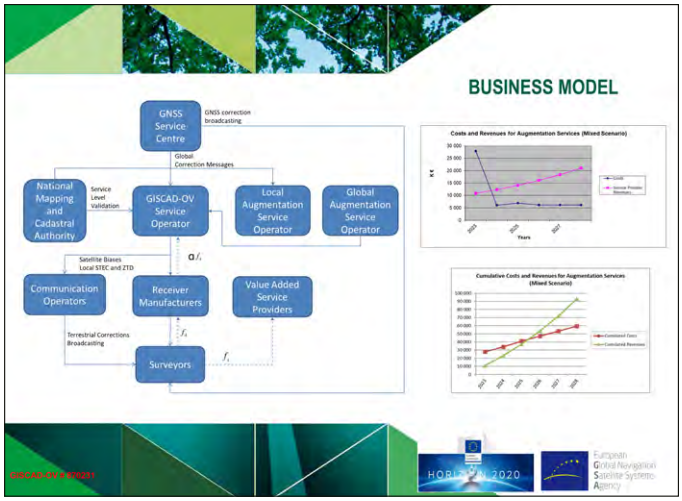

Fig. 3: Business Modell.

Fig. 4: Service Validation.

The evolution of HAS in last decades moved from classical OSR (Observation Space Representation), where Reference Stations raw measurements are used directly, to SSR (State Space Representations), where single errors are modelled by the Control Centre and transmitted to the user receivers. This has been the base for the development of standard PPP (Precise Point Positioning).
The alternative Global Augmentation technique named PPP (Precise Point Positioning) has been developed since 1997. It is based on providing the user receiver with single errors corrections (e.g. precise ephemeris and clock corrections). Due to the correlation with pseudorange measurements, long term convergence time are needed for achieving floating 10 cm accuracy solutions (e.g. non-carrier phase fixed to integer ambiguities).
Reducing the time for convergence has been demonstrated to be possible through a careful estimation of satellite instrumental biases and precise local Ionospheric TEC and tropospheric ZTD. While for the first point, several international centers are broadcasting in real-time satellite biases, for TEC (and ZTD) precise estimation, reference receivers on the field are needed. This led to the PPP-RTK concept. The time of convergence to a fixed ambiguity solution depends on several aspects ranging from the geographical distribution of stations to the quality of the internet connection or the user's multipath environment. The fixing ambiguities process leads to a reduction of convergence time: a sensible reduction of the time for convergence has been noted with quite dense networks of receivers.
Nowadays, with the availability of multi-constellation and multifrequency GNSS systems, and relevant MCAR (Multi-Carrier Ambiguity Resolution) techniques, an instantaneous PPP with Ambiguity Resolution service has been demonstrated to be achievable.

The benefit of GISCAD-OV for Property Surveying

HAS are needed by the Property and Cadastral surveying sector for implementing classical institutional services such as parcel subdivision, boundary determination, new building insertion in the map, coordinate reference systems update.
GNSS has been integrated in the Cadastral land surveying and mapping procedures in most of the European Countries for years. Mixed surveying, combining traditional topographic measurements (Total Stations and Electronic Distance Measurements) and GNSS are well established.
Furthermore, Land Administration, Property and Cadastral surveying remain very stable niche markets for GNSS. Several thousand private or public surveyors are operating, as well as National Cadastral and Mapping Authorities. In many countries, private surveyors are performing public tasks on behalf of these authorities; hence they are contributing to the public data infrastructure of their states.
The points slackening a complete adoption of High Accuracy service in the Cadastral Applications are HAS costs and high rover receiver costs as well. Augmentation service costs are mostly linked to high maintenance costs (receiver faults, reference receiver obsolescence, network operations and fault recovery). A cost-effective service is needed by Property and Cadastral Surveyors for deploying a full penetration of such technologies.
Modern PPP-AR/PPP-RTK technologies are expected to revolutionize the adoption of High Accuracy applications. The integration of Global (e.g. PPP ephemeris and clock corrections) and Local (e.g. Local Ionospheric and Tropospheric corrections estimation) systems is nowadays starting to be provided by several Service Providers around the world. Local enhancements can be implemented through alternative approaches, such as Crowdsourcing (e.g cooperative) techniques.
Galileo is expected to offer a new paradigm for HAS, through the advent of satellite corrections broadcasting (e.g. precise ephemeris, clock corrections and satellite biases) on E6B and the native triple frequency plan.
This can lead to High Accuracy at the user end in a completely transparent way. Adding the receiver price decreasing law and the classical network effect, this will definitively boost the world of High Accuracy applications and improve the quality of the public data infrastructure.
PPP-AR/PPP-RTK solutions have not been subject to an extensive validation at Regional and Continental level up to this moment. A European Level extensive testbed carried out by Property and Cadastral expert surveyors, as will be done in the GISCAD-OV proposal and scientific players and skilled professionals, can assure a robust validation of the service before the commercial launch for mass market application.

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Co-funded by the Horizon 2020 programme of the European Union

European GNSS Agency