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The BELS Pproject: an opportunity for setting collaboration links between Europe and South East Asia in the field of GNSS

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Abstract - **In 2016 the European Global Navigation Satellite System (EGNSS) Galileo should start initial services that will make it available for practical use together with other existing Global Navigation Satellite Systems (GNSS). South East Asia (SEA), which is the Region in the world with the highest multi-GNSS coverage, but has not developed any of them, is the ideal place to promote EGNSS solutions and related technologies to facilitate business while supporting sustainable development. This paper describes the opportunities offered by the project BELS to companies, institutions, researchers from Europe and SEA working in the field of GNSS. The project is funded by the European GNSS Agency (GSA) under the European Union's Research Framework Programme Horizon 2020..**

Keywords – Global Navigation Satellite Systems, International cooperation.

I. INTRODUCTION

With the next launch of two new Galileo satellites, foreseen for next 17th December 2015, the total number of in-orbit satellites of the European Global Navigation Satellite System (EGNSS) Galileo will rise to 12. As underlined by the European Space Agency (ESA) [1], "this will mean that the total number of Galileo satellites in space will have doubled within a year, setting the programme on track for the start of initial services during 2016". The next few years in which Galileo, while being fully deployed, will start to be already available for practical use are very important for its adoption in commercial applications and services, together with other existing Global Navigation Satellite Systems (GNSS). South East Asia (SEA), that is growing at an impressive pace with its GDP having increased by about 350% in ten years (from 2002 to 2012), with Regional governments actively promoting infrastructure, logistics and service development to boost sustainable growth, is the ideal region in which EGNSS technology promotion should take place. SEA is the Region in the world with the highest multi-GNSS coverage and is therefore the ideal place to compare

and test performance and opportunities offered by the different GNSS. On top of this, none of the existing GNSS is sponsored by local governments that are open to take advantage of the technology that best fits with their practical needs. It is therefore here that the features and the opportunities offered by Galileo and by the related EGNSS technology should be tested and properly advertised in order to secure a share of this important fast growing market represented by more than 600 million people. Meanwhile, the creation of links and collaborations at research and industrial level between European and South East Asian GNSS stakeholders can pave the way to long lasting relations and tighter collaboration between the two regions in GNSS related RTD and business.

This paper describes the opportunities offered by the project BELS (Building European Links toward South East Asia in the field of EGNSS) [2] to companies, institutions, researchers from Europe and South East Asia working in the field of GNSS. The project, funded under grant agreement no 636853 by the European GNSS Agency (GSA) in the framework of the European Union's Framework Programme for Research and Innovation Horizon 2020, has been conceived to favour the establishment and strengthening of collaborations between European and South East Asian institutions and companies. It focuses on the following actions: (i) to facilitate the testing of European GNSS solutions in the South East Asian environment and to attract South East Asian researchers to develop EGNSS based services/applications; (ii) to promote awareness on EGNSS solutions and related technologies in all the ASEAN Member States; (iii) to foster the mobility of students and researchers in the field of GNSS between the two regions.

To the actions of the BELS project contributes significantly the NAVIS Centre [3], an international research centre located in the Hanoi University of Science and Technology (HUST) that was setup in the framework of another EU funded project with the mission to act as linking entity between Europe and South East Asia in the field of Global Navigation Satellite Systems (GNSS) in order to ease cross-links between EU and South-East Asia actors, promote European Global Navigation Satellite System technology, and reinforce international collaboration among players.

The role of SEA in GNSS is analysed and the reasons for its importance are highlighted in Section 2. Section 3 is focused on NAVIS Centre, while in Section 4 the BELS project and its objectives are described. Section 5 details the activities which will be conducted during the BELS project lifespan, while future perspectives and expected outcomes are presented in Section 6.

II. WHY SOUTH EAST ASIA?

According to [4], SEA is a fast changing region where countries are experiencing different levels of development and have very diverse outlooks. What is evident in all SEA countries is their fast development. The SEA nations have a growing population of more than 600 million people, rather young (e.g. in Vietnam more than 61% of the population is under 25 years according to [5]), and quite keen to use and exploit the latest ICT technologies (nearly 40 millions smartphones sold in SEA in first half 2015 [6]). Global Navigation Satellite Systems (GNSS) technologies are a key component of ICT equipment such as mobile devices which, according to the GSA Market Report [7], are "the most popular platform to access Location-based Services, followed by devices used for road applications". The GSA Market Report highlighted that the primary region of global market growth of GNSS devices is the Asia Pacific region. Moreover, GNSS-based applications and services are very important in many fields, and are a key enabling factor for services and applications aimed at ensuring sustainable economic and social growth, which is a clear goal of the Governments in the Region. In particular in the transportation sector there is a huge opportunity of expansion and business. In fact, a constantly increasing demand for better services and improved safety in transportation - particularly for what concerns road transportation where the toll of human lives lost in accidents is very high - is going to require new applications and improved logistic solutions that make use of GNSS.

In addition, the SEA region has the highest multi-GNSS coverage and is therefore the ideal place to compare and test performance and opportunities offered by the different global and regional navigation satellite systems. An active promotion of EGNSS technology - rising awareness of its main features

meanwhile facilitating the linking of European companies with South East Asian GNSS stakeholders and attracting South East Asian researchers to develop EGNSS based services and applications - will contribute to global European leadership in this emerging sector. Support of European GNSS industry to enter the South East Asian market should be one of the key European GNSS policies in order to ensure a truly global adoption of EGNSS technology solutions also outside Europe. For example, GNSS is an enabling technology for the smart city, and a recent study from Navigant Research [8] states that "cumulative investment in smart city technology in Asia Pacific will total $63.4 billion during the period from 2014 to 2023".

In addition, it has to be noted that important ionospheric scintillation phenomena, affecting GNSS signals and services, take place in sub-tropical regions and can be observed in SEA. Mitigation of the consequences of scintillation is crucial for ensuring the development of better equipment and services fit for global use throughout the world. Properly facing and tackling scintillation influences is indeed a key factor for to gaining larger market share in this part of the world and in the global market.

III. THE NAVIS CENTRE

The NAVIS Centre [3], based in the Hanoi University of Science and Technology (HUST), was established in the framework of EU-funded projects to act as linking entity between Europe and SEA in the field of GNSS. Its objectives are to promote EGNSS technology, thus reinforcing cross-links between EU and SEA stakeholders, and to facilitate international collaboration among players. To fulfil its mission the NAVIS Centre focuses its activities on technology transfer, education and training, research and development, awareness raising, and support to public bodies. The NAVIS Centre has an international governing body, with members from Vietnam, Europe and Australia, and its Executive Committee consists of one European and one Vietnamese co-director assisted by a vice-director so as to ensure its multi-national nature. The NAVIS Centre is conducting research on various topics, such as software defined radio multi-GNSS receivers, techniques for precise positioning, low-latitude ionospheric monitoring, and others. In addition, it is engaged in technology development and transfer in the field of GNSS services and applications. In this regard the Centre is actively contributing to GNSS applications for ITS in cooperation with local authorities in so doing it is tackling one of the most important problems in SEA, where highly congested traffic often impacts on citizens' everyday life. In the last few years the NAVIS Centre has been collaborating with important key players in the field of GNSS from both European and Asia Pacific regions, such as the Institute for the Protection and Security of the Citizen of the European Commission's Joint Research Centre (JRC), the European GNSS Agency (GSA), the Japan Aerospace Exploration Agency (JAXA), the European Space Agency (ESA) and others. Most researchers and engineers within the NAVIS team hold a PhD degree and have spent research periods in European universities and research institutions, which makes them ready to work in an international environment. Although the Centre's activities started less than five years ago, the Centre now has a high national and international reputation. Its excellent work and expertise has been demonstrated by the certification received by the European Space Agency in 2013 as one of the first fifty institutions in the world which acquired position fixes using solely Galileo satellites. This achievement by the NAVIS Centre was unique in SEA.

IV. THE BELS PROJECT

The BELS Project consolidates a series of actions started by some of the authors in 2004. The collaboration between Vietnam and Europe on satellite navigation and positioning commenced with a project named

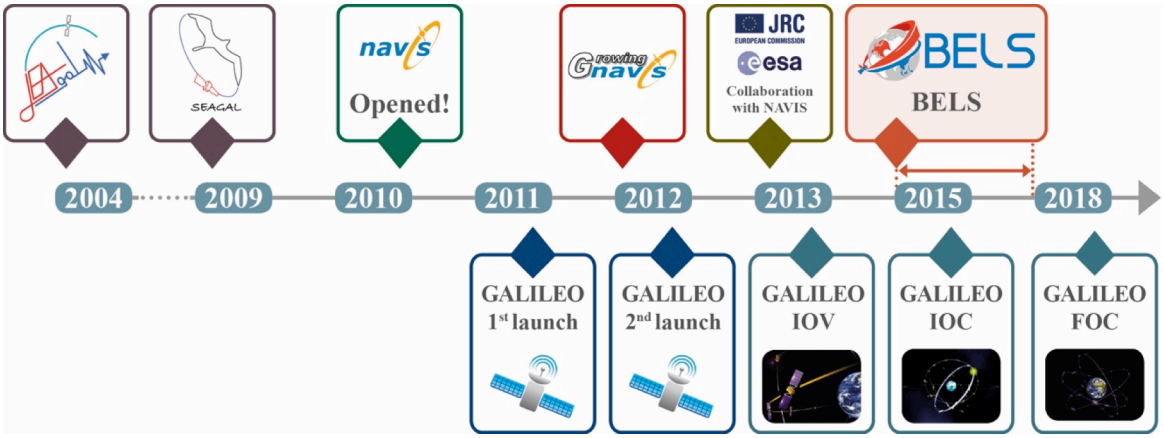

Figure 1. Development of the cooperation with South East Asia compared to the Galileo Programme development

JEAGAL, funded by the Asia IT&C line of the European Commission, a train-the-trainer action to prepare Chinese and Vietnamese future researchers on Galileo-related topics. The present Director of the NAVIS Centre was actually one of the Vietnamese students who benefitted from this project's activities, since he had the possibility to attend the Specialising Master on Navigation and Related Applications held in Italy by Politecnico di Torino [9].

More recently, the SEAGAL Project, answering an FP7 call which specifically sought the establishment of Collaboration Centres on European GNSS around the world, spurred the setup of the NAVIS Centre. The Centre was opened on 1st October 2010 in Hanoi, Vietnam, and it started operations in late 2011. SEAGAL was followed by a second project, Growing NAVIS, whose main objective was to support the growth of the NAVIS Centre, enhancing its technical capabilities and strengthening its cooperation with Europe, while starting a fruitful cooperation with several important stakeholders in the region. It is mainly during the lifespan of the Growing NAVIS project that the international connections of the Centre greatly expanded and the collaboration with local relevant public bodies (ministries, directorates, etc.) and research institutions were strengthened. It is important to underline the fact that the establishment of the NAVIS Centre aims to fulfil the guidelines of the Co-Chair's Statement of the 18th ASEAN-EU Ministerial Meeting - Madrid, 26 May 2010 - that reports "51. The Ministers welcomed the setting-up of a co-operation framework in the field of civilian use of satellite navigation systems, and expressed their willingness to promote the involvement of their relevant institutions and organizations. They encouraged in particular the establishment of a permanent EU-ASEAN collaboration centre on civilian use of satellite navigation systems." To this extent the NAVIS Centre is carefully developing connections and ties at regional level with institutions of different ASEAN Member States and with the ASEAN itself through links with the SCOSA (Sub Committee of Space Activities) of the ASEAN COST (Committee on Science and Technology).

While the NAVIS Centre has been set up and is evolving, the European Union has been developing and deploying its GNSS, Galileo, as shown in Figure 1. Indeed, the activities of the BELS Project are occurring during the Galileo deployment phase, and as the system has entered its Initial Operational Capability (IOC) testing of its performance in both Europe and Asia has commenced.

The BELS Project [2] aims to facilitate the breakthrough of EGNSS technology, with a particular focus on SEA, through a variety of coordinated activities in support of industrial partnership, promotion of EGNSS based services and applications, awareness raising and capacity building. The BELS consortium gathers European and South East Asian institutions, namely Istituto Superiore Mario Boella, Politecnico di Torino, Universitat Politecnica de Catalunya, bavAIRia E.V., Ecole Nationale de l'Aviation Civile, NAVIS Centre, Thailand National Science and Technology Development Agency, University of New South Wales, IfEN Gesellschaft fur Satellitennavigation MBH, Thales Alenia Space Italia S.p.A., Indra Systemas S.A.,

Septentrio N.V. Leveraging the facilities of the NAVIS Centre in Hanoi, which is a strategic asset for Europe, and other partners in SEA, this project aims to enhance the presence of EGNSS technology and of European enterprises in the SEA region. At the same time it plans to organise events and meetings to raise the awareness of European initiatives in the field of GNSS among stakeholders of the ASEAN Member States. BELS also offers opportunities to SEA young researchers and engineers, so as to pave the way for a closer cooperation between Europe and South East Asia, and in so doing will increase the benefits that satellite navigation, and the Galileo system in particular, can offer to SEA citizens.

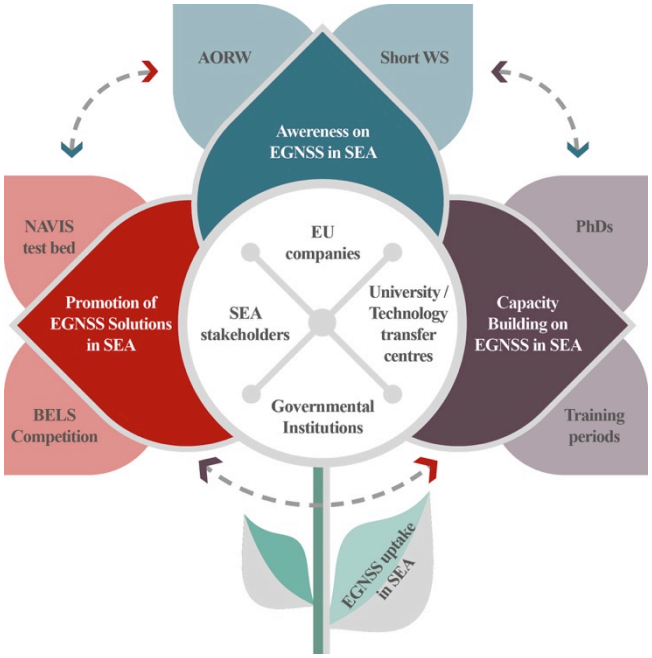

Figure 2. Typical IaaS cloud architecture

V. BELS ACTIVITIES

The overall concept of the BELS project is illustrated in Figure 2. It is mainly organized around 3 pillars:

Promotion of EGNSS Solutions in SEA – This activity is divided in two tasks: on the one hand, the NAVIS Centre will be the base for European companies and institutions to test their solutions taking advantage of the multi-GNSS environment and experiencing the effects of scintillations, thus helping them to be ready for the global market. This opportunity will be exploited by the companies which are members of the consortium, but an opportunity will also offered to companies outside the consortium. Workshops to advertise this opportunity will be organised in Europe, and specific calls will be issued to select the most interested in this initiative. On the other hand, a competition, opened to researchers that are citizens of ASEAN Member States, will be launched to identify the most promising ideas on the use of EGNSS in SEA and in the world. The competition aims to attract smart researchers/entrepreneurs from ASEAN Member States to develop EGNSS-based business ideas and applications and foresees a prize that consists of an incubation period with a European institution to start developing the winning project.

Awareness on EGNSS in SEA – The BELS Project will encourage cooperation between important GNSS stakeholders active in SEA so as to promote EGNSS solutions. In particular, the project will co-organise the AOR which is the annual event promoted by the Multi-GNSS Asia organisation [10], ensuring the participation of European researchers and experts of the GNSS sector that will provide information on the most recent solutions and applications developed in Europe. Furthermore, short workshops will be organized in each of the ASEAN Member States to ensure the spread-out of knowledge about EGNSS

technology throughout the relevant stakeholders in the Region. This will allow to reach also those countries that were not targeted by passed projects and will increase the regional links of the NAVIS Centre and of its European partners.

Capacity Building on EGNSS in SEA – These activities are mainly oriented to training in Europe of South East Asian researchers and engineers, so as to introduce a new generation of experts to European technology and culture as well as to facilitate the links between European companies and research institutions with South East Asian GNSS technicians. This is indeed an enabling factor for facilitating the expansion of European Industries in SEA. Grants for internship periods in European companies of SEA students attending the Master of Navigation and Related Applications offered at Politecnico di Torino, support for joint PhD programmes, research periods in European companies or research institutions for South East Asian researchers are among the activities that will be facilitated by the BELS Project.

Among the activities for the promotion of EGNSS Solutions in SEA, European companies participating in the BELS project have the possibility to test their solutions in the NAVIS Centre. Indra will use the facilities of the NAVIS Centre to collect data enabling a comparison of the performances of its equipment when used in a multi-GNSS environment rich of scintillations versus the performances achieved in Europe. Septentrio, as a producer of GNSS Receivers, will testis testing the performances of its equipment in an environment that is not available in its European research centres. Thales Alenia Space will carry out tests with its GISMO (GNSS Ionospheric Sensor Monitor) receiver which is a newly designed GNSS receiver that satisfies the specific task of Ionosphere Scintillation Monitoring.

As for the Competition organised for SEA researchers, this will be organised with and embedded in the European Satellite Navigation Competition (ESNC) 2016 where a special prize will be awarded to the researcher or team of researchers that are citizens of ASEAN Member States and will present the most promising application or service idea that is relevant for the SEA environment and makes use of EGNSS technology possibly to a significant extent. The special prize will consist in support to start developing the winning idea. It will include a small amount of money for possible costs related to the development of the project and support for up to 6 months of incubation in European research institutions for two researchers of the team.

VI. Future Perspectives

The BELS Project will run while the Galileo system is being fully deployed. This will help in building interest and momentum for its activities among not only GNSS companies and experts, but also local and regional authorities. The Project will pave the way for future cooperation between European and SEA stakeholders, and will contribute to identify the next steps necessary to convert the "European Links toward South East Asia in the field of EGNSS" into a sustainable connection.

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