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# Galileo in BavarianSky –Network of Excellence in Satellite Navigation

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## BIOGRAPHY

**Bärbel Deisting**, is Research Associate at the Institute of Geodesy and Navigation at the University FAF Munich. She has a degree in mathematics from the Ludwig-Maximilians-University Munich and is working in the field of GPS and Galileo. She is member of the team which is promoting the Bavarian area in the field of Satellite Navigation.

## ABSTRACT

The building up of the European satellite navigation system Galileo with its new services, the guaranteed reliability and continuity as well as the interoperable and complementary relation to GPS is expected to open new markets for satellite navigation applications all over the world. Many sectors will benefit from Galileo as the range of application is varied and an exponential grow is being expected for fields related to the development of satellite navigation.

During the last years several examinations dealing with satellite navigation sector in Bavaria have been carried out. The analyses revealed that satellite navigation signals serve as basis for a wide range of new applications. The results highlighted that especially the Munich region meets all criteria for becoming a centre in satellite navigation as the region is hosting quite a number of enterprises, research centers, universities, industries and service providers dealing with satellite navigation. Moreover capabilities in the key sectors of communication and IT can be found in this area as well as business in potential fields of application like automobile, chip and software development. This environment will be completed by the financial sector.

Besides the in the examination identified strength, weaknesses were detected and methods were presented to compensate them with the objective to reinforce existing capabilities and to foster networking and clustering between research institutes and industry. Therefore a program has been established containing several points to meet the required efforts.

The main components which are proposed in this program are:

1. A hub has to be established to coordinate and support the main activities mentioned below. The main tasks are
  - to reinforce existing capabilities and resources of the Bavarian economy, industry, politics and science,
  - to support the development of networks,
  - to foster transfer of technology and knowledge,
  - to initiate pilot schemes,
  - to support further education and training
  - initiate symposiums, congresses and meetings of experts.
2. Networking and exchange of specialized information were considered to be one of the major tasks. Existing databases should provide specialized information and be accessible for authorized users groups.
3. A technology and application program should be launched which is considered to create key technologies as well as to support core project and related research and development activities. Pilot schemes should be acquired and initiated. Moreover with GATE the German Test and Development Environment, a ground based, realistic test bed is available for receiver manufacturers and application developers to test their products at an early stage. It offers a system test bed for Galileo signal definition, a user test bed for Galileo receiver development as well as for GPS/Galileo application developments and a customized user test bed for special extensions/LBS applications.
4. To intensify the education and further education in the field of satellite navigation and related fields like communication and geo information technology, it was suggested to
  - found a new study course in satellite navigation at the University FAF Munich,
  - establish specialized training programs, containing a full rang of technical issues on the one hand and on the other hand fitting industrial needs. This training is considered to qualify particularly professionals.

5. To stimulate the development of Galileo based applications and instruments an active policy which facilitates the foundation of new companies as well as the revision of business environments for start-ups and especially for small end medium enterprises have to be taken into account. Together with the network facilities future founders of companies and customers will benefit from the advantages of the regional clustering of industry, science and entrepreneurship.
6. A joint concept has to be created to announce and to illustrate the varied skill of the existing industry, research institutes and universities. This has to be communicated within the Bavarian region as well as at the international level. As the target groups are varied, different actions have to be taken into account like revised internet presence, brochures, school lab...

The main objective of this article is to describe in detail the determined measures and efforts as well as their realization towards the improvement of the network of excellence in the Munich region. Besides the aim of the network to foster cooperation on the different national and international levels, to strengthen local and regional competences as well as to enhance the educational sector, one of the main aims is to contribute solutions as the qualified partner in the field of satellite navigation.

**INTRODUCTION**

Europe is building up its own satellite navigation system. The questions which arise in nearly every European country are, what are the main impacts of this building up for the own country, what can be the specific contribution in detail and what does this mean for existing and new

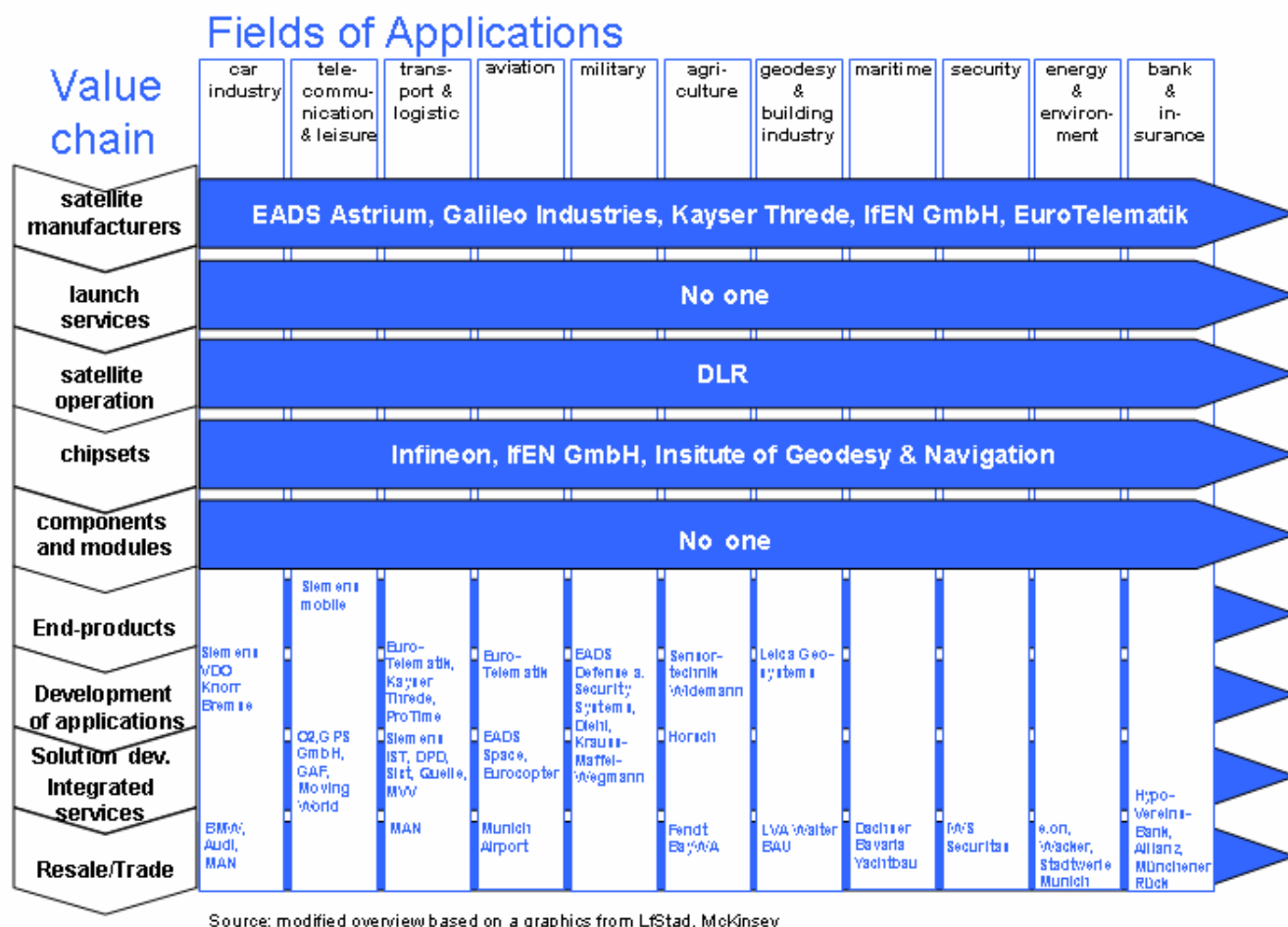
businesses. Moreover are there capacities available? How can existing capabilities be reinforced? During the last years several studies have been carried out, with the focus on satellite navigation in Bavaria. Main tasks of these studies were to gather information on all kinds of satellite navigation activities, e.g. projects, educational aspects, establishments working in the mentioned and related fields as well as existing networks. Main objective was to improve the existing network, to strengthen local and regional components as well as the education in the field of satellite navigation and to provide companies with a suitable environment.

**ANALYSIS AND RESULTS**

The analysis revealed that there is a high concentration of industries and enterprises as well as research and development institutes located in Bavaria covering the complete value chain in satellite navigation. On closer examination two regional hubs were identified where the main activities take place: on the one hand: the area around Munich and on the other hand the area around Nuremberg/Erlangen. Moreover the studies stated that there is a high aggregation of enterprises and industry in potential fields of applications, especially in the field of commercialization of satellite navigation like IT, communication technologies, car industry, software and chip development industry, etc. Furthermore the review showed that nearly the complete value chain in satellite navigation is covered by organizations and companies in Bavaria. The level of the value chain coverage also acts as an indicator for the evaluation of the requirements and conditions for establishing new businesses in satellite navigation technologies and related fields.

STUDY A	STUDY B	STUDY C
Agenda with seven measures	Recommended seven actions, which were updated in July 2004	seven directions of impact related to eleven procedures/business areas
RESULTS		
establish a hub to coordinate and support the main activities	Strengthen research and development in the related fields, coordinated with the existing regional capabilities	Internationalisation
Networking and Exchange	Use the potential of satellite navigation	Visualisation
Create suitable, legal as well as economic frameworks	Support for start-ups	Commercialisation
Establish a communication platform	Develop a joint concept for marketing and communication	Vertical integration
Technology and application programme	Establish education programmes and courses to the demands of industry and users	Specialisation
Establishment of new study courses	Set up, optimise and support specific networks	Mobilisation
Certified further training measures	Ensure and enlarge infrastructure	professional approach - Communication, branding - PR - Administration to coordinate the activities

**Table 1:** Overview of the study results (studies are anonymised)



Source: modified overview based on a graphics from LfStad, McKinsey

Figure 1: value chain in satellite navigation

Figure 1 exemplifies fields of applications, a value chain as well as companies and institutes in Bavaria related to their position in the value chain.

The results of all studies referred substantially to the following aspects:

- the necessity of any kind of management
- the need to provide platforms and meetings where exchange of information, the discussion and development of new projects are possible
- the establishment of appropriate requirements for start-ups and infrastructures to strengthen the development of projects in satellite navigation like testbeds etc.
- the improvement of the educational opportunities
- the necessity of a marketing and PR-concept
- the consolidation of the research and development sector

The WITS Study, which has been accomplished in 2003 and referred to satellite navigation with respect to communication and geo information technology, presented a programme with seven measures. Whereas the results of the ARGE, the aviation, space travel and

satellite navigation task force, recommended seven actions with regard to the three sectors: satellite navigation, space travel and aviation. McKinney proposed seven directions of impact related to eleven procedures/business areas. The results of the anonymised studies are outlined in table 1.

### REALISATION OF THE PROPOSED OBJECTIVES

The decision was to realise proposed recommendations, which are summarized in following keywords:

- Management
- Networking
- Testbed
- Support for start-ups and Incubator facility
- Research and Development
- Education and Training
- Marketing, PR and Communication

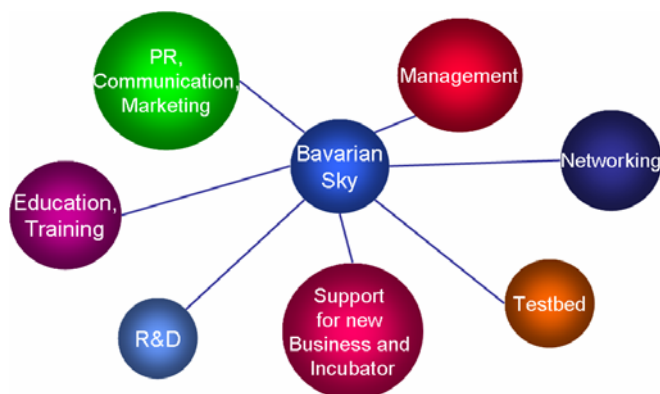
The operational objective in realising these results had to be the creation of a favourable environment for developing innovative applications and products as well as value added services and to put this in disposal of

companies and other organisations. The determined aspects have been realized in the following manner:

**Management: Moderator in Aerospace and Satellite Navigation in Bavaria**

The management of the network of excellence isn't expected to develop projects and make business but to line up the revealed actions. Therefore the position of a Moderator in Aerospace and Satellite Navigation in Bavaria has been created. To be accepted by competing companies as well as by universities the study emphasised the necessity of the neutrality of the moderators' position. His main tasks are as claimed in the studies:

- the coordination of the required activities,
- the initiation of networking activities
- the preparation and realisation of a marketing and PR-concept
- to be the contact person in concerns due to satellite navigation activities as mentioned in the keywords.



**Figure 2:** Results and their addressed fields

**Networking**

Main objectives in this field are the improvement and stimulation of the integration of participants from different fields of activity. To satisfy requirement of divers user groups, like

- experts working in satellite navigation related companies as well as in research and development institutes and universities
- companies and organisations from neighbour disciplines which can be related to satellite navigation
- other European competence centres (Gothenburg, Prague, Vienna, Sophia Antipolis, Toulouse, Leiden, ...)

different offers have been developed:

- Special meetings to exchange information, e.g. to clarify what's going on in the field of satellite navigation, to appoint special requirements needed to improve the situation of people working in this

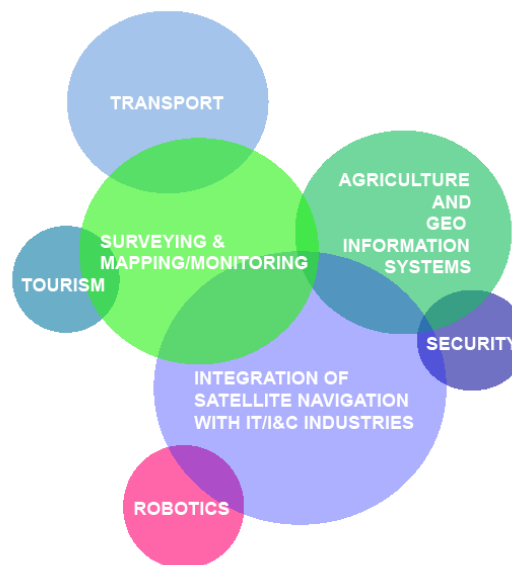
field or to establish new businesses. These meetings should optimise the contacts and exchange between SMEs, industry and research and development institutes.

- Forums have been established to bring together people working in the field of satellite navigation and neighbour disciplines.
- Networking with experts. The objective was to bring together experts from the worldwide scene and neighbour disciplines, to discuss with them the major topics and news in satellite navigation.
  - o The Munich Satellite Navigation Summit is one of these platforms. Aim was to avoid the establishment of another traditional congress, and to reach also the political side.
  - o By the means of the *SatNav Area* at the trade fair *SYSTEMS* in Munich the chance to give an overview for interested companies.
  - o The *Business Matching Programme* which took place in 2005 for the first times

**Forums:**

The forums are the initial place where networking starts. Experts of the different areas, from industry, R&D-institutes as well as administration and university are using the possibility to discuss topics related to satellite navigation as well as to initiate new joint projects. The existing forums cover the following topics:

- integration of satellite navigation with IT/I&C industries
- transport
- tourism
- security
- robotics
- surveying and mapping/monitoring
- agriculture and geo information systems



**Figure 3:** Overview user forums

**Testbed: GATE**

With GATE an experimental test and development environment for receivers has been established, which will be full operational in 08/06. The new aspect of this project: GATE will be open to all users. It's one of the projects where industry, research and development institutes as well as universities are cooperating.

GATE is a ground based radio navigation system which essentially consists of six ground based signal transmitters emitting the Galileo signal towards the GATE test area.

Besides the necessary basic infrastructure for developing and testing new receivers and application with regard to Galileo, GATE provides a test area with consideration to the requirements of different Galileo/GPS land, maritime and air applications. This will enable realistic test scenarios for manufactures. Moreover GATE doesn't provide the test environment solely but also the test receivers to users.

GATE fields of applications are:

- System test bed for GALILEO signal definition
- User test bed for GALILEO receiver development
- User test bed for GALILEO/GPS application developments
- 'Customised' User test bed for special extensions / LBS applications



Figure 4: GATE Test Area

**Support for new Business and Incubator**

Galileo will offer the chance to open new markets. To assist start-ups and other companies in entering these markets two facilities have been established, which give support from the development of the idea to marketing the offers. With the AZO (Anwendungszentrum in Oberpfaffenhofen) and „Invest in Bavaria“ potential

companies as well as founders and investors will get assistance in developing their business.

On the one hand the *Incubator* of the AZO supports the foundation and the establishment of new companies which have their focus on the growth markets navigation, satellite and mobile communication as well as geo-information technologies. The Incubator offers founders and companies besides a modern infrastructure a wide range of services with reference to:

- building and technical infrastructure
- consulting
- administration
- support in the field of research and development
- networking and cooperation
- The AZO contributes to the networking activities, it brings together research institutes, companies and founders wanting to develop, market or integrate new navigation-based products, applications or services in their business. The Business Matching Programme which was carried out before the Munich Satellite Navigation Summit 2005 was one of the related activities.

*Invest-in-Bavaria* is the division within the department of Foreign Direct Investment and International Trade of the Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology. It provides to interested investors:

- Information  
information materials on Bavaria, site information and information about specific location factors, overview of choices for possible public financing
- Service  
detailed location proposals, information on public financing aid for the new or relocated business, assistance with the set-up of business
- Attendance  
arrange personal contacts to technical and local authorities, to the Chambers of Commerce and Industry, to trade associations as well as to the business and technology communities. It will make sure that the necessary administrative formalities are attended to speedily and objectively.

**R&D**

The research and development activities in the Bavaria various and will be extended in the future. At the moment there are numerous activities, only a few of them should be mentioned herein.

- **HIGAPS**

Combined applications of GALILEO and GPS in the future will offer a wide range of applications. The combined use of GALILEO and GPS will provide precise location information which can be used in products from the telecommunication, automotive

and mobile communication industry. The goal of this project is to develop a large-scale integrated GALILEO/GPS receiver chipset. It's being developed for the open service of the GALILEO system which will be freely accessible in the future. A Bavarian consortium has been formed developing this.

- **In-Orbit Validation**

An experimental verification network for the in-orbit validation of Galileo and assessment of application systems will be set up.

- **LBS - Location Based Services**

Research and development activities in the field of LBS are carried out by Bavarian companies and research institutes. Herein especially the Paramount project can be mentioned. The objective of this project was to develop an info-mobility service prototype for mountain hikers by combining technologies, like telecommunication technologies on the one hand and on the other hand satellite navigation with geoinformation.

- **GNSS Receiver Development**

Work in the field of receiver development has been carried out e.g. in the ARTUS project which is coordinated by the IfEN GmbH.

- **Time & Clock synchronisation**

Efforts in the field of clock synchronisation and time distribution are made e.g. setting up a PTF (precise timing facility).

- **Indoor Positioning & Galileo Signal Structure**

Research and development activities in the fields of Galileo Signal Structure and Indoor Positioning are carried out by the Institute of Geodesy and Navigation of the University FAF Munich.

- **Galileo Centre of EADS Astrium GmbH**

A consortium is building up a centre for satellite navigation in Ottobrunn, which aims to

- bundle satellite navigation technology expertise as well as navigation technology competences in Munich
- cover key tasks for monitoring & verification of satellite navigation signals, systems and services as well as application systems
- to serve as flexible development and analysis environment

**Education and Training**

The study course will address professionals working in the SatNav industry. It turns to system engineers as well as executives and will make them conversant with the fast changing structures in satellite navigation. In addition it will provide technical and background knowledge in satellite navigation.

The programme can be divided into three parts: basics, advanced and final studies and a central case project. The

basic part of the master course begins with entry-level modules which focus on space engineering, orbits, navigation systems and signal processing as well as statistics and adjustment theory. The advanced part deals with data analysis, parameter estimation and receiver technology. It covers signal optimisation related to GNSS as well as satellite and ground based augmentation systems. Modules in project management are supplementing the basic and advanced studies. The core elements of third part are subjects in the fields of navigation and satellite navigation with the perspective on positioning applications and special applications on GNSS, GNSS integrity and signal monitoring, in-door positioning as well as sensor fusion and integration of GNSS and INS. The programme results in a detailed central case study where the participants have to work out a realistic mission from the concept to the realisation.

The course will take one year and will be carried out in cooperation with the Politecnico di Torino, Italy.

**PR, Marketing and Communication**

The aim is to conceptualise and realise appropriate actions to approach the satellite navigation area and its projects in the international focus. The concept has to involve industry, companies and universities similarly.

Several actions have already been realised like the joint brochure "Satellite Navigation in Bavaria" or the internet page which is available under the URL: <http://www.bayern-aerospace.com> or the joint logo for satellite navigation and aerospace in Bavaria.

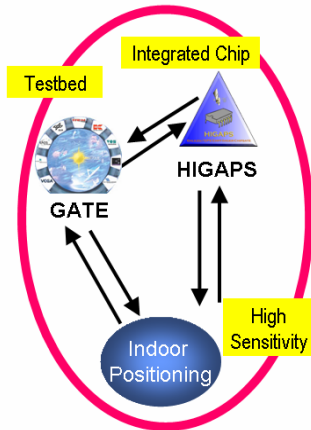


**Figure 5:** Logo of the Bavarian initiative for satellite navigation and aerospace

**SYNERGIES**

The described actions should reinforce existing capabilities. The combination of these components will serve to create synergies as already arisen in the combination of the indoor positioning activities, HIGAPS and GATE. Herein all projects benefit on each others input. GATE with its facilities serves as testbed for the development of applications and for receiver manufacturers. Within its framework tests under real

conditions will be possible. HIGAPS with its research for designing chips with emphasis on GPS/Galileo integration for mass market applications and the Indoor Positioning where high sensitivity chips are needed will also benefit from each others input.



**Figure 6:** Synergies of satellite navigation activities

## CONCLUSIONS

The orientation of the network of excellence in Bavarian is international; it's open to partnerships from all over the world.

## ACKNOWLEDGMENT

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