

Answers of Five Leading Companies

The Future of GNSS Applications

There are a few companies that develop solutions for spatial information like GNSS. We chose five of them to ask some questions on developments, foreseen killer applications, support of Glonass and Galileo and possibly the Chinese Beidou and Japanese MSAS. The five chosen companies are NavCom, Magellan, Trimble, Topcon and Leica Geosystems.



Supporting both GPS and Glonass and designed to track future signals too; Leica ATX1230 GG.

1) Please give an overview of your company and which markets your company primarily focuses at?

Leica: Based in Heerbrugg, Switzerland, Leica Geosystems is a global company with more than 2,400 employees in 22 countries and hundreds of partners located in more than 120 countries around the world. Leica Geosystems is the leader in innovative solutions to capture, analyze and present spatial information. Our company offers a broad array of very attractive solutions in optical and GPS technologies to measure positions, as well as state-of-art solutions for photogrammetry and imagery.

Topcon: Topcon has been established in 1932, and started as a manufacturer of optical surveying instruments. During the last decades, the company focus has been on developing a complete product portfolio for all position-

ing needs in the survey, construction, engineering, agricultural, hydrographical and related markets we serve.

It's Topcon's aim to provide the best solutions for each market, by innovation, and integration of technologies.

Trimble: Trimble applies technology to make field and mobile workers in businesses and government significantly more productive. Solutions are focused on applications requiring position or location - including surveying, construction, agriculture, fleet and asset management, public safety and mapping. In addition to utilizing positioning technologies, such as GPS, lasers and optics, Trimble solutions typically include significant software content spe-

cific to the needs of the user. Wireless technologies are utilized to deliver the solution to the user and to ensure a tight coupling of the field and the back office. Trimble also provides GPS boards, chipsets and licenses for system integrators. Founded in 1978 and headquartered in Sunnyvale, Calif., Trimble has a worldwide presence with more than 2,600 employees in over 18 countries.

Magellan: Magellan provides innovative positioning and navigation solutions to the professional and consumer markets, but also markets technologies and solutions through its OEM Solutions division.

The Magellan Professional business line focuses its efforts on the manufacturing and selling of survey and GIS products based upon advanced GNSS technology designed in house. Our GNSS solutions are also made available to numerous integrators who procuring boards from us.

NavCom: Established in 1992, NavCom Technology, Inc., a wholly owned subsidiary of Deere and Company, is a leading provider of advanced GNSS products for OEMs, VARs and system integrators.

NavCom's precision GNSS receivers and the decimetre accurate Global SBAS StarFire service are in wide use worldwide for RTK Land Survey, Offshore Precise Positioning, Military, GIS, OEM and Machine Control applications, most notably John Deere's Ag Management Solutions.

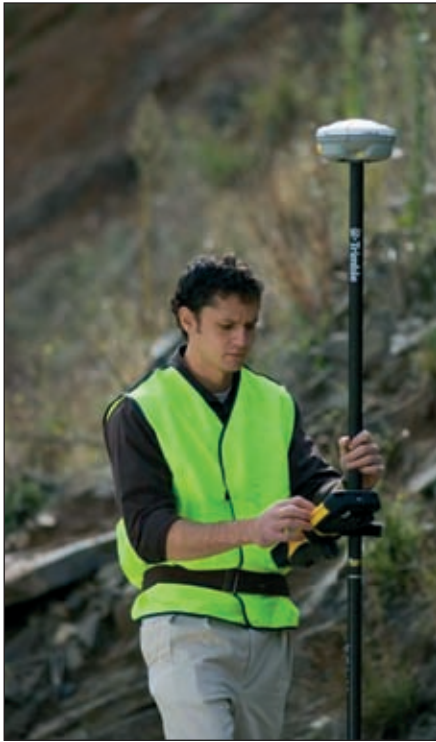
In addition, NavCom has expertise in wireless communications, local positioning and sensor fusion technologies and provides contract engineering services in these areas plus GNSS receiver technology and augmentation signals.

2) Which new developments do you see in your market with regard to GNSS?

Leica: GPS and GLONASS modernization as well as the introduction of Galileo will provide exciting new developments for the survey market over the next five years. The main challenges facing manufacturers will be a smart selection from more than 100 available signals while maintaining acceptable power consumption.

More GNSS signals and codes will provide the user with more options and greater confidence in the positioning results.

Provide total station level elevation accuracy in basically any GNSS application.



The R8 GNSS system and NetR5 reference station of Trimble encompass GPS and its next-generation signals, GLONASS and Galileo.

The benefits for the high-precision user will be improved position reliability, precision and ultimately productivity.

Topcon: New satellites will be launched and new signals will be implemented by the GPS, Glonass and Galileo responsible authorities in the near future. But end users do not have the slightest interest in effectively choosing which signals or satellites to use. For precise positioning, the end user needs access to as much satellites and signals as available. More means more places to work, higher accuracies, and greater ease of use. This has been Topcon's commitment since it started in the GNSS business; since 2000 we provide our customers the ability to use all available satellites and signals, and since recently, we also offer our customers the guarantee that they will be able to use all currently planned systems and signals. This is demonstrated with our new G3 technology

products, that are the only receivers today, that will receive all existing, and planned signals.

Trimble: GNSS developments include new GPS signals coming on line, GLONASS satellites being replenished and the launch of Galileo Giove-A. In addition, we are seeing new ground-based augments in Japan, India and others.

Magellan: Magellan Professional believes the time has come for a greater democratization of the technology. Ten years ago the customer was an early adopter, but in recent times we see considerable growth coming from new professionals requiring simple, easy-to-use, and easy-to-learn tools. Technology is well-accepted and is not required any longer to prove its benefit to the bottom line. Today's marketing attempts to tout technology breakthroughs that have very limited or no benefit to the customer at present are misguided. Rather the barriers to



A tractor guided by GPS.

overcome are: complexity, cost, training, executing large deployments throughout the workforce. The winners in the GPS market will be the companies which are able to grant users with quick learning curve solutions and a high return on investment.

NavCom: The greater availability of GNSS signals and codes coupled with smaller, lighter and more capable GNSS receivers are paving the way for adoption of precise positioning technology in an increasing number of applications. Continuing developments in receiver and sensor integration provide improved positioning in satellite obstructed locations such as urban canyons, near buildings and under foliage. These breakthrough technologies are increasingly adding value and reshaping very traditional applications. In John Deere's machine control and precision farming applications, for example, our GNSS and sensor fusion technology allows for operator-free guidance and control of the machine, freeing the driver to concentrate on control of towed implements while at the same time providing valuable data on vehicle status, soil nutrition, crop health and fertilizer requirements. Ultimately, these technological developments are enabling businesses across our markets to optimize efficiencies in both material and operating costs and offer a host of additional benefits ranging from environmental concerns to workforce safety.

3) Which killer application(s) do you foresee in the near future in your market?

Leica: The same limitations such as the need of line-of-sight between the GNSS antenna and the satellite will also apply in future for real-time kinematic (RTK) applications. Visions such as "Indoor positioning" with Galileo will not work for RTK applications.

Topcon: Although the increasing cost-performance ratio of many of our, especially GNSS products, increases the acceptance in growing markets like for instance construction and GIS, the largest growth will come from true integration of technologies. Through this, we believe to offer the best possible solutions for our customers, to increase quality and productivity of the work they perform on a daily basis. Examples of this are Topcon's GPT-7000i total station series that offer integration of digital imaging technology in a total station, and Topcon's GMS-2 GPS receiver, that offers an integrated compass and camera in a handheld GPS unit. These are examples

of creating complete data collection, mapping systems that offer a true solution for the user. Another good example of this is Topcon's Millimeter GPS, where we have integrated our laser technology with GNSS, to provide total station level elevation accuracy in basically any GNSS application.

Trimble: Killer applications are expected to use or integrate multiple technologies to simplify information to solve everyday problems for end-users - making them more productive. These applications are expected to combine positioning technology, wireless communications, mobile computing and application-specific software for a very broad range of industries.

Magellan: The most compelling driver we see currently in the marketplace is the addiction to real-time data - the deployment of large reference stations networks helps advance the ability to deliver this.

What was deemed acceptable thanks to post-processing techniques a few years ago is now more and more requested in real-time in the field, primarily for productivity reasons. This trend applies mostly to man carried applications in land surveying and GIS and for various accuracy ranges down to the centimeter level. The latter does not specifically mean that all users are ready to invest in expensive high-end, dual-frequency RTK systems. They expect the industry to offer new techniques at affordable prices to give them in the field what they formerly had to achieve through a cumbersome process only when back in the office. The latter change is also helped by the large deployment of reference station networks which offer RTK



Real time surveying with Magellan Z-Max.Net corrections received via GPRS.

An unclear schedule of the Beidou program makes investment decisions difficult.



The new G3 technology products of Topcon will receive all existing, and planned signals.

corrections through GPRS communications. With that signal in space and no requirement to set-up a base station, the complexity barrier to accuracy is lifted and new applications will emerge that we may not even know about today.

NavCom: Achieving instantaneous centimetre accuracy without the need for correction data from local base stations.

4) Do your products support Glonass and Galileo or will they in the near future?

Leica: All Leica Geosystems high end GNSS products support GPS and GLONASS. The high end products are all designed such that the planned third civil GPS frequency and Galileo can be supported in the future.

Topcon: Since 2000, Topcon has offered its customers access to all available satellite systems; GPS and GLONASS. More means better. In our current G3 technology based GNSS products, we offer not only all current and planned (GPS+GLONASS modernization) GPS+GLONASS signals, but also Galileo compatibility.

Trimble: GNSS is at the core of Trimble's technology strategy. For example, the Trimble® R8 GNSS system and NetR5 reference station were initial steps in product concepts that encompass GPS and its next-generation signals, GLONASS and Galileo.

Our plans for 2007 and beyond are to continue to release new products consistent with this expanded GNSS architecture, contemplating the continued development of the Galileo system. This continues our tradition of anticipating satellite infrastructure improvements - as evidenced by the release of our L2C-capable product one year ahead of the satellite launch. Trimble has also developed products for the coming L5 GPS signal. Our goal remains that of offering solutions that meet our customers' needs by utilizing the best technology available, now and in the future.

Magellan: Magellan was the first to offer Glonass receivers to the survey and GIS markets and was the first to work on the development of Galileo receivers for commercial use. We have further developed all these technologies which are ready in-house in order to be incorporated in our GNSS receivers as soon as users can truly benefit from them. Despite a still poor constellation, Glonass is making a remarkable come back. When a definitively stable outlook is evident for the Russian system, we will be ready to deploy. Galileo is really another story. Being as close as we are to the Galileo activities, it is crystal clear to us that no real benefit will be granted to users before 2012 - 5 years or more from now. We are one receiver generation, at least, ahead of Galileo and technology will have gone through another cycle before customers can benefit from the European constellation while surveying.

Magellan will then certainly offer this capability for customers to get the real benefits of a modernized hardware compatible with Galileo.

NavCom: NavCom GNSS receivers currently support WAAS and EGNOS SBAS, GPS L1 and L2 plus StarFire GSBAS L-Band corrections. As Glonass recovers to full strength and Galileo is deployed, NavCom's receiver technology will provide Glonass and Galileo capability when there are sufficient satellites with signal quality equivalent to GPS.

5) What is your view on new, primarily local, initiatives like the Japanese MSAS and the Chinese Beidou system?

Leica: The Japanese MSAS system and the Chinese Beidou system cannot be compared, since phase 2 of Beidou (Compass) would be an independent GNSS system with 30 orbiting satellites. I believe that China has the technical and financial capacity to launch their own "GPS", but an unclear schedule of the Beidou program makes investment decisions difficult.

Topcon: Topcon aims to be the leading supplier of positioning solutions. This can only be achieved by being a true global company. In

this respect, globalization means the ability to quickly adapt to, and provide local solutions. MSAS, WAAS and EGNOS signals are tracked by current Topcon receivers. The Chinese Beidou initiative is planned to be the basis of a new to be established world wide satellite system, and is still in its early stages. How this will evolve in the future is still unclear, but it is Topcon's commitment to use and integrate each and any augmentation systems, that provides added value to the user. Higher accuracies and increased coverage will lead to improved productivity and enlargement of the market.

Trimble: Trimble looks forward to supporting advancements in the GNSS market, whether local or global. We are committed to offering a variety of solutions that provide commercial benefit to our customers.

Magellan: As the question implies, the move to GNSS will not only include global initiatives such as GPS modernization and Galileo but also regional ones such as Beidou. They will be of a different nature and scope, which will trigger various solutions from different manufacturers. Here again, as soon as standardization is reached then a majority of users may benefit from them. Local systems that are too differentiated will call for local adaptations unless they are cross-compatible with other global solutions.

NavCom: We welcome the addition of Japan's MSAS and QZSS, China's Beidou-2 (Compass), India's GAGAN and IRNSS. Current GNSS accuracy can be as accurate as 10cm (StarFire) or 1-2cm (NavCom RTK). More GNSS signals and codes will unlikely increase upon these accuracy levels but will provide the user with more positioning receiver options and greater confidence in the positioning results. Beidou-2 represents an exciting opportunity, not just as a local system but potentially the fourth global GNSS. With so many local and global GNSS, the positioning issue may be considered 'solved', however we still have underwater, underground and a backup to GNSS for future consideration.

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www.leica-geosystems.com

www.topcon.com

www.trimble.com

www.magellangps.com

www.navcomtech.com