GNSS Milestones 2009–10

Rome wasn't built in a day, and neither was the Global Positioning System.

Nor will the emerging GNSS system of systems arising from the regional and global infrastructures being put in place or modernized today: GPS, GLONASS, Galileo, Compass (Beidou-2), QZSS, GAGAN, IRNSS, EGNOS, WAAS, MSAS, and undoubtedly other acronyms yet to be born.

As with any large and complex enterprise, a series of steps — and, sometimes, missteps — stretches away behind and ahead of each individual system. In discrete increments, many may not seem particularly significant or even noticeable.

But taken cumulatively — and from time to time, individually — certain efforts make a difference, stand out from the context of ongoing endeavor, and assume a form that marks them as waypoints along the GNSS journey.

As 2009 turns into 2010, *Inside GNSS* asked a small group of GNSS leaders to share their perspectives about the progress of global navigation satellite systems in the year past and the prospects for GNSS in the year ahead. In this special feature, here is what they told us.

Above: Original and restored section of Appian Way; inset, Ancient Roman milestone on Capitoline Hill, Rome, Italy. Scenic photos from Wikimedia Commons.

Steven Huybrechts, Vice President, Government Systems, Applied Minds, Inc., USA

What was the most significant event, development, decision or activity affecting GNSS in the past year (2009)?

2009 was the first year that all four global GNSS providers agreed to the principle of compatibility and agreed to work toward interoperability as a goal — the first illustrating the risk of multiple systems, the second the potential opportunities.

The proposal to have four global systems, as opposed to the one and a half that we have today, threatens to increase the noise floor in the GNSS bands and needs to be addressed. Additionally, the four systems will share a relatively small portion of the electromagnetic spectrum and must coordinate their signal locations and structures carefully.

Developing interoperability standards between the systems is an intriguing idea that would almost certainly benefit both users (due to increased availability) and providers (due to potential reduction in the numbers of satellites required in, and therefore cost of, each constellation).

What is the most important event, development, decision or activity that should or will take place in 2010?

The United States and Europe should move forward aggressively toward interoperability between GPS and Galileo, in both open and encrypted services. The benefits to both civil and military (M-Code and PRS) users on both sides would be great. If full interoperability is achieved, for example, the US and the EU, each providing a constellation of 20 satellites, could still provide to users a 40-satellite constellation. This would greatly reduce the sustainment costs of both systems, while greatly increasing user availability over today.

Additionally, GNSS technology should be pursued as a potential significant weapon in the fight against climate change. Already studies have shown that the use of precision farming and precision mining can reduce the carbon emissions of these two industries dramatically. Other applications along these lines should be pursued. The US Congress, as well as other governments around the world, should provide incentives for the use of GNSS technologies in this role.

Pedestal of the Golden Milestone in the Roman Forum

A New Golden Age?

All GNSS roads must lead to civil interoperability, most of our 11 experts affirm.

They also agree that next year — 2010 — will prove significant for all of the systems: new signals, launches, and new capabilities.

Inside GNSS asked leaders from among the GNSS system providers and industry to identify key "GNSS Milestones" by expressing their opinions on two related subjects:

- the most significant event, development, decision, or activity affecting GNSS in 2009
- the most important event, development, decision or activity that should or will take place in 2010.

The participants, in alphabetical order:

Steve Berglund, President and CEO, Trimble, USA

Donald G. DeGryse, Vice President, Navigation Systems, Lockheed Martin Space Systems Company, USA

Sharafat Gadimova, Program Officer, Executive Secretariat, International Committee on GNSS, Office for Outer Space Affairs, United Nations Office at Vienna, Austria

Jim Grace, Vice-President for Business Development, L3/Interstate Electronics Corporation, USA

Steven Huybrechts, Vice President, Government Systems, Applied Minds, Inc., USA

Hiroshi Nishiguchi, Director, Japan GPS Council

Michael Ritter, President & CEO, NovAtel, Inc., Canada

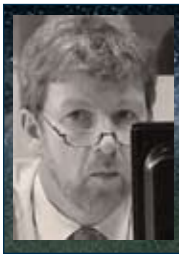
Doug Taggart, President, Overlook Systems Technologies, Inc., USA

Koji Terada, QZSS Project Manager, Japan Aerospace Exploration Agency

Paul Verhoef, European Commission, head of unit, EU satellite navigation Programs (Infrastructure Deployment and Exploitation)

Ruxin Zhou, Chairman, Beijing BDStar Navigation Co., China

1978 First GPS Block I satellite launched **1982** First GLONASS satellite launched **1983** President Reagan declares GPS available for civil use;



Paul Verhoef, European Commission, head of unit, EU satellite navigation Programmes

2009

2009 has been an interesting year, certainly from the perspective of the European satellite navigation programs.

EGNOS officially entered into operational phase with the provision of the Open Service as of October 1. The development of EGNOS started back in 1995, but the system was technically qualified only in 2005.

The declaration of the Open Service signals the maturity of the system, which has demonstrated excellent performances since the beginning of 2009, with augmentation of GPS reaching accuracies of one to two meters at an availability level above 99 percent.

In this context, the EGNOS assets were transferred from the European Space Agency (ESA) to the European Com-

Milepost near Osian in Jodhpur, Rajasthan, India

China plans its own GNSS, later named COMPASS **1991** First extensive military use of GPS (in Persian Gulf War – Operation Desert Storm)

mission (EC) in April, and the EC signed a contract for the operation of the system with ESSP SaS, a company founded by several air traffic management agencies.

As far as Galileo is concerned, the contract for the first four operational satellites was signed with Arianespace on June 15 and we expect a number of FOC procurement contracts to be signed by the end of the year.

2010

2010 will see further important progress on both programs.

EGNOS is expected to become certified according to the European Union's Open Sky regulations and ICAO requirements and will start providing the Safety-of-Life (SoL) Service for Aviation around mid-2010. This will mark the start of WAAS/EGNOS-assisted flights across the Atlantic Ocean.

For other SoL communities, the consolidation of user requirements and the validation of services will progress. The geographical coverage of the system will be extended to cover all European states including the Northern, Southern and Eastern extremes.

Galileo will take major steps forward with the signature of the remaining procurement contracts for the FOC phase and with the launch of the first operational satellites under the in-orbit validation (IOV) phase. This launch is expected to take place mid-November 2010 from Kourou in French Guyana, using Soyuz rockets.

Last but not least, we hope to see a positive outcome to the negotiations with China with regards to the frequencies used by Galileo and Compass.

Michael Ritter, President & CEO, NovAtel, Inc.

2009

As a GNSS manufacturer, one of the most significant events in 2009 was the launch of the L5 signal. This allowed NovAtel to characterize and evaluate the "real" L5 signal for the first time. Prior to the launch, NovAtel's product development work had been necessarily restricted to using WAAS GEO signals and L5 simulators.

2010

Availability of constellation information, the launch of new satellites, and the development of policies that govern access to satellite functionality promise to be key issues for NovAtel and the industry as a whole in 2010.

The planned release of the Galileo and Compass interface control documents (ICDs), slated for next year, will give manufacturers a stable definition of both the new signals and system operations. This will allow NovAtel to fully implement the support for these systems in our products and avoid uncertainty related to product design requirements.

Sahara Occidental (Western Sahara) milestone

The planned launch of Galileo's first two in-orbit-validation (IOV) satellites in 2010 will provide NovAtel with benefits similar to the launch of the L5 signal in 2009. The launch of these satellites means that NovAtel will no longer have to rely on GIOVE-A/B or simulators for product design work.

Going forward, it is our hope that policies will be put in place by any new GNSS system that will continue the open, equal access policies of the existing GPS system. We believe this is the best approach for maximizing the benefits of GNSS technology and for the people around the world who ultimately purchase GNSS-based applications.


Koji Terada, QZSS Project Manager, Japan Aerospace Exploration Agency

2009

Most significant: The activities for achieving the compatibility and interoperability of global navigation satellite systems, which were discussed in the Fourth Meeting of the International Committee on GNSS (ICG) held in Saint Petersburg, Russian Federation from September 14 to 18, 2009.

It is expected that civil applications of satellite-based navigation systems will grow rapidly to improve our quality of life, to secure our life, and to mitigate environment problems and so on in a sustainable manner throughout the world. For this purpose, GNSS/RNSS (Regional Navigation Satellite System) must work with user equipment, ground communication systems, and related software — as a whole system — effectively and efficiently to provide PNT-related services to end users worldwide.

GNSS and RNSS are not competitors but can work together from the users' viewpoint to promote new applications and new culture in the new era of a multi-GNSS world. The ICG gave us the opportunity to share views on GNSS compatibility and interoperability among representatives from industry, academia, and governments. And also the ICG decided to support a proposal for a multi-GNSS Demonstration Project in the Asia/Oceania region.

2010

Most significant: Launch of the first Japanese QZSS (Quasi-Zenith Satellite System) satellite.

It is apparent and fair to say that launches of GNSS and RNSS satellites that have a high level of interoperability will be significant events in 2010. Block IIF satellites of GPS, the first two satellites of Galileo, and our first QZSS satellite are among those. This is highly expected to promote civilian PNT applications not only in each system but also in collaboration among the systems.


Ruxin Zhou, Chairman, Beijing BDStar Navigation Co., China

2009

In 2009, significant progress was made in the establishment of four major satellite navigation systems in the world. And the GNSS system is under rapid construction. Meanwhile, the worldwide financial crisis caused profound changes to the global navigation industry; especially in mergers and business integration.

Major leading enterprises in the industry are adjusting their strategies, putting more attention to the potential of high-end OEM board market; the change of the high-end OEM board market pattern is already apparent.

As of 2009, BDStar has constructed the marine fishery security and information service system based on China's Compass Navigation Demonstration System, and there are more than ten thousands of subscribers. It has provided a solid basic infrastructure for the further development of location-based mobile e-commerce services and "Internet of things."

2010

The four major navigation satellite systems crossing the world and various regional systems will continuously make rapid developments in 2010. The high-end professional applications and consumer market will resume to grow rapidly by the new development after the worldwide financial crisis.

BDStar and other Chinese local enterprises have increased the investment of R&D in both critical cores of the GNSS system-related technology and product design, which will have first order achievement. Meanwhile, in another

aspect of location-based services, the integrated information services will be introduced basing on multiple networks (e.g. satellites, 3G, and so on). And more and more research efforts about location-based mobile e-commerce and "Internet of things" will be conducted gradually.

Doug Taggart, President, Overlook Systems Technologies, Inc., USA

2009

Contained within the framework of this question is what I believe to be the most significant development in the GNSS community in 2009. Seeds planted this year promise to burgeon into a paradigm change that may rival that of a decade-plus ago when GNSS first arrived on the scene.

The GNSS community may have begun to see the need to encompass a broader — not just space-based — understanding of what it means to be a positioning, navigation, and timing (PNT) service provider. PNT is pervasive and is critical to national security and to the commercial sector.

1823 Border milestone between County of Nice and France

The persistent, global presence of GNSS-provided PNT information has resulted in a concomitant rise in dependence on this information. The level of dependence in the national security and commercial sectors raises concern in light of the inherent fragility of GNSS-provided PNT information.

Underlying spectrum and power limitations mean that GNSS will not meet the growing hunger for PNT information. These vulnerabilities are particularly apparent in urban and sub-surface environments.

Providing ubiquitously available PNT in all conceivable surroundings demands that the GNSS community break out of its self-limiting paradigm. In the future, realizing this new paradigm, you could rightly ask "What is the most significant event, development, decision, or activity affecting PNT in the past year?"

2010

The challenge for 2010 is to continue morphing our space-based paradigm into a PNT paradigm. Breaking free of the GNSS mindset will allow us to understand and then realize the full potential of our community as a collection of PNT service providers, not just space-based providers.

Several opportunities present themselves in 2010. For example, the U.S. Space-Based Position, Navigation, and Timing Policy can be broadened, providing national direction for PNT information. Dropping the space-based limiter, a revised U.S. national policy for PNT would provide the momentum required to meet growing national, homeland, and economic PNT security requirements.

The GNSS International Providers Forum, established by the International Committee on GNSS under the United Nations Office for Outer Space Affairs, might consider expanding its charter. This expanded focus may allow for greater compatibility and interoperability among current and future PNT service providers.

Understanding this as a PNT problem-set, not just a GNSS issue will allow our community to more effectively meet ever growing requirements for precise positioning, navigation, and timing information.

Distance monument at Vladivostock, Russia, railway station

Block IIRM with demonstration L5 civil signal; first Compass-Beidou 2 geostationary (GEO) satellite launch; India's first GAGAN (scheduled);

As we all know, this information — particularly the timing element — continues to play an ever-increasing role in satisfying civil, commercial, scientific, economic, and national security needs in all regions of the globe. We owe it to our constituents to break the GNSS mold.

Jim Grace, Vice-President for Business Development, L3-Interstate Electronics Corporation, USA

2009

As [the defense] segment begins planning for the evolution from the current military capability that utilizes COMSEC-based SAASM products for the user community to the information assurance–based M-code products in support of GPS III, nonstop expansion of GPS applications continues.

In the weapons area, 2009 has seen the maturation of highly integrated GPS-based products and technologies that allow Army customers to achieve precision guidance of not only 155-millimeter Excalibur Artillery rounds but also 105-millimeter artillery and 81-millimeter/120-millimeter mortar applications.

Advanced levels of electronics integration with soldier systems — and targeting systems with highly integrated GPS-based products that are half the size of currently configured GPS receiver hardware — is allowing military customers to realize additional integration levels of other functions in spaces previously defined for just a GPS receiver.

In the military, as in the consumer world, the application is becoming king — GPS is just one of many enabling functions.

2010

In the coming year, the Department of Defense stands at a precipice. The strategy will be put in place for acquisition of next-generation modernized GPS user equipment.

Over the past few decades in the military the applications implementing GPS functionality have skyrocketed. Some applications utilized standardized hardware but others were unique and demanded functionality with wide swings of variation on cost, size, weight, and power. Servicing these customers and the unique solutions required to support their applications, a handful of very capable suppliers continuously innovated and supplied products to meet the needs.

As industry and the GPS Wing evolve the modernized GPS user equipment (MGUE) acquisition path, we must not lose sight of the advantages that innovation and competition brings. In 2010, the most important decision to be made is one that embraces competition going forward and does not limit military GPS users to one supplier intended to meet the needs for all applications.

Steve Berglund, President and CEO, Trimble

2009

Many events and developments helped shape GNSS in the past year. One of the most notable, but perhaps somewhat overlooked, is the ongoing deployment of real time kinematic (RTK) infrastructure networks worldwide to augment GNSS—these include regional and country-wide, public and private networks.

Two key developments have made this network growth possible: the proliferation of wireless communications and improved RTK techniques, which enable precision real-time GNSS positioning through the distribution of correction data over large geographic areas.

These networks provide a highly reliable and cost-effective means for surveyors and geospatial professionals to work faster and achieve accurate GNSS results for a variety of positioning applications, including geodetic and cadastral surveying, road and bridge construction, urban planning, fleet and asset management, mapping, agriculture, disaster prevention and mitigation, earthquake and tectonic plate movement monitoring, scientific research, and other high-accuracy positioning applications.

Distance post at Rovaniemi Airport in Lappi province, Finland

RTK networks are considered an integral tool for providing fast, high-precision, wide-area positioning in countries around the world.

2010

For 2010 and beyond, continued cooperation and compatibility of GNSS systems can offer improved positioning, navigation, and timing to users throughout the world.

The next year should be an exciting time for GNSS, with multiple systems in the operating, deployment, modernization, and planning stages. GNSS signal interoperability and the progress we are making worldwide is a testament to the cooperation among the international scientific and engineering community supported by governments.

Adoption of GNSS signals is fundamental to Trimble's technology strategy as demonstrated by our history. Plans to utilize new elements of GNSS include modernized GPS and GLONASS, and future Galileo and Compass signals. By combining GNSS and augmentations — WAAS, EGNOS,

QZSS and others — it will be possible to work in more locations and obtain more robust positioning in difficult environments. Also, the integration of lasers, optics, imaging and radio-location technologies with GNSS provides additional user benefits.

Our goal remains that of offering solutions that meet customers' needs by utilizing the best technology available, now and in the future.

Sharafat Gadimova, Program Officer, Executive Secretariat, International Committee on GNSS, Office for Outer Space Affairs, United Nations Office at Vienna, Austria

2009

At the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) in 1999 and at the 2001 session of the Committee on the Peaceful Uses of Outer Space, the issue of global navigation satellite systems was just one of many items for discussion.

It was only in 2005 that the issue was considered important enough to warrant the establishment of a separate body completely devoted to GNSS under the umbrella of the United Nations: the International Committee on GNSS (ICG) for which the Office for Outer Space Affairs acts as Executive Secretariat. ICG has had its first meeting in Vienna, in 2006. The second took place in India, in 2007. The third was held in the United States, in 2008.

In 2009, as an international forum to discuss GNSS to benefit people around the world, ICG brought together to its fourth meeting in Russia six major players in GNSS — namely, China, the European Union, India, Japan, the Russian Federation, and the United States — to promote the enhancement of and universal access to space-based navigation and positioning systems and their compatibility and interoperability. The goal of the ICG work was to have GNSS signals used coherently from all operating GNSS at any location at any time for civil applications.

Pursuant to elements of the ICG workplan, the coordination of future program plans among current and future GNSS operators, including augmentation systems, and increased awareness of the community of users will enhance the utility of GNSS services. This should result in a number of new international and national programs that support a broad range of interdisciplinary and international activities, particularly in developing nations.

2010

In 2010, as a part of the capacity building and information dissemination efforts of ICG, the Office for Outer Space Affairs through its program on GNSS applications, will support the International Space Weather Initiative, the development of GNSS education and training programs, creation of awareness of global GNSS applications, and increasing information on and accessibility to the technical characteristics of existing GNSS systems.

Close attention will be paid to the role of ICG information centers as hubs to promote GNSS applications and education, as well as task forces on geodetic and time references. The European Community and Italy will jointly host the fifth meeting of the ICG in Italy.

Hiroshi Nishiguchi, Director, Japan GPS Council

2009

The most significant events, policy decisions and development affecting GNSS in Japan are:

(1) Establishment of two basic laws: The Basic Law for National Geo-Spatial Data Infrastructure (NSDI) and The Basic Law for Space Utilization, which covers objectives beyond R&D that were the major subject in the conventional legal framework, and

(2) Working out of the implementation plan to materialize the synergistic effects of utilizing National Spatial Data Infrastructure (NSDI) and space-based PNT.

Presently, discussions are underway among industry, academia, and the government for the establishment of the NSDI standard platform and related legislative acts and regulations to define further details for realization of the implementation plan.

In order to have the importance of utilizing GNSS and implementing NSDI understood by the people, these activities were reported by mass media and published through the web site, as well as "What is NSDI?" seminars in various parts of Japan.

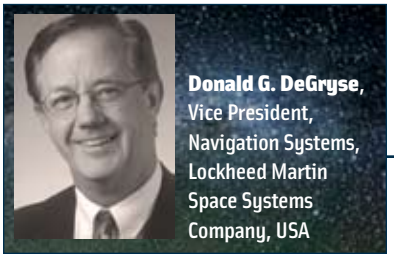
2010

In Japan, there was a historical change of the political regime in August, 2009. This was the most important event for us.

Presently, it is rather difficult to foresee the immediate future, as the new regime is busy with reforming the old political systems. It is, however, expected that the change of political regime would not negatively affect the GNSS and NSDI communities, as the above-mentioned two basic laws were enacted through the National Diet member proposition based upon the agreement by three political parties that then made up the majority.

Accordingly, the activities for materialization of the implementation plan are in progress as scheduled. Launch of the first satellite under the Quasi-Zenith Satellite System (QZSS) project would bear significant impacts on the GNSS community in Japan and the Asian region as well.

The anticipated launch of a QZSS satellite will promote replacement demand for advanced equipment in the matured car navigation market, and positively affect the growing PND and PNT-enabled cell phone markets. Specifically, QZSS will stimulate development of receivers with L2C and L1C capabilities, and activate the development of GPS applications for urban environment.



Donald G. DeGryse, Vice President, Navigation Systems, Lockheed Martin Space Systems Company, USA

2009

Overall it was a highly successful year for GNSS.

Major development and on-orbit milestones were achieved that improved position, navigation and timing (PNT) for GPS users, and international recognition of the need for GNSS capabilities increased.

Milestones included:

- Launch of a GPS IIR-M satellite with a L5 demonstration "Safety of Life" signal broadcast for the first time, paving the way for the operational signal.
- The final GPS IIR-M satellite was successfully launched and declared operational, bringing the overall constellation to a robust 30-plus satellites.
- Our GPS III team completed a highly successful preliminary design review and is progressing in the critical design review phase.

Today, at least six nations are in various stages of implementing global or regional satellite systems. By the end of the next decade, there may be as many as 12 systems in orbit.

2010

Looking ahead to 2010, we anticipate growing interest in how navigation capabilities, products, and services will a play vital role it the global economic and security environment.

Working with our Air Force partner, we look forward to meeting our GPS III commitment by completing key milestones on time and on budget, achieving mission success, and delivering improved PNT capabilities to GNSS users around the globe. IG