



A December 2008 meeting hosted by the Jet Propulsion Laboratory (JPL) in Pasadena, California brought together not only the “Big 3” GNSS constellation providers but the new kids on the block as well, driving home the point that while GNSS may be “worldly” by nature it is getting “worldier” (if I can coin a term) by the minute.

Old Faces and New Faces at the Table

The USA, Russia, and Europe (or one could say the ever evolving team of European stakeholders in the Galileo initiative) are now sharing the dais with China, Japan, India, and Nigeria.

The “Big 3” constellations, providing satellites for traditional GNSS “ranging”, are complimented by a number of public and private satellite systems providing “augmentation” (*e.g.*, WAAS, EGNOS, StarFire), with more on the way. Soon there will likely be another full “ranging” constellation with global coverage from China, along with at least one new regional “ranging” system from India, and many more augmentation systems hosted by regions or countries with specific needs, like Nigeria.

We hear much about the possibilities and options that integration of new constellations may bring for various facets of global navigation and positioning, and how these needs serve as drivers for development of such systems. It was evident from listening

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The ICG group gathered for a photo on the steps of Pasadena City Hall. The conference was hosted by the nearby Jet Propulsion Laboratory.

to the constellation providers that high precision may not be the prime driver for development, and that land surveying may be somewhat overlooked as a user segment, but that high precision surveying may be one of the few segments that will truly benefit from all that these new and upgraded constellations may provide.

ICG

The dream of a “constellation of constellations” as some would like to see GNSS, is progressing on two levels. On one level is traditional geopolitical negotiations—uni-

Getting the existing and potential GNSS providers and stakeholders together at the same table, even under the auspices of organizations without a mandate to develop substantial or binding agreements, like the International Committee on Global Navigation Systems (ICG), still serves the process well. Such gatherings keep the dialogue going in an open format.

Another forum, the Civil Global Positioning System Service Interface Committee (CGSIC), may be more familiar to surveyors (and especially

“The wide world is all about you; you can fence yourselves in, but you cannot forever fence it out.”

—J.R.R. Tolkien

lateral, bilateral, or multilateral—mainly governmental posturing that sometimes gets lost in a cloud of indecision. The other level is driven by necessity, practicality, markets, and science. The former being dry, prolonged, sometimes excruciating (like watching C-SPAN), and the latter sometimes circumventing the conventional wisdom of even the most learned insiders.

readers of this publication) as the premier mechanism for getting feedback from the end users to the constellation providers. In past decades, the proceedings of the CGSIC were concentrated mainly on matters concerning the U.S. government Navstar system, but they are now increasingly involving the other systems. The CGSIC is an outreach initiative fostered by the U.S. Department of Transportation

and the U.S. Coast Guard Navigation Center (NAVCEN), so it is viewed internationally as somewhat of a U.S. centric club. While it is recognized as a premier forum on GNSS, a great number of other organizations have popped up along the way. Boring you with the labyrinth of committees and acronyms will not help answer the question “What does it mean to us land surveyors?”, but it may be interesting to see how at least part of the sausage is made.

The good news is that we, the end users, are in relatively good hands. Regardless of how many organizations and forums on GNSS exist (and how redundant some of the proceedings may be), that the constellation providers must keep restating and redefining their positions at the frequent public forums means we are well informed. The prominence of the ICG may have more to do with timing and connections than anything, but it a good thing all the same. A need for a dialogue outside of existing formal channels was recognized by a number of organizations, as far back as the late 1960s with the U.N. Committee on Peaceful Uses of Outer Space. A trail of acronyms later and the ICG was formed; ICG1 met in Vienna in 2006, ICG2 was Bangalore in 2007, and ICG3 was in Pasadena in December 2008.

The Constellation Providers (in alphabetical order are, or are soon to be):

- China – COMPASS/BeiDou
- European Community/European Space Agency – Galileo, EGNOS
- India – GAGAN, IRNSS
- Japan – MSAS, QZSS
- Nigeria – NigComSat -1 SBAS
- Russian Federation – GLONASS, SDCM
- United States of America – GPS, WAAS

Compatible, Interoperable, Interchangeable, and Interesting

The constellation providers and stakeholders, in effort to find common ground (or conversely to establish their system as unique in some manner) sprinkle their presentations and prepared speeches with at least some fairly widely accepted terms:

- **Compatible** is used to describe conditions whereby the respective elements of two or more systems essentially “do no harm” to the other systems; these are usually considerations of signal and code that do not perilously overlap each other.



Americans on the near side, Chinese on the far side, Europeans and others in between.

- **Interoperable** would describe conditions whereby two or more systems share enough common elements (the most commonly discussed are clock, reference framework, and signal types, but not necessarily spectrum) that would enable practical design of end user equipment that could use multiple systems together in some manner. Whether GPS and GLONASS are currently interoperable is still debated even amongst the experts.
- **Interchangeable** would describe a condition whereby two or more systems share enough common elements that at least some signals and codes from one constellation could easily be augmented to the same in another. A lofty and idealistic goal for sure, and perhaps not on the immediate horizon given current trends.
- **“Interesting”** are developments, typically regional that are cool in their own right, but may not ever have an impact on high precision positioning in our part of the world.

Wouldn't it just make sense to put up multiple constellations with the same codes, signals, tracking, clocks, reference framework, and in neatly partitioned spectrum and orbit slots? Might be a hard sell when some government is asked to fund a multi-billion dollar (ruble, Euro, rupee, or other) program that does not appear to give some special advantage (real or imagined) to said country. The prime argument for a



Javad Ashjaee gave one of the manufacturers' perspectives and showed off some of his new gear for surveyors.

separate system is that it is completely within the control of those funding it, and does not depend on another. It is not so much cold war fears (though there are undoubtedly still elements of that) as it is a best practice for ensuring continuous services to economies increasingly dependent on GNSS. Each of the constellation providers stated as such in their presentations.

A new acronym showed up in a few of the presentations (but not by the constellation providers themselves): WGNSS, or “World GNSS”. Kind of odd in that “world global” is somewhat redundant. The intention of coining the new term is to try to put an acronym on the idealistic view of a “constellation of constellations”. Okay.

GEO, MEO, LEO, HEO...

Speaking of acronyms, the respective systems—be they ranging or augmentation—are composed of satellites utilizing various orbit types. While not in any way a comprehensive treatise, here are a few key terms:

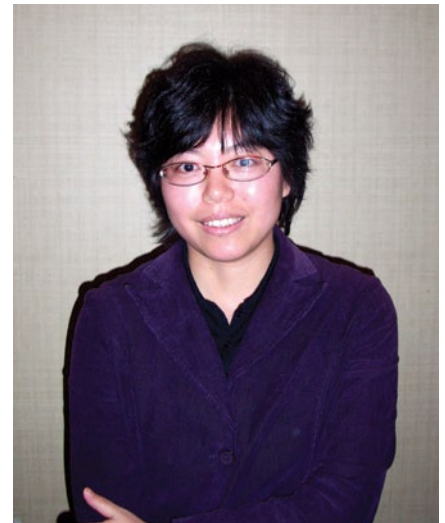
- **MEO** Medium Earth Orbit (though some call it “Middle-Earth orbit, but that sounds like something Hobbits might launch). Satellites that orbit in the range of 2,000km to 36,000km. This is where the GNSS satellites used for ranging (the use of direct observations for positioning) live at around 20,000km. These can remain in orbit for decades with little adjustment, and can be tracked precisely. It is possible to provide complete global coverage and visibility of at least four sats at any given time with a constellation of 24-30 sats.
- **GEO** Geostationary; from the vantage point of the ground observer they appear to not move, or in other geosynchronous orbit types the satellite may be observed in approximately the same position at a given time of day, or may remain for extended periods in the same part of the sky. Typically this requires a lot of adjustments and can prove challenging to track precisely. Useful for GNSS augmentation services and communications satellites.
- **LEO** the now congested band between 160-200km. Manned spacecraft, the space station, and remote sensing satellites would be found in this range. Not very practical for ranging or wide area communications purposes.
- **HEO** Highly Elliptical Orbit. Through a clever trick of orbital dynamics, this 24-hour orbit with a low perigee and high apogee results in an elongated north-south figure-8. Sats can dwell for as long as 12 hours in the small loop of figure-8 at a high elevation overhead. Does not lend itself well to a stand-alone ranging service, but great for augmentation and timing services.

“Authorized” Services

The term “dual use” is typically used to describe a GNSS system that has both civilian and military elements (and of course funding). Where certain services would be military only, or services that may otherwise be restricted in some man-



China plans regional as well as full global GNSS service. Graphic courtesy of the China National Administration of GNSS Applications.



Mrs. Jun Lu of the China Satellite Navigation Center



Sat 4 went up in April 2007

ner (like the proposed for-fee services of some systems), the new warm and fuzzy term is now “authorized services”.

China

The Chinese delegation consisted of lower-ranking officials who essentially read the same information as on the Power Point slides, but as with past presentations, a bit more is revealed each time. The soft spoken Mrs. Jun Lu outlined the proposed 35-sat constellation: five GEOs for comms and augmentation, and a 30-sat MEO constellation that will provide global coverage for ranging purposes.


The first sats in the experimental, military driven program originally dubbed BeiDou (“Big Dipper”) went up beginning in 2000, with the latest of four in 2007. These first ones are GEO and are used for limited navigation (as they could not provide what would be characterized as full GPS style ranging positioning on their own), and for limited emergency communications in then form of short message service (SMS). The first need to fulfill was the public safety aspect of the system. This was demonstrated during the recent Sichuan quake in the deployment of 1,000 field units to emergency response teams that would provide not only position but also SMS reports to central coordinating centers. The next

phase is the MEO-ranging satellites, 10 to launch in the next two years.

How will this affect land surveyors in the U.S.? One can only speculate. Even if the launches were to continue on such an optimistic schedule (30 in six years? That would be ahead of Galileo, the upgrade of GLONASS, and the modernization of the U.S. system) there would be the unresolved issues of code and spectrum, and an uncertain schedule for the issuing of the Interface Control Document (ICD), which provides the manufacturers with the details they need adapt. The possibility of some possible for-fee services (which the Chinese presentation both seemed to brush off on one hand stating “free and open”, but hinted to authorized services, possibly commercial on the other). Hopefully there is a clarification by the next round of conferences.

While many of the examples given as drivers for development of Compass and practical uses thereof were decidedly lower-precision (*e.g.*, tracking of more than 100,000 fishing fleet vessels and emergency response needs), I did ask the Chinese delegation offline if high precision was a substantial driver. The response cited construction support needs for high precision and that land surveying is mainly viewed as support for construction.

Part 2 Online

Part 2 of this article is available in the Exclusive Online-only Content section of amerisurv.com. In Part 2 you’ll see what the Americans, Russians, Indians, Europeans, and Japanese had to say, plus some perspectives from other GNSS user segments and science folks and how they fit into the picture. Also, oil, earthquakes, consumer GPS, flight paths, big-business-with-lobbyists, and the Nigerians. 

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