Industry Perspectives on IGS Collaboration, Impact and influence – Past, Present and Future.

Gordon T. Johnston MRICS, FRIN
United Kingdom
(gordon.johnston1@orange.net)

1. Abstract

This paper focuses upon the influence the IGS has had on industry over the past 10-year period and the next 10 years. It felt odd to be asked to contribute to such a knowledgeable and able group but also quite a challenge to try and envisage what the future may appear like. By reviewing and examining the various achievements the future is considered. The future, that is, of the IGS, as seen by an observer from Industry. In the ever-changing world it is impossible to clearly predict the situation in 10 years time, but it is fun to put some ideas and concepts forward. The views in this paper are those of a relative outsider, to the community that the IGS represents, and so the perspectives offered are not necessarily going to be accepted in the same way, but of course everybody has their own life history and experiences that create, for them, an individual model of their world. The intention of this paper is to raise the awareness of various components that make the world of the IGS so interesting and challenging.

2. Introduction

The announcement that the IGS was to celebrate its 10th anniversary in March 2004 came as a surprise as it seems only recently that the strategic review was being undertaken. Having been associated with GPS and satellite positioning for over 17 years, it seams that the IGS has been around since the early days of GPS. How easy it is to forget having to contact VLBI and SLR sites around the globe to gain access to zero order control for our ambitious real time Differential GPS plans. Time has passed really quickly and it's amazing to consider what the IGS has achieved in its first ten years. My perspective is very much that of a professional surveyor who both uses the products and data from the IGS but is also involved in the delivery of a commercial DGPS service within the Offshore and Marine Survey Industry sector. In this context this paper must therefore not be a technical one.

It is relatively straightforward to review the past and offer a brief series of examples that provide an impression of how the period has enabled Industry and Academic communities to work and develop successful programmes. It is only fair to also consider if perhaps there are aspects to the activity that have not generated success, at least on a relative basis. Many events occur, not due to planning and effort, but due to external factors and these, I believe, have created a huge impact on how the IGS has managed to influence and work with Industry.

The current situation is one that should need little explanation although the Industry perspective offered here may differ from the viewpoint of a more "internal" IGS observer. How we see ourselves and how others see us is one of the great themes explored by many great philosophers and minds over the centuries. Indeed the term "exploring" is quite apt as there is no real absolute, but many variations, of the perspective each of us develops from our experiences and interpretation of events. The final element of this short paper considers the future and how the interaction of the IGS with Industry may continue. The prediction of future events is not too easy so I make no apologies for a personal and perhaps quite narrow focus on the activities and how these could play out over the next 10 years.

3. The Past

The initial effort by the IGS to deliver a word wide tracking capability developed very quickly and was conceived with a quite brilliant federated approach. As time has passed by the multiple agencies and organisations involved have remained in a competitive and dynamic state to ensure the fabric of the IGS remains intact if not entirely secure in terms of it's financing. Industry appears to have largely ignored the calls and requests generated by the IGS and set about it's own programme of geodetic campaigns and networks without a clear statement of intent and therefore opportunity for collaboration with the IGS. On the face of it this was commercial sensitivity however there was also a general lack of awareness of what the IGS stood for and could contribute to the process. Many experiences of Industry considered that the individual mapping and geodetic institutes offered the real geodetic answers and resources. The IGS was something that initially lacked an identity and applied the data in another direction for later access if required.

The 1990's saw various technological advances and four in particular, I believe, enabled the IGS and Industry to move forward. Although in 1989, the IAG meeting in Edinburgh announced for the first time, at least for some of the Industry people, that the concept of long range, international geodetic campaigns could be carried out with fiducial sites acting as control for a homogenous framework. The significance use of dual frequency GPS observations would become apparent thereafter. A key enabling capability for the DGPS service providers in the marine Industry and latterly for the high accuracy services.

The development of the Internet is one of the key components to the success of many of today's ventures. Without the access to vast quantities of data using desk top, everyday technology, the GPS infrastructure, we have often come to rely on, could have remained in a very virtual and specialised world of IT and data analysis.

The 1990's also experienced one of the more significant changes in policy for the US control of GPS and as a result in 2000, President Bill Clinton approved the removal of the man-made Selective Availability (SA) thus releasing lots of developers to explore new ways of generating positioning and RF solutions. As a consequence the acceptance that real time high accuracy solutions for land as well as offshore users could be provided and the general awareness of the capability of GPS was further promoted.

The final technical advance that should be given credit is the European GNSS Galileo adventure. Although not here yet, and may arguably not represent a huge technical advance for many users, Galileo has created a hugely competitive atmosphere between many groups.

It appears obvious with hindsight that the IGS did not target Industry, but chose to concentrate upon the GPS activities within academia and governmental bodies. This was the right approach as it enabled the IGS to develop and create standard technical parameters for the various products and services. As a consequence however, Industry established only a small demand for the supply data and products. This use, when needed, would not have sustained the IGS even if the sales and marketing departments had established what the potential cost saving was. As an example take a geodetic campaign, visiting several VLBI and SLR sites in Europe. In each case we had to contact and agree dates and visiting rights with the owners, establish the correct co-ordinate reference frames for the individual specific marker we set up over and supply all the equipment, personnel and travelling and accommodation costs in order to obtain our 4 or 5 days of data. Thus the process could cost an estimated $6-10000 per site visit.

The impact of the IGS and the associated developments mentioned above have resulted in huge progress by Industry, not simply in alternative sources for cheaper data sets, but in providing positioning, navigation and location based solutions and services. Of significance for Industry was the ability to develop regional augmentation systems on the basis of precise international reference frameworks. The IGS created a market for high precision products and the reliance upon such products and the service associated with it increased.

Various sectors of Industry achieved many things with the use of GPS. In particular the timing provided the telecommunications Industry with new capability, transport and navigation was revolutionised and the meteorological community came to adopt GPS observations for their own uses. The overall impression is that a series of data products and services became useful to Industry through their specific technical needs and academic interest. At best a few interactions took place, more commonly Industry simply used what was available but really any true collaboration was rare. The IGS created for itself a market primarily within the academic community and as the general outreach made possible by technology continued so Industry accessed and used various elements. Despite the complete lack of commercial input form Industry the IGS survived and this is a tribute to the Board and very dedicated personnel who managed to maintain the momentum of the early years. The IGS demonstrated that the deliverables being produced were sustainable and this is what impacted most on Industry.

The success of these initiatives is such that local mapping agencies and other groups are now trying to offer a similar local service. For Industry the opportunities to develop new hardware products and systems and the increase in the acceptance of high accuracy solutions owe a debt to the IGS.

4. The Present

To review the current situation the approach in this paper is examine what current activities and initiatives of Industry are significant and dependant upon the existence of the IGS. This is not so easy as it could be argued that the influence or impact of the IGS on various Industry activities may not be significant. Nevertheless from a relatively narrow perspective a number of elements emerge. Other elements can be developed through considering a wider picture.

The current offshore and marine positioning market is developing Real Time High Accuracy solutions using Global Error Modelling (Wide Area) techniques. Whilst satellite based delivery of Differential corrections has been around for over 13 years the adoption of a truly global Wide Area system has only recently been adopted and introduced to commercial service. The delivery of Real Time services is a growth Industry at present.

Associated with the greater expectation of high accuracy and ever decreasing residuals and errors, a number of Clients have recognised the importance of the IGS and it's members. Consequently Industry often has to deal with specifications that require such processing packages as Bernese or similar. This increased acceptance and reliance upon what are essentially ingredients of the IGS and it's members creating an interesting situation where the traditional academic remit to serve science comes directly into contact with the need of Industry to serve Clients and, of course generate revenue. In the end to serve the academic institutions some funding needs to be identified. Whether the benefits are direct sponsorship or income or more indirect research grants and donations may not in the end be too critical.

Currently there are few true bilateral agreements in place between IGS members and Industry. Whilst these may actually be common for some of the larger organisations with government funds what is becoming significant is that the desire for the agreement is increasingly due to the elements identified

with the association of the IGS. With agreements to supply and offer solutions based upon a collaboration of academic and Industry, the IGS member is thus managing to derive benefit, either from direct revenue, professional research programmes or papers. It also brings much needed stability to the funding situation. One such example of this is the real time offshore platform subsidence monitoring. In this example the Academic group do not wish to carry extensive insurance and liability for data processing nor be held to operational requirements for going offshore. The Industry partner however does not have the latest GPS knowledge nor does it wish to if available elsewhere. Consequently a firm "win win" is created to deliver the latest technology to a Client.

It's worth at this stage to review the current expectations and requirements that Industry now expects when GPS and GNSS are involved. In the business sector of the Offshore Survey Industry a number of companies use GPS as the basis for their undersea engineering and route surveys as well as for hazard avoidance and safe navigation. The requirements for such groups can very enormously from project to project however currently the emphasis is on the following:

Deep Sea Survey Requirements for AUV's

- **Rapid Initialisation and re-acquisition for alignment, attitude as well as 3D/4D position.**
- **Repeatable accuracy annually of 1-5mm over 5-10+ years**
- **Availability – E.g. when an underwater vehicle such as an AUV surfaces (see figure).**
- **Relevant Integrity, Reliability and Continuity of Service parameters – Through QC.**
- **A full Customer Service and Support facility, globally.**
- **Dual installation and/or a Secondary (with redundancy) System.**

Figure 1. During the AUV deployment the GPS is often used for the initialisation of It's 3D position and precise attitude. (Picture courtesy of Subsea 7).

Overall the level of real collaboration and co-operation between Industry and the IGS members is relatively small. It is increasing slowly, but is an area of limited opportunity due, in part, to the need for specialised knowledge and specialised requirements by Industry that often limit mass appeal. From the Industry perspective there are many ways to analyse and interpret what the IGS has achieved and how it may be viewed.

In Figure 2 the concept of a value chain has been introduced to show where Industry considers the IGS lie in the overall matrix of GPS data products and services. Note that this is a very simplified assessment and a whole new paper could be written on the methods and analysis of such value chains as well as their content discussed.

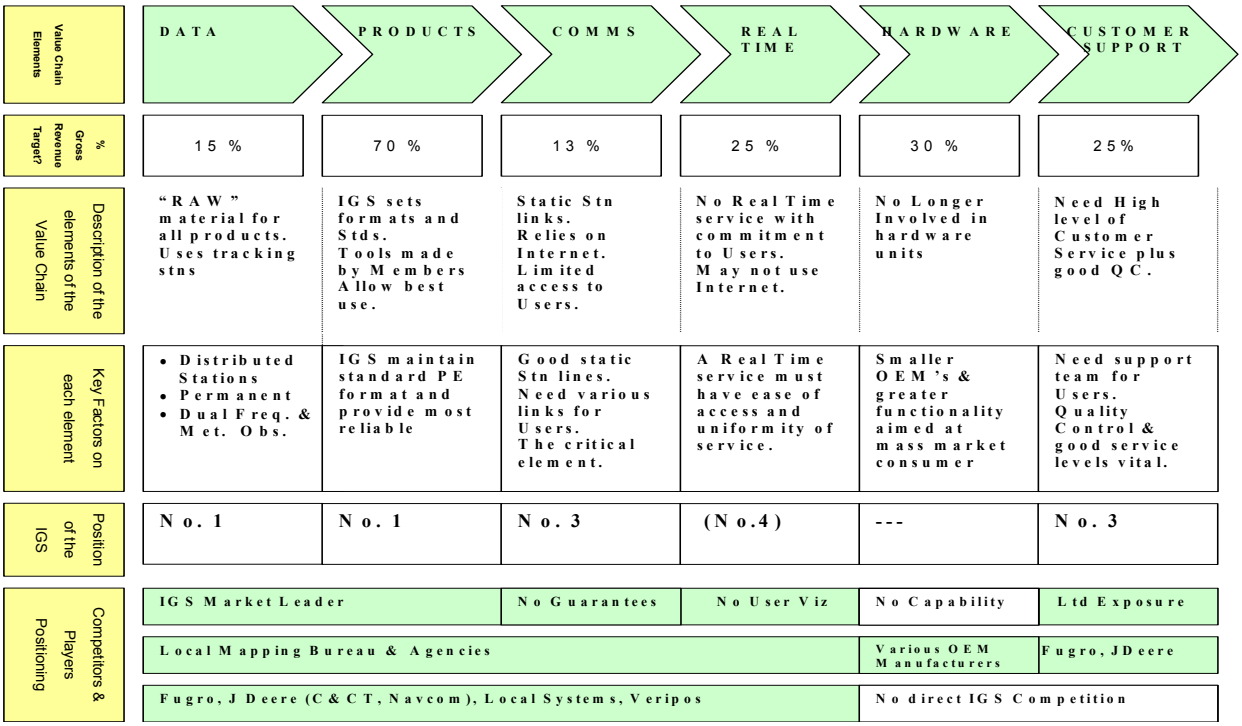

Figure 2. A Value Chain for the IGS.

In Figure 2 the Value Chain illustrates the various products and services of the IGS and how these may be interpreted in their overall context of a commercial and local government populated sector. On the top row is a series of arrows showing the progress made by the "raw" material in this case dual frequency GPS data. As each step is taken, in theory, some value is added to the element. So when step two is reached the data has been processed and formed into Precise Ephemeris or Orbit files thus adding value.

On the second row is the estimated revenue or margin an operator might wish to try and achieve with the activity in the column. Note: accurate figures for such activities are closely protected by companies and so these are example figures and do NOT reflect any current systems. Many factors can influence these numbers such as User numbers, timescales, asset liabilities, processing costs and complexity. Given that for the data and products there is no real commercial equivalent the revenue is just for completeness.

The 3rd row describes the key elements to that step and the 4th row outlines the positive components. In row 5, the position that the IGS is regarded as having in that particular activity is shown. So for data and products the IGS stands first but lacks real time infrastructure and customer interface to archive top marks in the later steps. Remember this is the perspective of Industry and not that of an IGS Member!
The remaining rows offer some comments on competitors and other service providers in the sector of providing real time positioning solutions.

How should the IGS view such a table and what does it offer in terms of forward progress for the IGS? The original title of the paper was very much one that seemed to balance the past, present and future but it's often more interesting and not easy to be proven wrong, at least initially, to speculate on the future. However, before contemplating the future, it is worth re-iterating that the current success of the IGS is due to it's excellent reputation gained through an uncompromising approach to delivering data and products that are the de facto standards within the Geosciences community. Not only is the IGS very successful, at the areas in which it has concentrated its efforts, but it has also proven to many during these 10 years that the process is sustainable.

At present a tremendous amount has been achieved and yet much of how the IGS obtains it's funding and financing remains precarious. It is certainly not an open demonstration of sustainable investment. Over the years the Bureau has developed and maintained a huge following and this despite annual threats on their income and an increasing demand for global representation and visibility. Today the IGS is a very strong community of federated organisations that generally compliment each other and provide great support to the efforts of the Central Bureau. Was it otherwise, I wonder if the IGS would have lasted this long?

The subject of funding cannot be answered in the present time, as there appears to be a continuing stationary situation between the organisations with funds, the IGS in the middle and the end Users. Some organisations are on both sides of the funding equation; others are not and so may lose out. After 10 years the situation is not ideal and must be addressed going forward for the future. From the Industry perspective it appears quite fragile and yet the situation probably has many parameters causing ebbs and flows in the balance. A different sort of earth tide really, where the effects are always present but only severe if you don't take account of them.

The long-term future of the IGS and its survival will depend upon stable funding and concentration on a set of the elements included in the Value Chain.

5 The Future

In setting out to look into the future and feel a way through possible scenarios, it is necessary to also take account of the experiences to date. History, we are told, is a window on the past, but it also often helps us to understand and develop in the future. Certainly the current trend of Users wishing to adopt real time solutions will vastly reduce, if not completely replace the need for certain categories of data and product uses. In reality a complete withdrawal of such services is unlikely to occur as the naturally conservative surveying and Geosciences Users are unlikely to let go of their traditional and time-honoured methods, at least not without encouragement. Will the IGS provide that encouragement and influence and if so in what form? Use of the data and products will also be reduced due to a more critical User demanding ever more QC parameters within files and independent QC. This coupled with the growth in the real time systems could threaten the IGS, as alternative sources of products will appear, either from local departments, government mapping agencies or commercial organisations. This competitive trend of multiple sources will be dependant upon whether the IGS, currently hugely influential, adopts primarily a Scientific role or a Commercial role. Can it fill both roles?

Let us review what history can show us with a couple of Case Studies.

Case Study 1: Reference Station Selection Criteria. In the late 1990's the Ionosphere was causing many Users difficulty. In particular areas close to the geo-magnetic equator would often experience scintillation effects causing loss of GPS tracking. Industry tackled this by adding more augmentation systems, using dual frequency receivers and adding GLONASS to the mix. However the "hot Spots" often were in remote areas and not well served with tracking stations. Since the left hand map from 1998, the IGS has almost doubled the tracking stations but not the coverage in the affected areas. With time coming for the solar maximum again what exactly is the IGS strategy for introducing more Tracking Sites? All potential sites must be assessed and reviewed in order to ensure a cost effective infrastructure for the data and products being generated in the future.

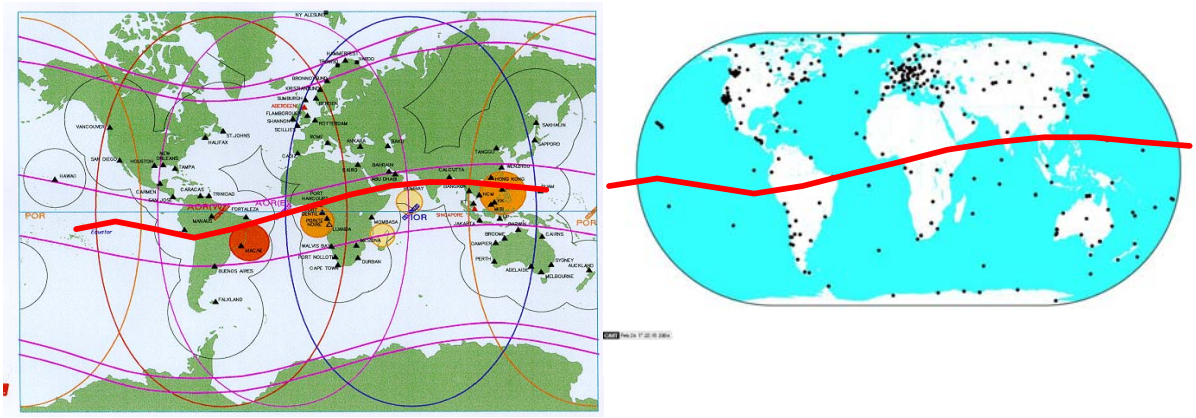

Fig. 3: 1998 Fig.3: 2003

Figure 3. The 1998 map on the left shows "hot spots" of Ionospheric interference and scintillation. The 2003 IGS map of Tracking Stations although now numbering many more appears to still have large areas within the geo-magnetic region still to be adequately covered.

Do the benefits of such an enormous infrastructure outweigh the costs and can the IGS sustain such a system? It is vital to preserve the quality and reliability but the Tropics need more sites and then what will be the influence of Galileo on sites the require equipment upgrades? This is not the first time that a new GNSS has been introduced to the IGS.

Case Study 2: GLONASS. The introduction of GLONASS observations was interesting and offered some opportunity to expand satellite based positioning activity, especially near the poles. The IGS very much helped to get GLONASS recognised and included on various campaigns causing groups to expand their interests and accept additional observation sets. However for Industry, GLONASS often represented a complication both with Time and Geodesy and other on very specific projects the value of its inclusion was not understood or realised.

What can we take from these two case studies? Firstly that Industry has a need and if the IGS has other priorities in developing it's Tracking Sites then a possible collaboration between both parties could offer a "win win" situation. More sites and better coverage for all. Collaboration with Industry should not be seen as a great betrayal of Scientific honour but a pragmatic acceptance that both can and must co-exist for future survival. As Industry develops new and more accurate, Real-Time, long-range decimetre accurate systems, coupled with general data capacity capability, the demand for real time services will increase. The price that the Customer is prepared to pay will not rise. Good Customer Service levels must also be provided and for the IGS to compete in this area, investment will be required but perhaps a

greater price to be paid will be the need to hold formal contracts. Without that crucial element, many Industry Customers will avoid depending upon the IGS and opt for an alternative because of the liabilities and commitment.

6 Conclusion

The IGS has a clear role to continue to monitor & update the reference co-ordinates and to aid research on the atmosphere. To avoid the arrival of a competitor for it's various data sets and products it should look at two possible sources of security. Firstly it must review and again consider it's ownership and how it reports into the rest of the world. As a United Nations organisation it could be adversely affected by administration. Better to feed up into an umbrella organisation such as the World Meteorological Organisation, or another with direct UN authority.

The introduction of the new Galileo system will impact the IGS by creating a possible competitor, especially in the Real Time activities and if the IGS continues without a clear strategy and an ability to hold formal service level contracts. By collaboration with Industry, some duplication could be avoided, new reference Sites could get supported and the core academic research could continue. Of course Galileo would also have to be a collaborator.

The IGS is a supplier of robust data products and is respected globally. The above potential threats and opportunities can be mitigated by careful planning and management and, with some limited developments, the IGS can remove most of the pressure to compete. A clear area that the IGS can enhance it's influence and authority is in Training. The User community needs a "one stop shop" for all manners of GPS, geodetic, satellite and related information. The IGS can provide this by developing a single point of contact for the Geosciences User community.