BIG DATA, Bigger opportunity

IT'S AN UNDENIABLE FACT THAT DATA FORMS THE BASIS FOR GEOSPATIAL INDUSTRY. WITH TECHNOLOGICAL ADVANCES IN THE COLLECTION, DISTRIBUTION, MANAGEMENT AND ACCESS OF DATA, THERE IS AN EXPONENTIAL INCREASE IN THE AMOUNT OF GEOSPATIAL INFORMATION AVAILABLE. HERE'S A COMPREHENSIVE ANALYSIS OF HOW GEOSPATIAL DATA IS DRIVING SOFTWARE AND SERVICES MARKET.

According to Daratech report for the period of 2004-2010, the overall growth of geospatial industry was 11% with a significant slowdown in 2009. However, the report suggested that the industry bounced back in 2010 registering a robust 10.3% growth. But perhaps of more significance, as the statistics from Daratech illustrate (Figure 1), is that the growth of geospatial data is outpacing both software and services and is definitely becoming a major contributor to the overall growth of the industry.

Central to this growth has been the change in the availability of geospatial data. As Daratech CEO Charles Foundyller reports, “GIS data is today the fastest growing segment of GIS/geospatial business. It has grown at a...
compound annual rate of 15.5 percent in the last eight years - about twice the rate of growth for software and services. GIS data is to GIS/geospatial applications what software is to computers. Consequently, as more location-related data becomes available, the use and scope of geospatial analysis is sure to grow dramatically.

For the purposes of this article, geospatial data and content are referring to any geo-referenced information. There are various types of spatial data - maps (raster and vector), imagery, derived data, publicly crowd sourced data, open sourced data, tagged data, temporal, metadata, classified, non classified, video, sensors, etc. As more and more geospatial data becomes available to more than the typical geospatial professional, it is finding its place within the larger community of published content. Geospatial data is evolving from data to what most people refer to as content which by definition is more about the logical organisation and improved accessibility of various types of structured and unstructured electronic information. There are a couple of elements that makes our industry very unique. One is geospatial data or geospatial referenced content and the other comprises the theories and algorithms inherent in extracting, managing, processing, analysing and visualising spatial data. The spatial analysis segment of our industry has been core to the definition of our industry and has supported solid historical growth.

HISTORICAL PERSPECTIVE

The origin and definition of ‘geospatial data’ can be attributed to the automation of paper maps. Initial attempts of ‘gridding’ maps and key coding in attributes can be traced back to Harvard University. Prof Howard Taylor Fisher developed the synegraphic mapping system (SYMAP) in the mid 1960s. Although the ‘cartographic’ ties to the paper maps were very crude - let alone the ‘ties’ to the actual earth surface - the concept of computerising paper maps into layers of information was a reality and there was no looking back. However, Prof Fisher’s emphasis was more on creating statistical maps than data automation. The crude data automating techniques continued until the computer technology display devices could support graphics and that was the point when automating existing paper maps took a major leap forward. This ability to actually see maps on a computer screen forced the development of better map automation software and created a market for colour terminals, digitisers and plotters. Table digitisers required X and Y coordinates and this drove computer mapping software to deal with issues that had never been important before, like cartographic projections, map scales and map accuracies. This in turn created a need to create new GIS software that could manage different data types. This was the stepping stone for the evolution of what we call GIS today. The initial growth of GIS in North America and Western Europe and now in many parts of the world was driven by national governments to build geospatial datasets. This support later included funding for the acquisition of geospatial systems within states and provinces as well as at the local government level. This availability of funding created the demand for geospatial systems and services and that in turn created an industry. Initially, data was of

![Figure 1](image1.png)

![Figure 2](image2.png)
low-accuracy, production involved many months and involved high costs but today, technology is enabling the production of high-accuracy data at a much cheaper cost. The expansion and growth of the industry in recent times is more a direct result of accurate and timely data. This is not to say that static geospatial data does not have a role in supporting the growth in the industry.

But as Figure 2 illustrates, with increasing accuracy and decreasing delivery times, the number of possible users for data increases. Advanced data collection technologies are giving considerable momentum to the growth of geospatial industry.

**LATEST DATA TECHNOLOGY**

There are many advances in technologies that make a huge difference in the availability and cost of geospatial data and they all have one thing in common - they record 'everything in their way'. These include technologies and delivery platforms like LiDAR, digital video, multi-spectral and hyperspectral sensors (for more details, refer Hyper-spectral Imaging: Beyond the Niche, Geospatial World, March 2011) and real-time sensors on farm and construction implements. These technologies can be delivered by both airborne and terrestrial technology. Here are a few technologies that are evolving into multipurpose data collection platforms.

**Terrestrial LiDAR and video imagery**

An example of this technology is being deployed in rural areas of the United States by GeoNav, Inc. This system essentially is a terrestrial LiDAR with a 360-degree digital video mounted on a standard pickup truck. The vehicle is driven on roads while the LiDAR and digital video captures 'everything in its path' (Figure 3).

An inherent advantage of combining LiDAR with digital video imagery is that it allows the customers to load both LiDAR and imagery into a GIS system and do inventories, maintain and manage assets from their office. The real advantage of these technologies is that multipurpose data is being collected simultaneously which has different horizontal applications. “In the past, GIS users saw only what they wanted to see by loading vector data and aerials. This birds-eye viewpoint excludes valuable information that can hinder quality decision making. The new data uncovers obstacles that previously were hidden by either a lack of data, poor data, or by obstructions like trees,” says Jason Hooten, Director of Sales & Marketing, GeoNav Group.

This combination of techniques removes most of the issues associated with standard LiDAR. “Every day we find new and interesting ways to utilise spherical imagery and LiDAR data. It truly is the Swiss Army Knife of the GIS world,” opines Casey Saxton, Chief Technical Officer, GeoNav Group. Terrestrial LiDAR is obviously not the only source of LiDAR. Airborne LiDAR has been around for many years and has become quite popular in the last five years. Similar to terrestrial LiDAR, airborne LiDAR com-
bined with aerial or satellite imagery provides information to a wider audience.

**Advanced satellite and aerial imaging**

Another interesting technology is satellite and aerial based imagery. As with LiDAR platforms, the advantage of this technology is that these platforms sweep across the sky recording everything in their path. Satellite imagery is not new by any means, but as sensors get more accurate and capture more data, more applicable data becomes available to multiple users.

The addition of more bands provides more information that can be classified into valuable content for different applications, such as determining the amount of damage after a hurricane. Because multispectral and hyperspectral sensors collect all of the bands at once and the data is spatially and time co-registered, the user has access to a robust quantity of valuable information for the same spatial area at the exact same time increment.

There are many creative applications being developed using satellite imagery. One interesting example is the product by Spot Corporation called SPOTMonitoring. This product addresses the challenge of getting the imagery and information of a smaller geographic area, an issue many satellite imagery users face. SPOTMonitoring allows the user to identify a geographic area, monitors that area and provides products specifically for that geographic area including raw imagery and change detection products. This type of service has the potential to open up new markets to users who do not have the technology or IT personnel to build an in-house solution.

The number of new satellites is increasing every year, as Prof Ian Dowman reported in the January 2011 issue of *Geospatial World* in the article titled, *Remote Sensing: Bustling with activity*. The 8-band DG imagery is just an example of all the new content that will be available from these constellations of satellites. As Prof Dowman notes, these earth observation satellites will continue to implement better spectral and spatial resolution capabilities. He also notes that radar development will continue and become a vital part of the geospatial content in the future. Programmes such as the cooperative effort between Digital Globe and Microsoft to build a nationwide coverage with aerial imagery will also provide vast amounts of additional higher resolutions content and a unique up-to-date commercial imagery database.

**CONTENT DRIVING SOFTWARE AND TECHNOLOGY**

One of the results of newer content collection technologies is what Joel Campbell, President of ERDAS, calls “the deluge of data”. In other words, the advent of massive amounts of new content creates challenges for both the technology companies and the consumers. For example, each mile of road driven with terrestrial LiDAR and digital video can produce terabytes of data. This large content output must be managed, processed, stored and displayed, all of which requires different technologies.

A critical aspect of this vast amount of content is that
it is often more accurate than most of the existing content. Geospatial analysis has always approached the development of geospatial databases with a layered approach. The idea was to divide the existing maps into data layers so that the information could be more easily managed allowing to better interpret the spatial relationship between the features and layers on the map and/or the earth’s surface. This situation has occurred due to the ‘stovepipe’ data acquisition process. Each of the layers of GIS data was collected separately and with varying degrees of spatial accuracy and attribution. However, in more recent times, the concepts of object oriented databases have been implemented.

The availability of more accurate content is definitely driving the GIS software companies to provide tools and methods for their users to incorporate this new content into legacy geospatial databases. For example, local governments in North America are incorporating higher accuracy content to update their existing ownership maps. One challenge geospatial industry has been addressing for years is to integrate new and better content with existing geospatial datasets that are older, less detailed and in some cases, much less accurate. The existing ownership maps have been cobbled together over time using many disparate data sources and processes. The incorporation of more accurate ownership boundaries creates many political and legal concerns surrounding actual boundaries and tax records. These include issues around legal rights of way, easements, etc. As Sam Wear, Assistant CIO for Westchester, NY, USA states, “All this new content is very valuable, but local government GIS managers walk a fine line as to how these new data sources can be integrated with our enterprise geospatial data warehouses, particularly in context that most local GIS programmes have been built on top of large scale, high-accuracy base maps.” Whether new or old, less accurate or more, spatial data is driving the geospatial industry to address these challenges.

This new geospatial content is also driving technology development in the area of ‘automated feature extraction’. Techniques like LiDAR and high definition satellite and aerial imagery data illustrate the need for automated feature extraction. The raw content is useful in and of itself, but as more content becomes available, the demand for better automated feature extraction technologies will grow. In order to support new concepts like Data as a Service (DaaS), industry must provide ready-to-use datasets to the consumer. Most users really don’t want raw LiDAR content; they want a specific, derived dataset such as telephone poles or vegetation encroachment with all the associated measurements compatible with their existing GIS system. They are essentially looking for the GIS version of ‘plug and play’.

Readily available geospatial content is also driving government organisations to innovate ways to deliver this content to their users. Dean Anderson of Polk County, Orlando, USA explains their use of Web services to gain access to diverse content by allowing their users the ability to link to more current content provided by private companies such as Google: “We give public access to a couple of Google apps online through our Web mapping system. We have links to Street View from Google through our system.” The availability of geospatial content and the technologies to integrate various in-house and external content sources is allowing governmental agencies the ability to reach more users and in turn create a demand for more geospatial services.

The growing enthusiasm for open source development is directly related to having current and accessible geospatial content. Open source applications are playing an increasing role in expanding the geospatial market - making content and applications more accessible. On the application front, Openstreetmap is growing in popularity. There are many challenges related to allowing multiple sources the ability to edit and add information to a common base map, but Openstreetmap and the concept of crowdsourcing is in fact great example of the role of new and more current geospatial content driving new applications and reaching new users in ways not thought of...
decades ago. The applicability of this concept is endless and collecting real-time geospatial content on an open-source map has applications in many areas including road maintenance. One only has to do an internet search to see the vast amount of content, services and applications that are now spatially enabled. One example of crowdsourcing is illustrated by the growing flood of user-uploaded, georeferenced travel photographs found in applications of Google. The ‘crowd’ is providing the content piggybacked on a geospatial commercial application making it possible, for example, to ‘visit’ a location for a planned vacation anywhere in the world through spatially enabled photographs. One very interesting example of using near real-time geospatial content combined with Openstreetmap is being done by Staircase 3, a company focussed on developing accurate mobile cell signal strength maps in the United States. Charlie White in an article on Mashable.com writes, “If Staircase 3 could combine its data-driven approach with user generated cellphone signals of a site such as SignalMap, this could be a comprehensive crowdsourced signal strength measurement device. Finally, we’d have a source of real-world information to counteract the questionable maps we see from wireless providers.”

There are many other examples of how this more detailed and more spatially accurate content is driving geospatial industry. This includes content management, 3D visualisation and cloud computing. For example, creating surface terrain models or digital terrain models was difficult and expensive but techniques like LiDAR have significantly brought down the costs, especially in larger scale geospatial studies or smaller highly accurate projects.

**CONTENT DRIVING GEOSPATIAL MARKET**

### i. From planning to operational

Historically, applications based on geospatial content focussed on planning and general studies. But for more operational applications, most of the content still needed costly field verification and was not appropriate for enterprise implementation. For most businesses that provide goods and services, the RoI comes from the efficiencies inherent in the day-to-day operations that are the true cost of doing business.

The availability of better and less expensive geospatial content is allowing organisations to innovate ways to reduce costs while providing more and better products and services. For example, in utility industry, there are opportunities for layering and visualising real time business data using customer specific infrastructure maps. These opportunities have existed since most infrastructure maps were automated, but accurate business data visualised on not-so-accurate infrastructure maps or infrastructure maps not suitable for operational applications has always been grounds for limited satisfaction,
functionality and adoption. This has also been true for other growing markets including insurance, banking and telecommunications.

Finally, we have seen a jump in enterprise licensing by geospatial companies in particular Esri, Google, Microsoft, Erdas and others. The geospatial industry, like the database industry, found that once their databases became relevant to many users within an organisation, they needed an efficient way to provide access to this content throughout the organisation. These enterprise licenses are key to the continued growth and expansion of geospatial service to new users. A secondary effect of these enterprise licenses is that most companies and governmental organisations are able to shift the cost of geospatial content and software/applications into the operational budget instead of the capital budget. This trend has a major impact in the percolation of geospatial applications throughout government and industry. Geospatial centres within an organisation no longer have to apply for yearly or multi-year capital expenditures to support or grow their activities. It is now an expense of running the organisation. This paradigm shift and its relationship to expanding the GIS industry have been well understood by Esri for many years and this focus has been key to their dominance worldwide. This trend has also impacted the acquisition of geospatial data; many organisations are viewing the timely collection of geospatial information as an on-going expense, vital to their operations.

Similar in concept to enterprise software licensing is enterprise data licensing. Companies like Pictometry, NavTeq, Tele Atlas and others have creatively implemented data licensing and annual renewal for their content. This licensing has had the same result of shifting the content cost within an organisation to operational budgets instead of capital budgets. This in turn has resulted in driving the growth of the geospatial business and making geospatial an accepted component of a successful business and organisation. Again, accurate and timely geospatial data is core to the success of this enterprise licensing. As Daratech puts it, "Without data, GIS/geospatial apps have nothing to tell us. Consequently, as more location-related data becomes available, the use and scope of geospatial analyses is sure to grow dramatically."

**ii. New markets**

More accurate and timely content is expanding the use of geospatial data within an industry such as agriculture. In the past, most geospatial data applications within agriculture involved large scale research and worldwide monitoring of crop yields, soil conditions, crop damage and inventories of crop production. As with other industries, the real acceptance of geospatial applications is directly related to addressing the day-to-day operational issues of agriculture. These day-to-day operations are being addressed by the introduction of higher level GPS, in-field sensors and monitors on the actual equipment and the acceptance of geospatial applications are causing rapid expansion.

The recent Colorado Farm Show, an annual US trade show that highlights advances in farm equipment, illustrated that most new farm equipment is equipped with sophisticated GPS, guidance systems and monitors for measuring field compaction and yields. Another indication of the growth of geospatial content in this market is reflected in a press release from Trimble, Inc dated Feb. 3, 2011 covering Fourth Quarter and Fiscal 2010 Results: "...Fourth quarter 2010 Field Solutions revenue was $74.8 million, up 31 percent as compared to the fourth quarter of 2009 primarily due to strong sales of agricultural products."

Geospatial content and revenue from applications are co-dependent and another trend seen in the last few years illustrates that non-traditional GIS companies are aggressively adopting geospatial content and applications to extend and grow their traditional markets. As Jack
Dangermond, President- Esri, points out in his interview in Geospatial World (January, 2011), "...we are seeing that happen in core companies like IBM, Microsoft, SAP and Oracle."

A statement by Louella Fernandes, Principal Analyst, Quocirca, taken from an article in IT-DIRECTOR.COM provides insight into the potential of geospatial content in business intelligence: “As much as 80% of an organisation’s data can be associated with a geographic location. When viewing this data on a map, as opposed to a spreadsheet, trends become easier to identify. The key to the power of geospatial-enabled applications is with data. For example, by adding demographic information to an organisation’s existing business data, maps become truly interactive through the capability for users to drill down to data associated with any given location. Such information is extremely valuable when, for example, planning new store locations.” The business intelligence market is also ripe for the implementation of cloud computing. This market in particular could take advantage of systems like Esri’s ArcGIS online mapping service combined with technologies such as those provided by Alteryx, including platform-as-a-service, or PaaS, that uses geospatial data for business intelligence. Geospatial content has been one of the major drivers behind the growth and popularity of location based services. One revealing example related to geomarketing is in a recent survey report published by Jiwire related to the use of mobile devices titled: Jiwire Mobile Audience Insight Report, Q4 2010. The report says that between Q1 and Q4 of 2010, there is 11% increase in users being more likely to engage with an ad that is relevant to their location.

Also, according to The Mobile Marketing Association (MMA), nearly half of those who noticed any ads while using location-based services took at least some action. This is a significantly higher rate than for those who noticed advertisements while sending/receiving text messages (37 percent) and almost twice the rate of those who saw an advertisement while browsing websites (28 percent).

These studies support the notion that location-based marketing services are real and will only continue to grow with better and more advanced mobile devices and geospatial content. This new market will drive the need for more up-to-date and accurate business, street and street level geospatial content.

CONCLUSION

Geospatial content is of course, only one aspect of the geospatial industry. It would be easy to argue that software and applications are as critical to our industry as the content. But one may observe that there are many mature GIS applications that are only limited by not having the ‘right’ geospatial content to address the requirements of existing and new markets. The movement of GIS technology to SaaS, PaaS or DaaS will only be popular or profitable if they have valuable geospatial content to serve. As the geospatial industry matures, the demand for better and more accurate geospatial content will grow and so will the overall industry. Regardless of the issues surrounding privacy and public good, it is clear that more accurate and timely content will drive more technology, applications, gain more users and expand our industry beyond anything people like Howard Fisher could have imagined.