Harnessing the Internet for geographic image applications

Jonathan Shears

That there is an increasing abundance of geo-spatial image data is self evident from the mass of companies offering ready processed imagery for your GIS – magazines and web sites are brimming with the latest high resolution coverages. Nobody it seems can do without it. Unlike Harry Potter, however, professional use of geographic imagery has been coming for some time, so why has the emergence taken so long? There are many reasons for this – such as cost, education and availability, but one of the barriers to full market penetration was simply a logistic one – how to deliver high resolution imagery or image based solutions to the users who might benefit from it. Although the other factors play a part, harnessing the Internet as an enabling technology for marketing, on-line sales and delivery of imagery and imagery based services is a significant one. This paper looks at some of the associated problems and investigates other technologies that might accelerate the professional use of geographic imagery.

Over supply?

There is more imagery, both satellite and aerial, being collected than ever before. Despite our inclement weather, the UK perversely has the most active number of aerial photographic flying programs in Europe, both mapping and survey companies embarking on small scale project based flying and ortho-image creation to digital imagery providers undertaking regional and national flying and mapping programs. The latter now also includes the Ordnance Survey as well, who as part of their DNF strategy, are developing a nation-wide image layer to complement the vector, raster graphics and DTM layers already base lined. A seamless colour mosaic of 300,000 images is envisaged to give their customers access to consistent digital imagery covering the whole country.

Professional use of imagery in the UK has pervaded GIS and is gaining popularity with CAD users too. Imagery will no doubt eventually be as widespread in its use as conventional mapping is today, from central government to small private organisations, through all market sectors. Although applications are predominantly geographic in nature, some like golf course maps for score cards are not, however they all take advantage of the rich 'content' contained within them compared to conventional maps. The consumer market is also being targeted, image portals are in abundance – no one it seems can ignore imagery!

Common economic principles dictate that as with any market in a state of over supply, prices will fall, evidenced even in the satellite imagery market with EOSAT's tumbling Landsat 7 prices. There is consequently a very cut throat market for high resolution imagery.

Virtually Connected: WWW

Suppliers of imagery and their users are rarely in the same department or even organisation. Whilst physically separated, everyone is virtually connected thanks to highly evolved communications like the Internet. Theoretically therefore, information exchange and on-line business transactions should flourish. But are we taking the Internet for granted?

The origins of the World Wide Web are in CERN, near Geneva. Between June and December 1980, Tim Berners-Lee wrote a notebook program, "Enquire-Within-Upon-Everything", which allowed links to be made between arbitrary nodes. Each node had a title, a type, and a list of bi-directional typed links. Now, more than 20 years after this humble beginning, the 'World Wide Web' is a household name. Despite the immense revolution it has caused, we should be aware that it has limitations and is not a panacea for all.

The World Wide Web is effectively a single amorphous network in which every terminal/node/computer on it can potentially communicate with every other one, to create a truly seamless and 'open' network not limited by distance or geographical location. For this to work, every terminal/node/computer has to use a common communication language or protocol. These protocols have evolved enormously since March 1989 when 'Hypertext' was first coined as a phrase and Tim Berners-Lee used the term "Worldwide Web" as a name for the first working system the following year.

HTML today is the *lingua franca* for publishing hypertext on the World Wide Web, and has been complemented by other 'mark up' languages since;

XML : Extensible mark up language which is a method for putting structured data into a text file,

GML : XML encoding for the transport and storage of geographic information

WML : Specifies the presentation of content for narrow band devices, like cell phones and pagers.

At the end of the day, the World Wide Web works - but can it deliver fast enough to support bandwidth hungry businesses using raster imagery? We have all used search engines and seen how they retrieve information from the other side of the world faster than a speeding bullet, but meta data is tiny compared to raster data. Consider that a single 1

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km^2 aerial photo, 24 bit colour at 12½ cm pixel resolution is 183 Mb, then data transmission become a major issue even over 100BaseT networks, never mind 56k modems for mobile platforms.

There are several solutions on both client side and server sides that can facilitate more efficient information exchange. A third option is to reduce the quantity that 'has' to be transmitted – an obvious operational work around is to install the base, bandwidth hungry data on the target device prior to going off-line and/or remote, requiring only smaller transfers of update data thereafter.

Client Side solutions

For a user with a small footprint hardware device – laptop or palmtop - the challenge is to access huge files without unacceptable time delays. This can be achieved using free plug-ins that can view compressed data formats. The viewers only cache imagery (or levels of imagery) locally and with compression ratios of 50:1 now eminently achievable for imagery, this goes some way to making file exchange possible. But let's face it, even a fifty times reduction in file size will still only make a minor dent in some operations, but it's a step in the right direction. For interactive 3D applications, VRML uses compression and so enables real time viewing of large 3D image databases remotely.

A more interesting trend is developing imaging plug-ins for clients to perform on-the-fly processing, thereby relieving the server of processing tasks and some of the traffic.

Such developments have already been developed by ERDAS and are used today by thousands of imaging professionals. A good example of 'real time' processing is geometric correction and re-projection. The server stores just raw image files, each of which has the necessary information stored in the header defining how the client software has to warp or re-project the image as it is displayed. This concept is already being extended to include mosaicing, image sub-setting to facilitate 'on demand' mapping of any area regardless of image coverage, scale or projection from a series of raw files held on the server.

Figure 1: Using VMRL viewers to navigate 3D image databases from a browser

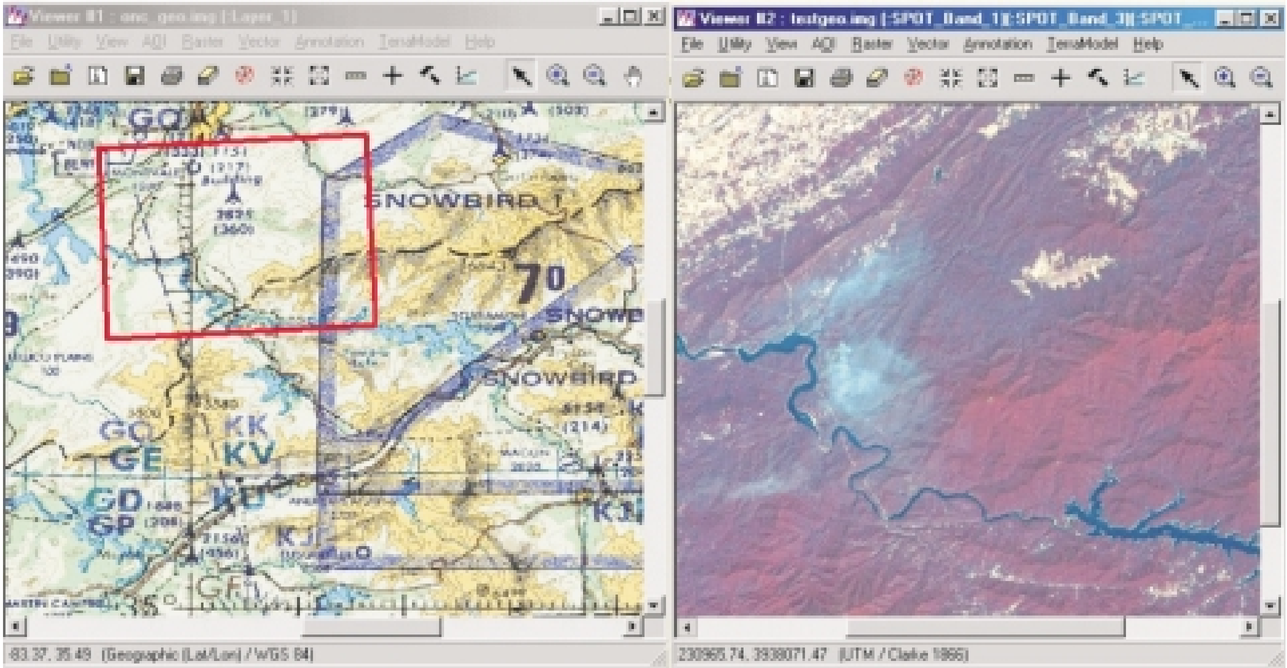

Figure 2: Client software that can locate and geo-link from different projections in real time (Image courtesy: ERDAS Inc)

Server side solutions

Apart from serving up compressed image products, be it wavelet compression for imagery, VRML or full motion video compression for AVI or MPEG movies, servers can also host the image application itself. This concept of DIY processing suits low frequency usage clients like farmers or re-insurance brokers, who effectively remotely use an application as if it were their own local licenced copy. Users pay for full access to internet-enabled versions of COTS software. Whilst these sites do function efficiently, this business model has yet to take off principally because the frequency and timing of imagery required by subscribers cannot be guaranteed. This is particularly the case in agriculture where guaranteed images at specific times during the growing season are critical.

Mobile solutions

At the end of the day, the customer is king. As the customer can always get a more powerful device, smaller and inevitably mobile, then wireless communications will prevail. Applications that can be used out of the office and even 'out of the pocket' (with PDA's), have enormous benefits for usability. Logging onto a stock control database from the middle of the warehouse floor, updating tree stand inventories from the middle of the woods or locating the position of an ambulance on an image backdrop heralds a new era for production efficiency and is the foundation for the decade's first IT buzz words 'Location Based Services' (LBS). LBS is about providing applications that use positioning information about the user, so the mobile device needs to be able to be able to locate itself. There are a number of different technologies for providing precise location, but none has so far proved cheap and reliable. This is despite the E911 initiative in the US to enforce automatic location identification to within 100 metres for emergency services. GPS positioning currently enables precise location-based services, such as in-car navigation, but GPS chips are not embedded as standard in mobile phones.

Figure 3: Streaming imagery to a wireless handheld device and using GPS for location is limited only by bandwidth (Image courtesy: Leica Geosystems)

Fortunately many location-based services work well enough with approximate location, such as Cell ID. For example, traffic reports, nearby hotels and restaurants, and automatic clock updates across time zones can all work without precise positioning. However, the network operators are keen to keep users' location information for their own exploitation, and considering the privacy concerns this might not be a bad thing.

Wireless or Useless?

A topical example of a location based application using imagery might be a forward air controller calling in an air strike by identifying his target from imagery immediately surrounding his current location derived from GPS and downloaded to his mobile PDA. For this, the communications backbone must not only support high bandwidth but it has to be wireless too for which there are several emerging technologies. These are Bluetooth wireless based consumer products, General Packet Radio Service (GPRS) and High Speed Circuit-Switched Data (HSCSD), all of which will increase wireless bandwidth to mobile devices. And let us not overlook GSM, on which GPRS is based and which will be around for some time to come.

Bluetooth, so called after Harald Bluetooth a Danish king whose skill in making people talk to each other, now immortalises current wireless technology. Bluetooth is a low-cost, low-power, short-range radio link for mobile devices and WAN/LAN access points. With a maximum capacity of 720 Kb/s per channel it is designed to replace local cables up to an effective range of up to 100m. As such it is not suited to the long range delivery of data that LBS and imagery applications demand.

General Packet Radio Service on the other hand is both extensive in coverage and wireless, extending the capabilities of the current GSM system that mobile phones and pagers are based on. Unlike GSM, GPRS is packet switched as opposed to circuit switched - it is always 'on' - like SMS or email where a circuit (as in caller to receiver and back again) does not have to be established before data can be transmitted. As a result of this, it is primarily for non-voice data. Despite claims that data rates may be three times faster than current fixed communications and 10 times faster than current wireless GSM (56k limit), realistic initial speeds are nearer 20 to 30 kbps. And 'often on' rather than 'always on' is nearer the mark too.

High Speed Circuit-Switched Data on the other hand is comparable to the speed of many computer modems. With HSCSD the wireless connection to the Internet is much faster at 28.8 kbps, which is up to four times faster than today's standard GSM. HSCSD is especially well suited for time sensitive, real-time services. Examples could be transferring of large files with specified quality of service such as video surveillance or vehicle tracking. Commercial HSCSD implementations are important steps towards 3rd generation wideband wireless multimedia services, although only one network has implemented it. '3G' wireless systems will allegedly handle services up to 384 kbps in wide area applications and up to 2 Mbps for indoor applications.

Where will it end?

So there is no doubt that the technology abounds. Unfortunately however the locating technology required in cellular networks on which LBS is based is as much of a hurdle as broadband wireless transmission speeds. Location solutions are still in the hands of the network operators and they are very reluctant to share that information with anyone else. Industry analyst Guy Beauchamp, concludes that "there are competing LBS systems with no standard and possibly the best that carriers can achieve consistently at present is merely Cell ID. Whilst GPS chips are getting smaller and cheaper, they are unlikely to achieve ubiquity in the short term" *(Cartezia, November 2001).*

If market expectations are to be believed, then the future is most certainly broadband wireless. An industry consultant Simon Buckingham, said that "by 2002 GPRS will be routinely incorporated into GSM mobile phones and will reach a critical mass equivalent to the status of SMS in 1999"(*Mobile Lifestreams Limited, January 2000).* Although perhaps a little optimistic, there are plenty of GPRS phones on the market today, but the technology will not likely achieve significant market penetration much before 2003.

Only time will tell whether Internet based technologies will develop at the pace, and with the success of, its current incarnation. There are several major hurdles to overcome such as if manufacturers of handheld devices will see the return on investment for developing compliant devices and if there will be sufficient applications wanting to use them.

Whether the utilisation of geographic imagery in LBS applications or value-add service delivery will be big enough to warrant the development alone is questionable. There are however other market areas unconnected with these that might provide the necessary leverage, such as the games industry and media, particularly journalism, where the market revenues and hence profits are much higher to create the necessary pull-through.

It is evident that wireless communication technologies today are rather limited for high speed transmission for image delivery, certainly for the next few years, but there are definitely promising signs ahead. So the future is bright, just not sure about the colour.