GEOINFORMATION REVOLUTION: RISE OF THE MOBILE SOCIETY

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Abstract

Geoinformation is intrinsically valuable and when used to enhance other information sources, it can significantly improve the quality of life. Surprisingly, the intrinsic value of geoinformation has been traditionally exploited mainly at government and enterprise levels. Beyond the prevailing traditional market, there exist an enormous market opportunity for geoinformation use by the mass market. The mobile mass market is the private consumers who fully expect to have an instantaneous access to up-to-date, relevant geoinformation anytime and anywhere. The main reason behind this is; geoinformation can be used to enhance the quality of daily tasks of the mass consumer in a countless number of ways. Market research estimates that the overall traditional market for geoinformation is worth at least $5 billion today and over $50 billion annually after five years. Apart from the traditional market, the potential market for accessing geoinformation services from mobile devices is extremely large and the way mobile devices users can access that geoinformation is through applications running on their i-Phones, Android and Symbian-based devices. The estimated total market potential for geoinformation (the combination of the traditional earth observation market and the mobile applications market) is worth $17.5 billion today and is projected to be worth $61 billion in 2014. This paper will analyse data from reliable information and highlight studies which are carried out around the globe regarding the potential applications and the market value of geoinformation in the mobile mass market and also the link connecting the mass mobile society and geoinformation.

Keyword: *Geoinformation, Mobile society, Mobile mass-market, Location Based-Services, Mobile apps*

1 GEOINFORMATION

Geoinformation is defined as a set of information about a specific point on earth. It also can be defined as spatial information about features or attributes. The information about the point can be a set of existing information or, it can be in a specific required time or, it can be real-time figures. What is in common between these three types of geoinformation, all are intrinsically valuable to the intended users and when it is used to enhance other information sources, it will significantly improve the quality of life. In the internet age now, geoinformation will be a part of every living aspect in order to reach our goals for the day or for years to come. Surprisingly, as for today, the market for geoinformation is mainly driven by those who have an important need of national and business interest despite the fact that private or individual consumers are the one who are fully in need of the up-to-date geoinformation.

1.1 Sources of geoinformation

Data from land surveying has traditionally been the first layer of geoinformation by providing accurate maps and positioning. On-site survey producing topographic maps in multiple scales and from various sets of datum has been the base of every spin-off maps produced. Later, with the technological advancement of optical instruments combined with aerial capability, photogrammetry was born. Air borne images was considered a more established technique to require earth attributes information, having being used in reconnaissance and surveillance since World War I. Aerial image offers the opportunity of having the maps originally by the land surveyors to be cross-checked for consistency and updating purposes.

The utilization of space technology has truly revolutionized the way of getting data of the earth. Global Positioning System (GPS) provides accurate positioning of earth attributes by the will of the user. Developed by the United States Department of Defence (DOD) in early 1980's, the contribution has been enormous in the sense of positioning, navigation and timing. Positioning provided on ground in sub meter is a revelation to the location based enterprises and agencies dealing with environment and disaster management. Space technology again took a huge step ahead by introduction of earth observation satellites (and more generally known as remote sensing). Earth observation is the act of gathering information about the physical, chemical and biological systems. High resolution earth observation information can be used to monitor and assess the status of and changes in the natural and the built environment.

Above all, space-borne and air-borne data has made raw information more reliable, accurate and timely to the recipients. Furthermore with these new age data sources, the raw information of geoinformation is made more visually attractive and more understandable to the mass market.

1.2 The Integrator and dissemination

In order for the information to be meaningful to the public, data sources from the above paragraph must be integrated and interlinked with each other. Not to leave behind, integration of data from other sources intended for specific purposes such as meteorological and hydrographical data.

Geographic Information System (GIS) is the main tool acting as the integrator. GIS will integrate the data and it will also be managing, analysing, and displaying all forms of geographically referenced information. GIS allows the user to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. With the integration done in a simple and meaningful way, geoinformation will be disseminate to the users via internet/mobile service provider (ISP/MSP). From this point forward, geoinformation are ready available to the specific users according to their specific task or request. The traditional way of disseminating geoinformation is by 'pull services' by the user. Pull services for geoinformation defined as delivering geoinformation directly requested by the user either while mobile or static. The information received by the user will be specific as demanded. As an alternative, 'Push services' will deliver information which are either not or indirectly requested from the user. Both of these services will be elaborated in detail in the 'mass market needs' section.

The internet browser plays a huge role of introducing the benefits of geoinformation application to the public. February 2005, Google Map was launched by Google. The site led the revolution of online geoinformation to the public. With the simple business model of micro transaction through advertisement, Google have achieve what is unthinkable during that era which is gaining profit in millions by exploiting geoinformation to the mass public.

2 THE MOBILE SOCIETY REVOLUTION

Mobile society refers to a massive group of people which are heavily dependable to their mobile devices to communicate, to execute their daily jobs and to enhance their quality of life. A mobile device is referred to as a handheld, handheld device or handheld computer is a pocket-size computing device. Mobile devices usually come with a touch or non-touch display screen.

At the end of 2011, there are 6 billion mobile subscriptions estimated by The International Telecommunication Union (ITU). That is equivalent to 87 percent of the world population. It is a huge increase from 5.4 billion in 2010 and 4.7 billion mobile subscriptions in 2009. As for smartphone sales in 2011 reached 472 million units and accounted for 31 percent of all mobile devices sales. It all begins in 2007, with the introduction of Apple iPhone and Android powered smartphones which spark the revolution of the mobile society worldwide.

2.1 The revolution catalyst: Mobile applications for iOS and Android

Mobile applications is also called mobile apps, it is a term used to describe an application that run on smartphones and other mobile devices. Mobile applications usually help users by connecting them to internet services more commonly accessed on desktop or notebook computers or help them by making it easier to use the internet on their portable devices. A mobile app may be a mobile web site bookmarking utility, a mobile-based instant messaging client, Gmail for mobile and many other applications.

Mobile application development is the process by which application software is developed for small low-power handheld devices such as personal digital assistants, enterprise digital assistants or mobile phones. These applications are either pre-installed on phones during manufacture, or downloaded by customers from app stores and other mobile software distribution platforms.

Key mobile applications provider is a duopoly by Apple's App Store and Android Market. The Apple's store attracted nearly 24,000 of app developers whereas the Android Market attracted over 4,000 developers in the same period. In 2009, the total number of apps downloads globally were approximately 7 billion with Asia leading the way with 37 percent of the global downloads. By 2012, the total number of apps downloads are expected to grow at 92 percent to almost 50 billion downloads per year. Among the most popular are apps that provide some form of entertainment such as games, music, food, travel and sports; as well as those that help people find information they need and accomplish tasks (maps and navigation, weather, news, banking).

2.2 Location-based Services Apps

Gartner, Inc. has identified the top ten consumer mobile applications for 2012 and onwards. Gartner listed applications based on their impact on consumers and industry players, considering revenue, loyalty, business model, consumer value and estimated market penetration. The prediction made was that most users will use no more than five mobile applications at a time and most future opportunities will come from niche market 'killer applications'. The top ten consumer mobile applications in the future are money transfer, Location-based Services (LBS), mobile search, mobile browsing, mobile health monitoring, mobile payment, near field communication services, mobile advertising, mobile instant messaging and mobile music.

LBS form part of context-aware services, a service that Gartner expects will be one of the most disruptive in the next few years. Gartner predicts that the LBS user base will grow globally from 96 million in 2009 to more than 526 million in 2012. LBS are ranked No. 2 in Gartner's top 10 because of its perceived high user value and its influence on user loyalty. Its high user value is the result of its ability to meet a range of needs, ranging from productivity

and goal fulfilment to social networking and entertainment. Market awareness of geoinformation is driving a high adoption rate for applications on mobile devices. Of the $118 million in revenue that downloadable mobile applications such as LBS, weather applications, chat/community, and personal organization tools generated during second quarter of 2007, LBS represented 51 percent.

3 THE MARKET FOR GEOINFORMATION

As of today, the market for geoinformation consisting mainly of raw satellite imagery is driven by those who have an important need for this type of geoinformation and who can afford to pay the high costs of obtaining the satellite imagery. This market is dominated by governments and large enterprises that use the imagery from both space and air for defence & security, resource planning & management, land surveying, agriculture, and scientific purposes.

Table 1. Revenues for geoinformation, includes sales of satellite imagery and value added services derived from satellite imagery

Region	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	CAGR
North America	$966	$1,030	$1,102	$1,193	$1,300	$1,429	$1,579	$1,749	$1,953	$2,179	9.5%
South America	$101	$109	$117	$127	$137	$149	$162	$176	$191	$208	8.4%
Europe	$692	$746	$804	$867	$938	$1,017	$1,102	$1,195	$1,297	$1,414	8.3%
Asia	$204	$221	$239	$259	$281	$306	$334	$367	$404	$446	9.1%
Middle-East and Africa	$135	$144	$153	$162	$173	$184	$195	$208	$222	$238	6.5%
Total (US$ M)	**$2,098**	**$2,248**	**$2,415**	**$2,609**	**$2,830**	**$3,086**	**$3,373**	**$3,694**	**$4,067**	**$4,485**	**8.8%**

As of 2009, the total market for geoinformation, which includes revenues of sales of satellite imagery and value added services base, was worth a total of $2.1 billion and more than 75 percent of all satellite imagery revenues were from government sales. Analysts predict that by 2018, if there are no fundamental paradigm shifts, the market for geoinformation will double and be worth $4.5 billion.

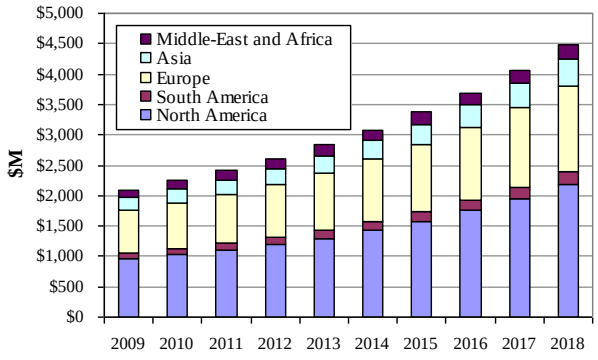

Figure 1. Graph of revenues for geoinformation, includes sales of satellite imagery and value added services derived from satellite imagery

3.1 The global market landscape

The geoinformation market value chain can be understood by three components: (1) the information component, (2) the value added service component, and (3) the distribution of information and value added services to end user component. The relationship between these three components is shown in Figure 2.

Figure 2. Value chain for the geoinformation market

End users have a need to access geoinformation from their mobile devices. The information sources component of the value chain represents the sets of information required to create value added services. The value added service part of the value chain is the process of creating, deriving or combining information together to create geoinformation. The distribution part of the value chain is the process of delivering the geoinformation to the end users through a mobile device.

The players in the geoinformation market today can be categorised by what they offer along the value chain. One set of players, the imagery and limited value added service providers such as Digital Globe and Spot Image, provide high resolution imagery that is updated on the order of once a year, and only offer a limited set of value added services that are customized to each customer's needs. The second set of players, the LBS providers creates location based value added services for mobile devices. Players in this market include Facebook and FourSquare. The third set of players, the information delivery providers, connects people to information. Information delivery providers include both hardware device providers, such as Nokia, storage and processing players such as Sun Systems, network platforms, such as Cisco and information organizations such as Google and Yahoo.

3.2 Mobile apps market opportunity for geoinformation

According to a report, worldwide revenue from mobile applications totalled about $6.8 billion in 2010, an increase of 60 percent over the $4.2 billion spent in 2009. Growth in revenue from mobile apps can be expected to continue at a rapid rate, as more consumers purchase smartphone and more apps become available. It is predicted that in 2013, 21.6 billion apps will be downloaded, generating nearly $30 billion in revenue. Gartner Inc. reported that 82 percent of all downloads are free in 2010, and that the share of free apps will increase to 87 percent by 2013. This leaves mobile advertising to make up for the loss in share for paid apps - Gartner claims that in 2010, 0.9 percent ($0.6 billion) of mobile app revenue will be generated by advertising.

App makers will be more dependent on advertising revenue as the number of free apps proliferates. Just from 2009 to 2010, average revenue per app is expected to drop by 11 percent, from $1.68 to $1.50. By 2013, according to Gartner's numbers, the average revenue per app will be $1.36.

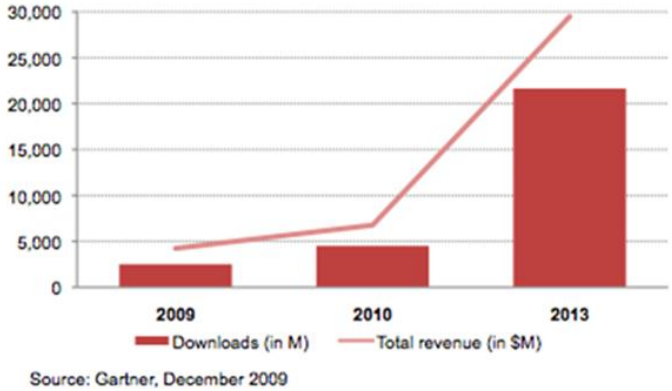

Figure 3. Mobile application store's number of worldwide downloads and revenue.

Another report from International Data Corp. (IDC) is projecting that the mobile application business will soon grow from 10.9 billion downloads in 2010 to 76.9 billion downloads in 2014. This growth will also mean a 60 percent per year increase in mobile application revenue, says the report.

Consumers will spend $6.2 billion in 2010 in mobile application stores while advertising revenue is expected to generate $0.6 billion worldwide. Analysts said mobile application stores exceeded 4.5 billion downloads in 2010, eight out of ten of which will be free to end

users. Gartner forecasts worldwide download in mobile application stores to surpass 21.6 billion by 2013.

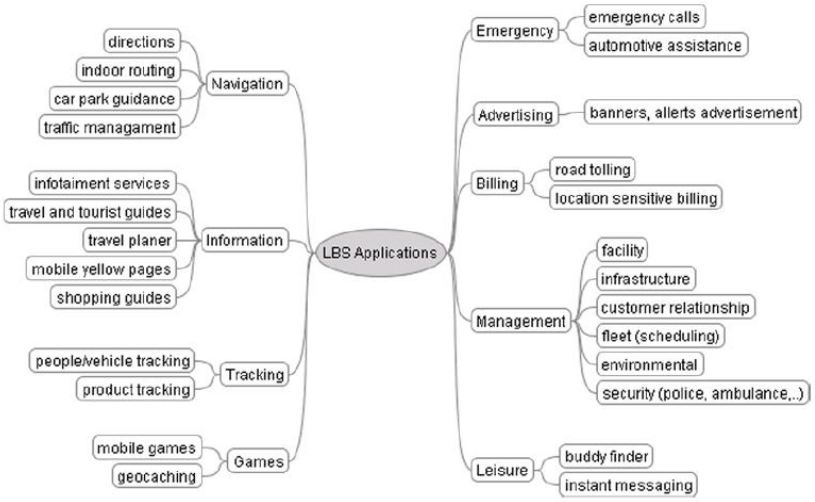

Figure 4. Various potential and market segments for geoinformation services

Figure 4 provides an overview of the existing and potential markets for which geoinformation can be used for. The application ranges from games for mobile devices to mapping and navigation.

3.3 The drivers

- Smartphone getting cheaper: Smartphone manufacturer are mass producing phones for the market. With the competition between smartphone manufactures giants such Nokia, Samsung, HTC, Apple and Sony, the price of sophisticated smartphone are getting cheaper every day, thus it is affordable for the mass market to have one.
- Mobile Technology: The current technology of computers software, hardware, processing and mobile communication and has allowed for the mobile phones to be as powerful as a laptop or a desktop computer. The applications usually are not compatible to be executed in a normal mobile phones are now possible.
- The rise of the 'Apps Culture': Along with the widespread embrace of mobile technology has come the development of an "apps culture." As the mobile phone has morphed from a voice device to a multi-channel device to an internet-accessing mini-computer, a large market of mobile software applications.
- The need of information: Information is the key for people to make decisions. With the information available from a push of a button, decisions could be made that can save millions of dollars or to save a life. Apps that supply information to people need to accomplish tasks such as maps and navigation, weather, news and banking is essential to most of the adults who have a smartphone.
- The booming of Social Media Culture: Facebook and Twitter has made a lot of impact to the citizen of the world today. Recent event that shook the world politically spreads around the community with the usage social media that originates from the smartphone that has a social media app.
- The iPhone, iPad and Android factor: The impact of iPhone and iPad starts from the United States and rapidly spreads to the rest of the world by storm. With the tremendous achievement of the iPhone sale and the Apple App Store, other phone manufactures starts trying to replicate the accomplishment by developing other types of smartphone and came along Android OS which is the operation system for the developed smartphone.

4 THE MOBILE MASS MARKET NEEDS FROM GEOINFORMATION

Geoinformation is intrinsically valuable, and when it is made relevant, accessible and affordable anytime, anywhere, geoinformation will revolutionise the way each and every person on this Earth lives and interacts with the world around them.
According to research, to provide useful and relevant geoinformation data for the mobile mass market, the following primary objectives must be met:

- Imagery with less than or equal to one metre resolution, to enable detection of small changes, such as a fallen tree, or the movement of a car, on the earth's surface.
- Imagery catalogue that is at most one week old, to track changes on the earth's surface and to provide the commercially most up to date geoinformation.
- Optical imagery, to provide true colour images desired by the mobile mass market.
- Synthetic aperture radar (SAR) imagery, to provide further information about the earth's surface, as well as a fully reliable imagery source independent of lighting or cloud conditions.
- Accessible anytime anywhere from mobile devices such as mobile phones, tablets, or laptops.
- Affordable prices for the services that do not require the mobile mass market user to pay more than a few cents for geoinformation.

In other words, in order to cater the needs of mobile mass market to accept and regularly use geoinformation apps, the information provided must be (1) timely, (2) accurate, (3) up-to-date, (4) on-demand, and (5) cheap.

4.1 Geoinformation services for the mobile mass market

Business model is fundamental to tackle the geoinformation needs of the mass market. In general, one can distinguish two different kinds of geoinformation services considering if the information is delivered on user interaction or not.

a. Pull services deliver information directly requested from the user. This is similar to call a website in the internet by fill in its address in the web browser-address field. For pull services a further separation can be done into functional services, like ordering a taxi or an ambulance by just pressing a button on the device, or information services, like the search for a close fast food restaurant.
b. Push services deliver information which is either not or indirectly requested from the user. Such push services are activated by an event, which could be triggered if a specific area is entered or triggered by a timer. An example for an indirectly requested service is a news service subscription which contains event information with respect to the actual city. A not requested service could be advertisement messages if a specific area in a shopping mall is entered or warning messages if weather conditions change (e.g. hurricane warnings). Since push services are not bound on previous user interaction with the service, they are more complex to establish.

The business models for apps have evolved over time. Initially, the focus was entirely on the paid downloads or the subscription based models that bundled other forms of content like the ringtones and pictures with applications.

4.2 Mobile geoinformation apps categories

The following list is by no means an exhaustive one of geoinformation app types, only a sampling. Note that some example apps might actually fall into several categories.

a. Social networks - Twitter, Facebook native apps on various mobile devices. While Twitter and Facebook location data is still limited at present, there is implicit information included in status updates posted. However, both companies are said to be adding more location data in the near feature.

b. Social shopping - Yelp, Foursquare, MyTown, Gowalla. Found a good or bad place to shop, eat and enjoy? Let others know by checking-in your location and adding a comment.
c. Moodsourcing - Stuck, Pocket Life. Both of these apps not only let you check-in the users location but select an icon or some pre-worded text to convey the users current mood.
d. Location-planning - Loopt Pulse, which is similar to the above social shopping apps in that the user can browse for nearby venues, stores, cafes. The user can also browse for places and even see relevant pictures for a place.
e. Navigation, trip tracking - Trapster, Glympse. Trapster functions as crowdsourced speed trap warning and navigation system. Glympse also lets the user to see real-time location trails of friends who have enabled this while taking a road trip.
f. Freelancing - Field Agent, which crowd sources freelancers to complete paid tasks typically related to brand placement and pricing in stores.
g. Paperless ticketing - Apple's Concert Ticket+ system, which was granted a patent but could appear in the next generation of iPhone devices. It's too early to tell exactly how this system will use location data, but because of the additional "benefits" described, it could be to create ad hoc networks and various events such as concerts or conferences.
h. Ad hoc networking - Apple's iGroups patent, also granted recently. Enabled mobile devices (e.g., iPhone) could be detected by a "master" device at an event and the owner offered the opportunity to join an ad hoc network.

4.3 Potential Geoinformation based Application

The market analysis performed by several researches identified four set of potential geoinformation based application that is going to be huge in the near future for the mobile mass market. The application categories are (1) Overlayed system services, (2) Overlay Globes, (3) Image Delivery and (4) Change Detection. These applications are fundamentally using earth observation images as the base layer of the application, which is then topped up with other types of geoinformation.

a. Overlaid system services - It contains applications which use images overlaid with additional data to provide customers with an increased level of information. Primary use is as upgrade for the LBS now. Typical use of overlaid services is:
    - direct access on personal devices (e.g. mobile, tablets)
    - emailed to other party/people
    - posting on social networks
b. Overlay globes - In this application category, a map of the entire world is created (both 2D and 3D), and overlaid with information, such as providing very accurate position information, street information, yellow pages information etc. The key to the overlay globe is that a high resolution image of the earth is overlaid with all additional information associated with each location in the globe. This category is really about all the information that can be incorporated into a virtual globe (which would also include 2D and 3D imaging) be accessed through accurate positioning in the globe.
c. Image delivery - The delivery of current and historical geospatial imagery for the government, commercial and research applications collected earth observation satellites intended to match the customers' demand at any location on the Earth. Although, it is now currently in service but the image delivery is not a up-to-date images.
d. Change detection - It contains applications which use change detection technique to provide customers with information on the changes occurred on targets after a specific

event (i.e.: disasters). Precise information on the geographic coordinates are requested as well as good spatial resolution and fast delivery of products.

4 THE MISSING LINK

The missing link between geoinformation and the mass society now are (1) up-to-date images of the world, (2) up-to-date geoinformation, (3) relevant geoinformation and (4) geoinformation by request from the service provider.

a. Up-to-date images of the world - Earth observation will be acting as the base layer of geoinformation, up to now there are no known capabilities for an earth observation image provider to supply an image of a point that will be refreshed daily commercially. For the mass market, images older than a few days have no or very little value.
b. Up-to-date geoinformation - The geoinformation of a point must be refreshed as soon as possible to have a value to the mass market. Information distributed are meant to be useful to the recipient, that is if the content are new and will be refreshed again in a few hours.
c. Relevant geoinformation - The mass market needs to have relevant information delivered to them. People are annoyed if the information given to them is useless although it is very valuable for another party. For example, a service provider delivers a message about a landslide on the north bound PLUS highway to a person in Perth.
d. Geoinformation by request - Geoinformation is best to disseminate by request of the mass market (pull service). Mass market will be really pleased if the geoinformation they request are accurate, timely and presented with a high resolution earth observation image. To the public a picture speak a thousand words and information on the image is a bonus.

4.1 Up-to-date earth observation images for the mass market

For the mass market, an image of a specific point on earth as requested by them will be highly valued. As for now, there are no capabilities for an image provider to provide such a service to the mass market.

The known technical solution to have this major stumbling block resolved is to build a constellation of optical and Synthetic Aperture Radar (SAR) that can give the mass market an image refreshed less than a week.

Table 2.Constellation of optical and SAR satellite for images refreshed once a week

Sensor	Optical constellation	SAR constellation
No. of sat.	12 satellites	5 satellites
Orbit	Sun synchronous orbit	Sun synchronous orbit
Plane	Single orbital plane	Single orbital plane
Des. node	10:00 am local time descending node	6:00 am local time descending node
Altitude	Altitude 530 km	Altitude 510 km

5 CONCLUSION

Although geoinformation has been around since the day of the Pharaohs in ancient Egypt, it has never really been utilized by the mass society. The only main utilizer of geoinformation is the government and medium to large enterprises which have the capabilities in procuring the highly priced images. Not to blame the earth observation image provider, but it is well known to the public, to establish a space infrastructure (space segment, ground segment and launch

campaign) is extremely costly and exorbitant. Delayed and postponed mission caused by funding issues are common in the business.
In February 2005, Google Map was launched by Google. The site led a massive online geoinformation revolution. The mass society suddenly is woken up to the importance of geoinformation through earth observation images. All of a sudden, almost all online business has their coordinates and map linked with the Google Map. Google Map now are the essential tool in geoinformation for business and the site also is a major reference for the public to do online reconnaissance before getting on the road to a destination.
The mobile revolution started since the introduction a smart phone called the iPhone by Apple in June 2007. The invention later sparked more fire with the creation of the Android OS by rivals lead by the search engine, Google. Android seems to be more disruptive than iOS since it is compatible with all other smartphones. The capability of smartphones excepting large files and in high resolution is the catalyst of having geoinformation to the mass mobile society.
Since the mass society now are having a smartphone that have the capability to receive high resolution pictures, earth images can be delivered directly to their mobile devices. Apple and Android, both are having their own platform to create apps are the perfect channel for geoinformation type of apps to penetrate to the mass mobile society. Applications created by integrating earth images, GPS coordinate and useful spatial information is readily to be delivered to the mass mobile public. Not to mention, access to the net via mobile devices is getting faster with the 4G network and it is expected to be faster in the next decade.
The only limitations to disseminate timely, accurate, up-to-date and on demand geoinformation are the costly space infrastructure, and the will of geomatitions to venture and exploit the application platform provided by Apple and Android to create a killer geoinformation app for the mobile society. The 'Angry Bird' story should inspire!

6 REFERENCES

Meng, L., Zipf, A. and Reichenbacher, T., 2004. *Map Design for Mobile Applications.* Heidelberg, Springer Verlag.

Reichenbacher, T., 2004. *Mobile Cartography - Adaptive Visualisation of Geographic Information on Mobile Devices.* (Ph.D.). http://tumb1.biblio.tu-muenchen.de/publ/diss/bv/2004/reichenbacher.html

Schiller, J. H., and Voisard, A., 2004. *Location-based services*. Morgan Kaufmann Publishers.

Delft University of Technology. 2011. *Letting The World See The World*, Space Tech13, Masters of Space System Engineering Final Report, Faculty of Aerospace Engineering, Netherlands

Delft University of Technology. 2011. *Market Survey and Analysis Report, Vol III (Frascati)*, Space Tech13, Masters of Space System Engineering, Faculty of Aerospace Engineering, Netherlands

Futron. *State of the Satellite Industry Report*, June 2010. Sponsored by SIA.

Northern Sky Research NSR, *Global Satellite-Based Earth Observation*, 2009.

Euroconsult, *Satellite Based-Earth Observation*, 2009.

ESA, *Emerging Markets and Future Applications: Final Report*, ESA AO/1-5508/08/TI.

Global Digital Map Market 2009-2013 February 2010

Steiniger, S. 2005. Lesson 1. Neun, M., Edwardes, A., *Cartography for Swiss Higher Education*, Swiss Virtual Campus Project, Zurich