Positioning Services in Web 2.0

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Key words: GNSS, Positioning, Internet, Web 2.0, ICT, Positioning Infrastructure

SUMMARY

Geodetic Surveying is a long-established science with the use of advanced technology of the age. The Continuously Operating Reference Stations (CORS) systems with real time positioning services have revolutionized the way of position fixing from conventional methods of triangulation, traversing and radiation, to direct fixation using positioning systems. Today, with the development of Information and Communication Technology (ICT), geodetic data and results could be converted into bits and bytes and delivered to millions of users through the Internet. The evolution of ICT has made GNSS data and correctional signals available in anytime, anywhere for real-time high accuracy positioning; The web platform has been proved being an effective means for such purpose.

In the near future, telecommunication infrastructure, such as Cellular network, RFID and Wi-Fi, can be used as the potential infrastructure for positioning. The Web 2.0 concepts have been affecting people's habit in the Internet. Location-based services are reaching the daily life of the citizens. These new trends and technologies would change the entire positioning profession in cultural, managerial and technical aspects. One step forward in the ICT world will, at the same time, push the development of the positioning industry and change the way of our work and life.

By reviewing and studying on the latest Web and ICT developments and the works being done by the pioneers, the authors would take a glance to the new scope of positioning services in the world of digital convergence, the required paradigm shift of the surveying industry in the era of Web 2.0; and find the new ways to serve people in positioning: more than measurements, providing services in the trend of Web 2.0; and collaboration in building the positioning infrastructure for the community.

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1. INTRODUCTION

The Times Magazine has announced the "Person of the year" award of 2006 goes to "You" [*Grossman (2006)*]. This phenomenon has proved that the Information and Communication Technology (ICT)[1] developments have played an influential role in everybody's life. The penetration of the Internet has also attracted integration and migration of services from their traditional platforms to the cyberspace. We can do almost everything in the web environment: business transactions on e-banking systems, virtual-reality medical consultation, getting a degree at the virtual campus, having different varieties of games, music and video entertainments.

The emergence of Web 2.0 changes the Internet from a read-only Web to a dynamic and interactive Web. It encompasses the notion of mass collaborative under the social-networking environment of ICT. Furthermore, mobile computing and location-based services (LBS) integrate the Web into real life on the spot. To meet these challenges, surveyors find their new roles with new scope of positioning services in the world of digital convergence, the required paradigm shift in running the business; and the new ways to better serve the community.

2. GET READY FOR THE TRENDS AND CHALLENGES

2.1 Digital Convergence

As different media such as books, photographs, music all go digital, more and more all-in-one products with different combined features of cellular phone, radio, MP3 player, PDA, camera, video and positioning sensor come to the market and realize digital convergence. Such digital convergence with the broadband and wireless telecommunication technology allows people to have entertainment and communication in a social-networking environment.

2.2 The World Connected as One

The ICT have been the dynamo of social developments in modern history. It has created waves of "creative destructions" in the traditional business models and driven the economic growth [*Cheung (2007)*]. It not only improves the productivity of existing businesses, but also provides a new stage for innovative applications and revolutionary ideas to come true.

[1] This paper generally adopts "ICT" as the term to refer to all technologies and applications that involve information processing and/or exchange over communication network(s), including the Internet. It is used interchangeably with the another commonly used short form as "IT" (information technology) in many other publications.

Taking the example of Korea, 25% of the country's population have registered in a web community site called "Cyworld". The website serves as a platform for different kinds of social networking. Users can create avatars to do things like buying new clothes or furniture and make friends. In another example go further, a virtual community called "Second Life" is developed by Linden Lab. It is an online 3-D virtual world "inhibited" by a population of more than 4.4 million people worldwide [*Linden Labs (2007)*]. "Residents" could acquire the virtual land and property, and create goods for sell. It has attracted firms like IBM, Cisco, Dell, General Motors, Toyota, etc. to establish their shops for the virtual world to make real money. BBC has rented a virtual island to stage online music festivals. The Reuters has also set up a news bureau to report the activities and news happening within Second Life. The virtual community is getting as realistic as the real world.

If we try to quantify the powers of these virtual communities, the following figures could provide some hints: the daily revenue of Korean's Cyworld in selling "acorns" (the Cyworld's virtual currency) is estimated to be around US$300,000 [*Wikipedia (2007a)*]; and the GDP of the Second Life's virtual economy is equivalent to US$64 million in September 2005 [*Reiss (2006)*]. The virtual cyberspace has broken the physical barriers in the real world. It connects the people, social networks, business activities and daily lives together as the global village. The severe disruptions to the Internet connectivity between Southeast Asia and North America caused by damage of the submarine cable in an earthquake near Taiwan in December 2006 brought inconvenience to Internet users at different extents, but definitely to all it was an experience of being disconnected and we realized that the world is connected as one.

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Figure 1: Screen-shot of the Reuters/Second Life News Center [Reuters (2007)]

2.3 The Emergence of Web 2.0

The Internet world is changing in a rate faster than the famous Moore's Law. The Web is changing from the read-only html pages of "dot.com" era to a dynamic "Web 2.0" mode. "Web 2.0" is an umbrella term for the second wave of World Wide Web. The terminology first appeared in a conference brainstorming session between O'Reilly and MediaLive

International [*O'Reilly (2005)*]. Although it sounds like a new generation of technical development, it is in fact a phenomenal change of the Web.

Web 2.0 creates a social-networking environment to facilitate mass collaboration of the e-community in all aspects. It not only shares information and knowledge on the Web, but also connects people, transforms services and changes the business model. Wikipedia, MySpace, Flickr, and YouTube, etc. are typical websites demonstrating the collectivism of Web 2.0.

"Web 2.0 is a set of economic, social, and technology trends that collectively form the basis for the next generation of the Internet— a more mature, distinctive medium characterized by user participation, openness, and network effects."

[*Musser et al (2006)*]

Figure 2: The mind-map sums up the memes of Web 2.0 [Angermeier (2005)]

2.4 A User-centric Web

In the past, the content providers have developed static web pages, and published them in a one-way authoritative style on the Web. Today, users would expect some dedicated space for real-time interactions, for dropping down feedbacks, ratings, or even open-ended comments. Many of the Web 2.0 sites start primitively in content but provide unlimited opportunities for users to add in details.

Users have become the core and king for the Web 2.0. They directly get involved and contributed to the site developments, make the content and even determine the style of the websites. Wikipedia and Yahoo! Knowledge+ use the collaborative intelligence to formulate the revolutionary mode of encyclopaedia and knowledge sharing. YouTube attracts millions of users to upload and share their home-made videos, and further attracts another billions of viewers to visit the site. The popular use of "tags" in many websites has collaboratively-personalized the Web by borrowing one user's idea to enhance other users' experience. These could not be done without users' participations.

Another key change in Web 2.0 is the shift of focus to "The Long Tail". People have their focus on the mainstream in the past, but now they would start looking at the alternatives. In the digital world, the collective sum of the "misses" (at the tail side) could in many cases

contribute to a greater quantity in market shares than "the hits" [*Anderson (2004)*]. The classical 80/20 rule in the marketing textbooks was questioned.

The behaviour and power of the users at the Web 2.0 era have illustrated the challenges to traditional enterprises and industries. This wave would, sooner or later, makes an impact to every sector of the community.

2.5 Information Sharing by Web Feed and Wikis

In any decision-making or analysis task, information has to be shared among different parties. Getting the required and updated information is often the most expensive process and is most crucial to the success of analysis that contributes to correct decision-making.

Web feed is a way of serving users with frequently updated content through Internet. It is commonly used by "blog" (short form of "web-log"), news website and Internet radio/TV broadcasting. Traditional newspapers have started to allocate columns to report latest news read from blogs, or even set up their official blogs. In technical aspect, the Really Simple Syndication (RSS) has won the hearts of millions Internet users that require to be always informed, but not disturbed. With one-off subscriptions, users could get the feeds from the various content providers, with the most updated headlines, quietly, but readily available, at a single corner of their desktops.

Knowledge and information are shared in the Wiki mode on Internet. Open and fair collaborative effort would eventually establish an equilibrium state for any particular issue at its accuracy, updateness, completeness, neutrality and instant availability, to support decision-making processes.

2.6 The Copyleft Calling

The tendency of sharing sparks off debates on intellectual property rights. While copyright was designed for protecting intellectual property rights of the authors, some people argue that with modern technology and new forms of media and expression, copyright is too limiting and difficult, and that users of a work or idea should be allowed to do more with it. A new form of license has evolved, called "Copyleft" for the purpose of which is to clarify how a work can be used, modified, and redistributed, and by who [*Dinkgrave (2005)*].

Wikipedia has adopted the Copyleft licensing (or GNU license) to make sure its information could be freely transferred. Copyleft means "*the practice of using copyright law to remove restrictions on distributing copies and modified versions of a work for others and requiring that the same freedoms be preserved in modified versions*."[*Wikipedia (2007b)*]. The use of Copyleft is considered as a tactics to ensure sustainable product developments, compete in monopolized markets, and at the same time, protect the intellectual property from being "stolen" away from the public users. It aims reinforce the intellectual property for the owners, instead of causing loses of the rights as expected by the conservatists and protectionists.

The free transfer of information in Copyleft mode could help the community at large, creating non-tangible benefits to the public. However, one might doubt that the copylefted products is not commercially viable and unlikely to make as high income as proprietary products, it was proven that consultancy or training services, copyrighted add-on applications or commercial services on top could be the source of revenues for businesses. The Red Hat Enterprise Linux is one of the examples of adopting subscriptions-based business model [*Red Hat, Inc. (2006)*].

2.7 The Geospatial World and Where 2.0

In 2005, the originator of phrase Web 2.0, Tim O'Reilly, has initiated another new term "Where 2.0" that refers to "*where developers building location aware technology intersect with the businesses and entrepreneurs seeking out location apps, platforms, and hardware to gain a competitive edge*."[*O'Reilly (2007)*]. The first Where 2.0 Conference was held in 2005 with discussion topics on mobile positioning, spatial information, wireless industry developments, LBS on Mobile Blogging, augmented reality and mixed reality, geocaching, and indoor positioning. Topics relating to the concepts in the Web 2.0 such as "citizen journalism" or "crowdsourcing" are also included. They hint on some direction of developments for positioning services in future.

In geospatial applications, Google Earth has provided the basic and open platform to allow individual users to add their own information on to the plain maps. The collective contributions have established the largest ever and most comprehensive source of data, that we could hardly imagine the time and the cost if they were to be collected by a single organization. The success of Google Earth is not only due to its open platform for data creation, but also its open platform for services. *O'Reilly* pointed out that Web services from GIS vendors were available for some time but failed to create sparks, while the simplicity of the Google Earth have created way for creatively re-use of data and "*set the world on fire*" [*O'Reilly (2005)*]. It has extended its possibilities for applications of spatial data to the maximum extent. Many third-party applications and services have hooked-up with its database that stimulate the development of many innovative applications. For instance, the Found Bin (http://www.thefoundbin.com) is a website providing lost-and-found listing services, and with example of using the Google Earth services to show the locations of the lost and found on the map.

In addition, the market of Location Based Services is blooming with the technoglogy advancement of Internet, wireless telecom network and GPS and other positionig sensor systems. The Web 2.0 trend highlights the importance of making information shared. It

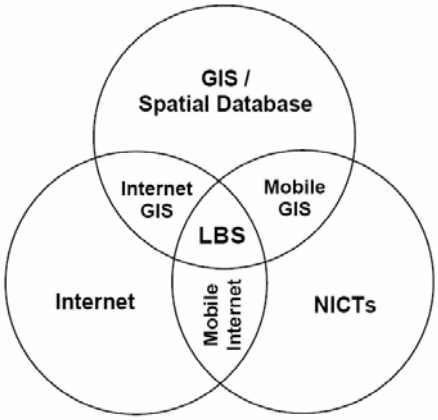

Figure 3: Convergence of technologies creating LBS
[Brimicombe (2002)]

would push further the demand of a comprehensive Spatial Data Infrastructure (SDI) for the global village.

3. THE REQUIRED CHANGES TO THE SURVEYING INDUSTRY

3.1 New Roles under Wikinomics

In the trend of Web 2.0, people and organizations are harnessing the principles of openness, peering, sharing, and acting globally to drive innovation in their workplaces, communities, and industries. Such new mass collaboration, termed "Wikinomics" [*Tapscott and Williams (2006)*], would transform services and change the business models of all. Surveyors are of no exception, and have to review their mode of services and find their new roles under the Wikinomics.

3.2 Evolution of Positioning Services

Back to the earlier days, surveyors worked on getting accurately surveyed coordinates for ground features, served customers with plans and maps. Such survey and mapping works heavily rely on a high accuracy geodetic control network and require knowledge and skill on breakdown of triangulations, traversing, levelling, radiations, and computations.

In Hong Kong, a geodetic control network was established with about 230 trigonometric stations, 3,500 traverse stations and 1,600 benchmarks. These horizontal and vertical survey control points form the geodetic reference framework in support of land developments and engineering works in Hong Kong. Following the technological developments of GNSS and land-based augmentation system, a satellite positioning reference station network (SatRef) with 12 Continuously Operating Reference Stations scattered in the territory was established with positioning services launched in 2006. It comes to the time of changing from a passive geodetic control network to an active positioning system that provides users with their real-time positions to an accuracy of decimetre by DGPS and centimetre accuracy by network-RTK. A website is developed to provide and deliver the services in support of various kinds of positioning activities. The use of ICT and web technology is much more anticipated in the future that will bring the positioning services to the new heights.

3.3 Paradigm Shift: User-Centric

Service providers of the Web 2.0 render user-centric services. The shift from "Cathedrals" to the "Bazaar"[2] [*Raymond (1998)*] allows active users to participate, to share the fruits and to get involved in building the services. The Google does not force users to view the ads at its home pages, but set up user-friendly links at the users' websites through the AdSense program and pay dividends to them. In addition, YouTube has planned to offer dividends to registered users who upload videos to the website according to the hit rates of the videos [*Weber (2007)*].

[2] The term "Cathedral" and "Bazaar" is borrowed from the idea of Eric Raymond's paper describing the development of commercial software as the "Cathedral" style and open source software like Linux as "Bazaar"

The positioning service providers should, not only deliver professional services, but also be ready to address the need of the community at large, at the Long Tail, by delivering omnipresent and all-encompassing services. With the penetration of ICT to all sectors, the number of non-specialist uses and non-traditional applications is increasing. Service providers have to act proactively to consider what and how they can do for the potential users. A strategic move to creating a critical mass of users would eventually drive down the costs and run on a sustainable business model.

With the advancement of satellite positioning technology and augmentation systems, users holding the small receiver, in whatever form of surveying equipment or mobile phone with GPS function, could get an accurate position for various kinds of location-based service applications. The business and service model of the surveying industry needs to be considered in different user-centric applications.

3.4 Paradigm Shift: From Focus to Pervasive

Visionaries in the ICT world are projecting utopias like the semantic web whereby computers can automatically cooperate to derive results or get things done [*Office of Government Chief Information Officer (2002)*]. Web services for simple functions and tasks were being developed and integrated together, in the form of Service Oriented Architecture (SOA), to provide advanced functions to the users.

The increasing use of SOA, interoperable Web Services, and public APIs has helped the communication between applications to applications, in a loosely coupled way. The business logic or individual functions are modularised and presented as services for client applications. Different applications could be connected to each other at the interfaces without concern on its underlying logic, computing platform and system, provided that they are following the standards. The Web connects the processes and changes the business model from focus to pervasive.

Many CORS networks have made their raw data and information available, or broadcasting the data streams on the Web. This is probably only the start. Under the trend of ICT developments, the demand from users has changed from information-based to service-oriented and seeking for total solutions. User does not only need a piece of map showing his or her destination, but require services that tell him or her to get the job done. That would involve the easy integration of a series of services from various providers. Numerous applications tagged on Google Map vividly demonstrate the pervasive power on the use of maps. The integration of the 3S, viz. GPS, GIS, RS has been mentioned for a long time. Such integration should further go into the ICT mainstream of mass collaboration on Internet and pave the way of building SDI and positioning infrastructure for the community.

4. FIND THE NEW WAYS TO SERVE IN POSITIONING

4.1 More than Measurements

When the GNSS infrastructures are continuously improving, the receivers are getting ready for the changes. Increasing number of GPS equipment vendors are providing receivers ready for GLONASS and Galileo systems. The receivers with traditional survey functions are developed. Furthermore, GNSS receivers integrate with GIS software, map matching techniques, inertial sensors and Kalman filter algorithm to provide a total solution on positioning and navigation.

Apart from satellite positioning sensors, the wireless positioning technologies using communication devices are developing rapidly. Radio Frequency (RF), laser, ultrasonic, infrared, and almost every signal are being considered for positioning. Each of the signals has its own related positioning technology. Among the variety of wireless positioning techniques, the use of mobile cell phone networks would be a natural solution with high penetration rate and extensive coverage within the community. The study commissioned by the GSM Association reported that the mobile phone networks currently covering 80% of the world population, double the level in 2000. It further projected that 90% of the world will be covered by mobile network by 2010 [*Taipei Times (2006)*]. As revealed from these figures, the mobile network is more than ready to serve as an infrastructure for the provision of positioning services.

In addition, Wi-Fi positioning by analysis on the signals emitted from the Access Point (AP) locations or use of the RF fingerprinting algorithm to indicate the proximity of the user location in a large area is on the way. Products such as “AeroScout”, “AireSpace” and “WhereNet” could achieve 1-2m accuracy. They required special hardware to determine the TDOA [*Office of Government Chief Information Officer (2004)*]. The Ekahau, used its own engine to model Wi-Fi signal strength with calibrated results in the database to derive the position. The Wi-Fi positioning coverage could reach 60-100m for indoor environment and 150-300m for outdoors.

Unlike the above wireless communication technologies, RFID was originally designed for Automatic Identification and Data Capture (AIDC). However, it is also a possible device for positioning. Currently, the RFID is mainly used to replace the barcodes. *Kubitz et al* developed RFID for robot navigation at the Samsung Electronics in 1997 [*Chon et al (2004)*]. Samsung Electronics found that RFID could serve as a complement to GPS for vehicle navigation. Their study showed that the RFID reader in vehicle with a speed of 150 km/h was able to receive and identify the RFID tag installed on the road. It would allow the navigation device to retrieve relevant information, including the position, from the RFID tag database. In addition, *Hallberg and Nilsson* has a detailed research on positioning using IrDA, RFID and Bluetooth in 2002. They showed that Bluetooth was their best choice among the three with its network connection and information sharing ability, but RFID would be a good alternative considering the accuracy and even lower cost implication [*Hallberg and Nilsson (2002)*]. At application level, the Hong Kong Polytechnic University has investigated about the integrated

use of various sensors and GNSS to monitor the Ready-mixed Concrete delivery with an improved performance compared with GPS-alone methods [*Lu et al (2005)*].

The Where 2.0 is pushing another wave of location aware technology in collaboration for the developments of different sensors and mapping tools for obtaining location data, open standards for data and location web services. The emerging positioning technologies are tipped to supplement if not replace the traditional angle observations and distance measurements to provide real-time accurate positional information to users. Position fixation changes from the conventional surveying methods to direct positioning through GNSS together with other augmentation systems. Surveyors would require knowledge on various methods of telemetry, get the know-how on Wi-Fi positioning and RFID in collaboration with other professions on the development of positioning technologies.

4.2 Providing Services in the Trend of Web 2.0

While we observe the trend of Web 2.0 developments and recognise its significance, integrating the positioning services with the Web is of paramount importance. The use of Internet should not be confined to the transmission of GPS data or correctional signals from satellite positioning augmentation system to users, but making the data itself compliant to the open standards of Internet and residing the data on the Web for all users. The development of Ntrip (Network Transport of RTCM via Internet Protocol) serves the purpose.

According to the *Bundesamt für Kartographie und Geodäsie (2005)*, Ntrip is an application-level protocol streaming Global Navigation Satellite System (GNSS) data over the Internet. It is now adopted as an RTCM standard for disseminating differential correction data (e.g in the RTCM-104 format) or other kinds of GNSS streaming data to stationary or mobile users over the Internet, allowing simultaneous PC, Laptop, PDA, or receiver connections to a broadcasting host. Ntrip supports wireless Internet access through Mobile IP Networks like GSM, GPRS, EDGE, or UMTS [*Bundesamt für Kartographie und Geodäsie (2005)*].

With the Ntrip implementation, the satellite positioning services could ride on the Internet at anytime, anywhere for anyone. GPS correction signals could be accessible by users who need accurate positions for their location-based services (LBS). Furthermore, on the technical side, the satellite positioning services or augmentation systems should be developed with the use of the Web 2.0 programming tools and interface, adopting the user-centric mode of system developments to facilitate users to integrate their own applications and services on the Web as successfully demonstrated by those AJAX applications on Google Earth.

4.3 Collaboration in building the Positioning Infrastructure

Fraser et al (2004) suggested that satellite positioning augmentation systems could be established by using Web Services and Wireless Mobile Devices using two-way communications on the wireless network. Users could use some low-cost GPS/GNSS receivers to forward the raw GPS observation data to a centralized server that connected to a CORS network. The server would provide the Web Services to perform DGPS corrections and pass back the corrected coordinates directly to the user device [*Fraser et al (2004)*].

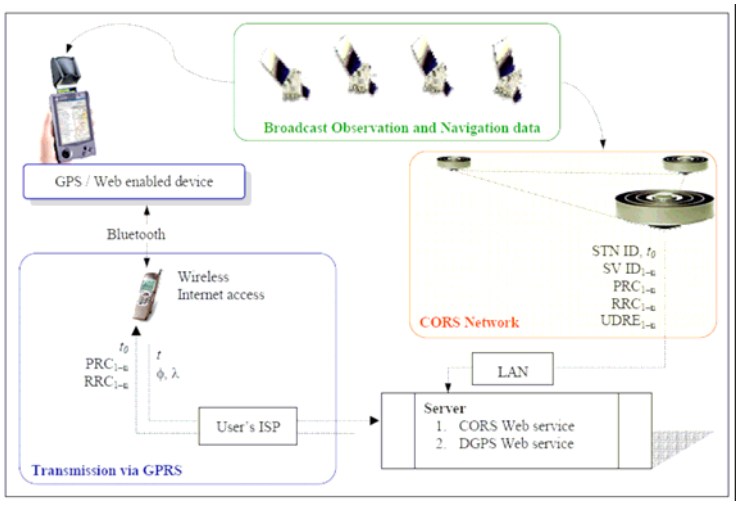

Figure 4 – Architecture of the Web services DGPS augmentation prototype
[Fraser et al (2004)]

Rizos and Van Cranenbroeck (2006) had voiced out a similar view of "Client-Server architecture" that the service providers would perform the augmentation and real-time / near real-time processing at the server side. They further suggested some operators could work as the "service broker" to integrate streams from various public or private GNSS networks to provide correction services to user in the brand name called "*Ubiquitous RTK*". All the proposed business models are focused on the need and requirement of users, trying to feed them with the best available GNSS services on the Internet platform [*Rizos and Van Cranenbroeck (2006)*].

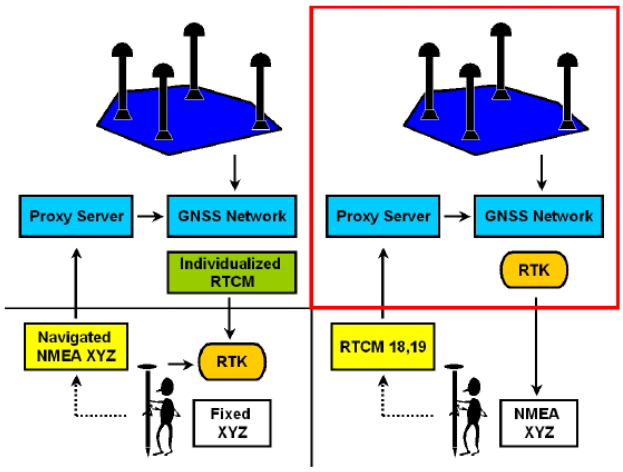

Figure 5 – Standard GNSS-RTK (left) and Reverse (Client-server) GNSS-RTK (right)
[Rizos and Van Cranenbroeck (2006)]

Such viewpoint was echoed by a number of surveyors that proposed to form a working group named "Positioning Infrastructures" in the FIG Commission 5 to "*investigate these technologies that are, and likely to be the key components of the future positioning infrastructure*". They redefine the term "positioning infrastructures" to cover not only the GNSS CORS networks, but also other terrestrial positioning / navigation technologies such as pseudolites, RFID, WiFi and etc. They have the view that the surveyors' community can no

longer ignore the progress in LBS, Assisted-GPS and the new indoor-outdoor positioning technologies, and have to start discussion on their impacts on future surveying products and services. They also advise to establish contact with the telecommunications and IT companies as the new ICT partners of our profession [*Van Cranenbroeck et al (2007)*].

In the context of Hong Kong, the government formulate the "Digital 21 Strategy[3] as the blueprint for the development of ICT in Hong Kong. Its 2007 Consultancy Paper mentions the importance of ICT that has a direct bearing on almost every facet of our daily lives [*Commerce, Industry and Technology Bureau (2006)*]. In terms of positioning and spatial information, the Consultation Paper has outlined the development of an Intelligent transport systems (ITS). It would be the all-in-one infrastructure to provide a GIS platform for traffic information and a web-based information service for route searching by public transports and drivers. These basic facilities are expected to "*open up new opportunities for the private sector to provide value-added services such as car navigation, fleet management systems and the provision of personalised services to the public through the application of technologies such as GPS and RFID.*" In addition, the Paper suggested that the Government would spearhead pilot projects using technologies such as RFID and GPS to promote assurance and encourage wider adoption at the community. It aim at building up a critical mass of users and eventually drives down the costs, in order to facilitate the market developments.

The trend of positioning infrastructure development with integrated technology is obvious. Its success would rely on participation and collaboration from multiple disciplines.

5. CONCLUSION

ICT development leads the world towards a new era. It calls for paradigm shift of the people and induces culture changes in all workplaces and communities. Different kinds of products and services are converging on the digital platform. The Web 2.0 shifts the focal points of business models towards the Long Tail users. Mass collaborations are cultivated in all sectors, with increasing number of innovative projects such as Enterprise 2.0, Science 2.0, etc. The next generation of services are moving towards a pervasive business model that can penetrate to all users on the Web. The world is connected as one.

The positioning technologies are advancing, tightly integrating with the new wireless and mobile communication technologies. Surveyors specialized in measurement science and geospatial data management would find their new roles in positioning. Services providers have to review and revamp their scope of work, culture, and technical competence to transcend the boundaries. The knowledge and skill on various positioning technologies, change of business model for render positioning services in the trend of Web 2.0, and

[3] The Digital 21 Strategy is the blueprint for the development of information and communications technology (ICT) in Hong Kong. It was first published by the Government in 1998, the Digital 21 Strategy set out our vision of developing Hong Kong into a leading digital city. As a living document, updated in 2001 and 2004, it has taken into account the evolving needs of the community and technological advancements. The Government of the Hong Kong Special Administrative Region conducted a public consultation on the 2007 Digital 21 Strategy, and will finalise the 2007 Strategy for announcement in the first half of 2007.

participation in the mass collaboration for building the positioning infrastructure for the community will be the challenges for surveyors. To embrace the trends and to meet the challenges, surveyors need to apply technologies in an innovative way, to nurture the revolutionary mindset for infrastructure development and management, to be proactive in developing strategies for the new business models; and to be pragmatic in supporting clients and serving the community.

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