Future Trends in Spatial Information Management: Suggestion to New Generation (Internet of Free-Open)

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***Abstract*—The use of spatial information is increasing rapidly. There is a growing recognition amongst both governments and the private sector that an understanding of location and place is a vital component of effective decision making. Citizens with no recognized expertise in spatial information and who are unlikely to even be familiar with the term, are also increasingly using and interacting with spatial information; indeed in some cases they are contributing to its collection – often in an involuntary way. Based on the contributions received, trends have been broken down into broad themes covering major aspects of the spatial information. They are as follows: trends in technology and the future direction of data creation, maintenance and management in spatial data provision and management.**

***Index Terms*—IoT (internet of things), cloud computing, user participation, LBS, IoF (internet of free-open)**

I. Introduction

A number of important technology driven trends are likely to have a major impact in the coming years, creating previously-unimaginable amounts of location referenced information and questioning our very understanding of what constitutes spatial information. These developments offer significant opportunities but also present challenges, both in terms of policy and in terms of law. Meeting these challenges and ensuring that the potential benefits can be realized by all countries will be important in ensuring that the full value of spatial information can be maximized in the coming five to ten years. It is recognized that different countries are at very different stages in terms of the development, sophistication and use of their spatial information infrastructures. There is a risk, inevitably, that not all countries will be in a position to invest in and realize the full potential of spatial information for governments, businesses and citizens. International institutions such as the United Nations have an increasingly important role in helping to minimize this risk, communicating the value and importance of investing in and developing an authoritative and maintained spatial information base and reducing the prospect of any 'digital divide' emerging.

Ensuring that the full value of spatial information is realized in the coming years will also rely on having the necessary training mechanisms in place. New and changing skills will be required to manage the increasing amount of spatial information that is likely to be created and to ensure that the maximum value is secured from it.

The number of actors involved in generating, managing and providing spatial information has increased significantly in the last ten years, and this proliferation will continue and indeed is likely to accelerate in the coming five to ten years. The private sector and the public will continue to play a significant role in providing the technologies and information required to maximize the opportunities available. They are likely to provide valuable, and in many cases unique, elements of spatial information and the technologies and services required to maximize it, in addition to offering a growing understanding of the end user base for spatial information. Governments will continue to have a key role in the provision of spatial information and be substantial users of spatial data; however, governments' role in spatial information management may well change in the coming five to ten years. Nevertheless it will continue to be vital. Building bridges between organizations, collaborating with other areas of the spatial information community and, most importantly, providing complete spatial frameworks with trusted, authoritative and maintained spatial information, will be crucial to ensuring that users have access to reliable and trusted spatial information and have confidence when using it. This information is vital to inform decision making, from long term planning to emergency response, and to ensure that the potential benefit of a fully spatially enabled society are realized.

II. Trends in Technology, Future of Data Freation, Management

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A. New Wave of Data Creation

We are witnessing an exponential growth in both the number of data capture methods and perhaps more significant, in the amount of data being generated and captured. Geography has long been 'mobile'; indeed, one of the most significant trends of the last five to ten years has been the number of devices in use that have Global Navigation Satellite System (GNSS) functionality and an Internet connection and that, as a result, both use and create location information. This trend will continue over the next five to ten years, we can envisage a scenario in which many objects will be, in some sense, a spatial beacon; referencing to or generating location information. The proliferation of low cost, low tech, network enabled sensor be it in mobile phones, computers, energy meters or any other everyday device will mean that previously unimaginable amounts of data will be created [1].

Data creation will be both active but also increasingly passive. Users of social media such as Twitter® and Facebook® are likely to generate vast amounts of spatially related information, without ever being particularly conscious of the fact they are doing so, as detailed information is collected as a product of everyday activities. Tweeting from a place where you have gathered with friends or posting a picture on Facebook from your phone may not be a conscious effort to create or provide spatial information but this is still, in essence, what is take a places. New layers of data will increasingly be generated as a result of these activities, leading to what can be described as 'modelled spatial actor data, whereby information generated by individuals using websites and social media is overlaid on top of spatially accurate spatial information. The information generated through use of social media and the use of everyday devices will further enable the detection of patterns and the prediction of behavior. This is not a new trend many online companies and resources already analyze and interpret information in this way and the proliferation of LBS has been one of the major trends of the last five to ten years. But the extent to which this takes place is likely to continue to grow over the next five to ten years as yet more and more data is generated through such channels.

There is a diverse range of existing demonstrable benefits that suggest this trend will continue from life critical information in the aftermath of a disaster to lifestyle information such as finding a restaurant. In the coming five to ten years, more are likely to emerge, from lowering insurance premiums, to being able to see on a mobile device the nearest source of fresh water or the owner of a parcel of land. Individuals will continue to 'opt in' to a lifestyle that is enhanced by an ever growing number of spatial beacons and sensors, in turn providing 'analytical superfood' that can and will, if used effectively and appropriately, improve people's lives across the globe.

B. Managing of World Data

The creation of such huge amounts of data will bring with it a requirement for the ability to make sense of this data, which, in and of itself, will drive demand for spatial information as people look to location to help to make sense of and identify patterns within the sea of data that is being created. We are currently suffering from a data overload; our ability to create data is, in general, ahead of our ability to use that data effectively to solve problems. There is no doubt that there is a huge amount of value to be gained from the information contained within all this data that is being generated. However, the growth in the amount of data brings with it an ever growing requirement to be able to find the right information at the right time. The huge quantities of data now generated, and the increasing amounts of data that are likely to be created, will bring a requirement for enhanced data management systems. With approximately 2.5 quintillion bytes of data created every day, a significant amount of which will have some kind of location reference, the challenges of data management and data integration will be significant [1].

The need to address this problem will drive one of the main trends in the next five to ten years an increasing use of and reliance on 'big data' technologies technology that enable the analysis of vast quantities of information within useable and practical timeframes. Currently, many of the big data solutions being generated are custom crafted. Technology is already available to deal with big data, but the reliance on this kind of technology will grow in the next five to ten years.

The demand for real time information and real time modelling seems certain to increase in the coming years and presents major challenges. Nevertheless, techniques such as graphical processing units (GPUs), NoSQL and powerful in memory SQL databases are becoming available, which will meet the demand for integrated spatial and non-spatial analytics in orders of magnitude less elapsed time. Looking forward over the next five to ten years, new massively scalable, distributed systems for processing unstructured and semi structured data will emerge, and will become widely accepted and relied upon in the management and interpretation of spatial information. Use of these technologies will facilitate the effective use of the reams of raw data being generated by the increasing number of spatial sensors, eliminating 'the white noise of excessive data enabling us to locate the right information at the right time, thus driving effective and well informed decision making [1].

Whilst the proliferation of devices generating such information may reach most corners of the globe, the funds necessary to collate and manage such data in an effective way may not be so well distributed. There is, therefore, a risk of a digital spatial divide emerging. Technologies, and the financial resourcing required to access such technologies, are not available equally across the globe. Although many developing nations have leapfrogged in areas such as mobile communications, the lack of fibre optics and core processing power may inhibit some from taking advantage of the opportunities offered by some of these technologies. Whilst some of the technological developments highlighted have the potential to reduce costs and increase efficiencies, there is a danger that a lack of funds prevents some countries

from benefitting from these opportunities, thus creating or increasing the division between those who are able to make use of such resources and those who are not. Furthermore, in countries where securing funding to develop a base spatial infrastructure is still the primary challenge, prioritizing the collection of basic spatial data is likely to remain the primary focus. The potential trend towards greater outsourcing and offshoring of processing and analysis, as well as technological developments such as greater use of the cloud discussed in greater detail below could go some way to mitigate this risk.

III. Spatial Information Technique Trends

A. IoT (Internet of Things)

The network of tomorrow, built on an increasing number of sensors and thus increasing data volumes, will produce a hyper-connected environment or 'Internet of Things', with estimates of over 50 billion things connected by 2020. The 'omnipresence' of spatial information5 in our lives, whereby almost all pieces of data have some form of location reference, will continue, with location providing a vital link between the sensors that will generate the Internet of Things and the Uniform Resource Identifier (URI) assigned to a thing or object within that connected world of things. In order to maximize usability this will drive the demand for informative standardized metadata as part of spatial data [2].

We are increasingly likely to see spatial information needed to assist the evolution of this connected ecosystem over the next five to ten years. The emergence and use of precise location information in this way offers great opportunities and will see it form a core part of information technology infrastructure. Nevertheless, use in this way will also present spatial management challenges over the coming years [3]. Below image is used to represent a IoT (Fig. 1).

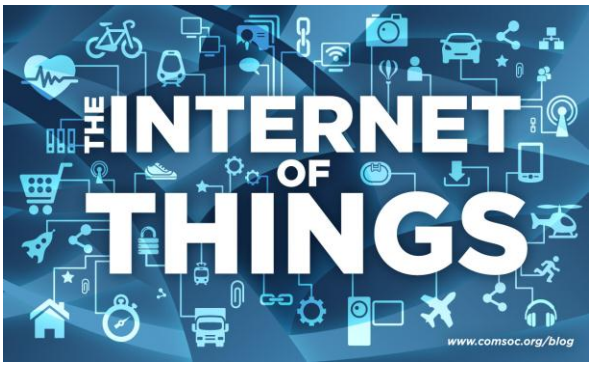

Figure 1. IoT (Roberto Saracco)

B. Cloud Computing

A necessary technology in handling big data cloud computing, the data throughput to other computers connected to the Internet, processing technology, and distributed processing over multiple servers is essential. The core technology of distributed processing, so the cloud is big data and close relationship.

The core technology of cloud computing, virtualization of the distributed processing [4]. What is virtualization server that actually processes the information the only that site is divided into multiple servers at the same time is a technology that enables multiple tasks you rate the utilization rate of the server can increase [5]. Distributed processing on multiple computers share processing tasks and collect the results back through the network is a way. The distributed system consists of a number of computer systems that behave as if they were one single computer system by large-scale operations can be processed quickly [5]. Thus, virtualization technologies and distributed processing technologies, if the data can have a greater efficiency in processing, so if you are using cloud computing technology to great effect can be obtained.

C. 3D Data Management for Big Data

Big Data and efficient processing of such data, analysis, and in order to take advantage of was the emergence, Big Data is usually data volume, variety, velocity as a combination of three factors is characterized by changes [6]. Big Data and analysis techniques for processing such data, the text mining, opinion mining, social network analysis, cluster analysis has dual images similar to nested characteristics of the object together with the cluster analysis technique was used for outgoing [7].

D. Crowd Sourcing

When As mentioned earlier, many of Crowdsourcing development and through user participation can be consumed. Today based on the evolution of online communication technologies with the public to show the infinite possibilities [8]. Crowdsourcing is therefore beneficial to both businesses and the public to be used, a systematic procedure based on a clear sense of purpose can be satisfied through the participants should be provided with appropriate incentives [9].

E. User Participation

Wikipedia users to make their way directly participated map programs are gaining popularity recently. Focusing on user participation in Wikipedia map Global Positioning System (GPS)-equipped people to use a smartphone without any prior knowledge help us be able to create a map of the world. Participation typically made of an open-source map 'Waze' and Open Street Map there [10].

Israel Tal Aviv 'Waze' for the first time in 2006, began. Users are not marked on the map into a dead end when the Wise stood no way connected to the place on the map to display the next place to visit for people who can help. 'Waze' is now the driver of the 14 million people worldwide and is used to edit the map and 45,000 people living in 5,000 people in his area manager to verify the accuracy of the map is active [10].

Open Street Map is a 'Waze' was born with a similar purpose or non-profit model is more like Wikipedia. Open Street Map is like Wikipedia, which anyone can add information to connect to the home page and can be modified because it is free to use. Usage of open street map homepage and searching for the place is similar to

Google Maps. However, unlike Google Maps and Open Street Map is a map, not just anyone can use without having to pay a geographic information features [10].

Recent popular location-based social network services company Foursquare have the same characteristics of the open street map to identify the user where their friends are staying open, make sure that you had to use a street map unveiled last month.

Disaster relief organizations are also 'maps of the terrain is changed just change' increasingly rely on participatory map. Earthquake in 2010 significantly changed the topography of the entire country rescuers in Haiti is that using the example of the open street map. Nine trillion won at the time of the Haiti relief efforts using real-time information to modify the map where the terrain is changed when it arrived and prayed to inform the open street map.

Jonathan Bennett, open street map users "that there is no other way to create a map from the open street map is not inferior to the rate of progress," he said [10].

F. LBS

Location Based Services (LBS) is a wireless Internet user, user-specific information according to the changing location of the points to provide wireless content services. Location Services (LCS) may be referred. The main advantage of the LBS wireless mobile Internet users in multiple locations, but directly enter the address or area classification, and that you do not have GPS positioning technology make it possible to easily access the wireless Internet access technology is one of the major factors [9].

- **Here are some examples of location-based services are**: ATM, restaurant, close to the location of services and facilities to look up information. Save your gas station location information and notification services, such as traffic congestion warning. Find a friend's location [11].

LBS market has gradually expanded the number of services being offered internationally.

IV. TRENDS IN 'OPEN' TECHNOLOGY

A. Open-Source

Open-Source solutions are likely to grow significantly as a viable alternative to proprietary suppliers. The open source spatial community already has a well-established 'infrastructure' through the Open Source Geospatial foundation (OSGeo) and a vibrant and relatively tight knit community who champion its potential. The drive by governments towards greater acceptance of open-source solutions may remove many of the perceived barriers to wider adoption, as the value will grow as more users adopt these solutions and feedback improvements. A number of NMCAs those government bodies responsible for the provision of authoritative spatial information within a country have already adopted open-source solutions into some of their services [12].

Three trends seem likely to drive this adoption. Firstly, in countries where resources are particularly scarce, the availability of free to use software clearly has upfront economic benefits. Secondly, the ability to share and modify software relatively easily also helps to facilitate knowledge exchange and the building of common user communities. In countries where the development of spatial infrastructures is in its early stages, the availability of open-source solutions offers a genuine alternative to previous operating methods. Finally, the next generation of spatial graduates will have been exposed to open source during their academic studies and potentially in their personal lives and hence will be technically as well as culturally attuned to using it. Significant education will be required on the total cost of ownership of open-source technology, recognizing that even when the core software may be free open source technology development and maintenance costs can attract labor costs [12].

B. Open Standards

There are a number of organizations, at both national and international levels, responsible for the development of standards for use in acquiring, implementing, maintaining and using spatial data. At an international level these are led by the Open Geospatial Consortium (OGC®) and the International Organization for Standardization (ISO®) in partnership with many broader technology standards organizations to ensure interoperability. The standards developed by these organizations will continue to enable interoperability throughout the industry and improve access to data across the world. Open-source solutions are likely to grow significantly as a viable alternative to proprietary suppliers [13].

C. Open Data

The drive for access to government generated spatial information free at the point of use is likely to continue, albeit in an uneven way, in the coming years. A number of trends will drive this. The most significant force behind this is simply the widespread availability of other mapping information free at the point of use. The Internet has shaken the foundations of a huge number of content based industries. The creative industries, particularly music and movie, have been arguably the highest profile of the industries affected by this trend (Fig. 2). However, spatial content providers, particularly NMCAs, are not immune from this trend [14].

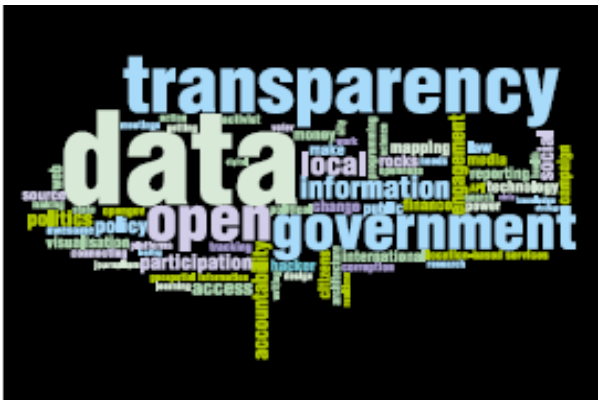

Figure 2. Open data (French-Startup)

One of the greatest policy challenges over the coming years in the global spatial community will be how countries can meet the increasing demand for free content that the internet and the presence of organizations, such as Google® and Microsoft®/Bing®, has brought. This may particularly affect those who still require significant funding to improve the quality of core spatial information in their country. However, in the next five years the drive for open data is likely to face two main counter pressures; funding, especially where making the data open carries a cost and/or where it is currently charged for; and security/privacy issues.

D. IoF (Internet of Free-Open)

Currently flow is latest information between users blogs and social networks that you can share the spotlight with the biggest issue is covers the nature of the service. Most of the IT services, the trend is utilized.

We supposed to make the upgrade of 'IoT'. So, this project name is 'IoF'. 'IoF' means 'Internet of Free-open'. 'IoT' is take advantage of anytime and anywhere, but separate management system is needed.

However, 'IoF' is we think that you can solve these problems. Because 'IoF' is maintenance free-open internet. So, Consumers may be managers or providers. This suggest to from user participation.

This is no longer a passive consumer of the information location means does not preferred activity.

Thus, the market related information in the map, in your role as a provider of essential being. Generating the user to date data that can provide the service needs of the growing spot became.

We think we know all the advance, we will provide the appropriate services. This is only 'IoF'.

V. Extracting Value from a World of Data

Although the use and availability of spatial information will be increasingly democratic, for reasons identified elsewhere in the paper, the proliferation of data, especially unstructured data, will place a premium on highly skilled data modelers. Even among the leading database companies and most advanced NMCAs, the number of experts who truly understand the interrelationships between data models and data flow is generally quite low for each organization.

Data models will need to continuously evolve to answer the range of questions and manage the rising volume of data. Hence the training of a cadre of data experts, who understand the additional complexities of spatial, non-spatial data and time based data, must be a priority if the potential benefits are to be realized. In the future this expertise is likely to reside in all sectors and hence it will be in the interest of all to sponsor appropriate education. As today, much of this will be in collaboration with the academic sector, but increasingly focused in the areas of mathematics and computer science, rather than in the more traditional geographical information systems (GIS) field.

There will of course continue to be a role for traditional GIS skills, as data outputs will still need interpretation to create information for decision‐ makers. However, these experts will need to become more comfortable with interpreting fuzzy and unstructured data and will also need to find more effective channels for communicating their results.

There is still a tendency in many organizations to see GIS as a backroom function with little connection to policy or action; hence, as well as continuous development of technical skills, there is a need to focus on equipping spatial experts with softer skills in areas such as communication, presentation and influencing.

As mentioned previously, the development of robust open-source technologies will also gain further momentum over this period, and will increasingly sit alongside proprietary solutions, as has happened elsewhere in the software industry. Developers will need to be comfortable in both environments the option to specialize in one 'language' will no longer be sufficient.

This type of learning would be particularly enabled through building global networked communities to share experience and ideas, reducing the reliance on formal structures.

VI. The Future Role of Spatial Data Management

Many of the changes mentioned in this document will have a considerable impact on the role of governments in spatial data provision and management. However, despite the increasing number of organizations and entities collecting spatial information, NMCAs and indeed government and business users of spatial information are unlikely to be able to or wish to wholly rely on data from the private sector or other sources.

As such, governments will remain in a unique position to consider the requirements for spatial information for society as a whole and will continue to play a key role in providing a reliable, trusted and maintained spatial information base. The exact role a government chooses to take in spatial information management, the predominant challenges faced and the changes made will inevitably vary from country to country.

In some countries, a major trend will be to replace obsolete data collected many decades ago as the economic benefits of up to date data can now be quantified; in other countries a major trend will be adapting business models and access regimes to meet the changing expectations of an ever more demanding customer base accustomed to easy access to online mapping in a user friendly environment. Some countries will look increasingly to limit their activities to what may be seen as their core task whilst in others the focus may be on increased engagement and partnership with the private sector. Nevertheless, as in the previous ten years, government providers of spatial data are likely to witness significant change in the coming years. Fig. 3. We suggest that future of 'IoF', similarly to trends in collaboration.

Figure 3. Future of IoF, trends in collaboration (Kurt Mueffelmann)

VII. Future of Spatial Information Base (Conclusion)

A number of uses of spatial information, essential for sustainable economic and social development and in some cases life critical, rely on the provision of spatial information that is detailed, is provided to a high level of specified accuracy across an entire country is trusted and is regularly maintained. This information is used in many ways, but by example, it provides the registers of land to enable a managed system of property ownership and dispute resolution; assists in identifying health inequalities and effectively targets interventions to household level; and is used to route emergency response vehicles to a major incident, ensuring that all those responding have a common operating picture.

The procurement of data from a wider number of sources could release human and financial 33 resources that can then focus on overseeing the management and maintenance of the data collected. Effort can then be put on ensuring that rich sources of information are available, are maintained and are available as widely as possible.

The role of government as an authoritative supplier of quality, detailed and accurate spatial information, drawing on the wide range of valuable sources of information, will become increasingly crucial as awareness of the value of spatial information increases amongst decision makers and reliance on this information in the decision making process increases. End users should be able to consume government assured spatial data with the level of trust in its quality and provenance as they do when they consume water from a tap or electricity from the socket knowing that as soon as they access data from that source they are going to get what they expect every time.

Spatial information has a key role to play in delivering sustainable social and economic development across the globe. As economic and social issues continue to increasingly be cross border in nature, we will see the growth of regional and global cooperation and solutions between NMCAs, and also with and between other regional and supranational agencies such as the UN. Awareness and understanding of this is likely to increase in the coming years as more people interact with spatial information and an ever greater number of people experience the value of using spatial information to inform decision making. Governments have a key role to play in bringing all actors together to ensure that our future society is a sustainable, location‐enabled one, underpinned by the sustainable provision and effective management of reliable and trusted spatial information.

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References

[1] C. B. V. Lawrence, "Future trends in geospatial information management: The five to ten year vision," *UN-GGIM (United Nations Initiative on Global Geospatial Information Management*, pp. 1-42, 2014.
[2] Wikipedia, "IoT (Internet of Things)," Wikipedia, 2012.
[3] R. Saracco, "The internet of things (and with things)," *IEEE Communications Society*, 2014.
[4] M. Armmrust, "A view of cloud computing," *Communications of the ACM*, vol. 53, pp. 50-58, 2010.
[5] L. M. Vaquero, L. R. Merino, J. Caceres, and M. Lindner, "A break in the clouds: Towards a cloud definition," *ACM SIGCOMM Computer Communication*, vol. 39, pp. 50-55, 2009.
[6] O'Reilly Radar Team, *Planning for Big Data*, O'Reilly, 2012.
[7] M. M. Kang, S. R. Kim, and S. M. Park, "Analysis and utilization of big data," *Journal of Information Science*, vol. 30, pp. 25-32, 2013.
[8] J. H. Yoo, "The wisdom of the masses to be successful crowdsourcing is mine," LG Business Insight, pp. 46-53, 2010.
[9] M. Kalsi, "Crowdsourcing through knowledge marketplace," SpinAct, 2010.
[10] Wikipedia Today, "Wikimap, hot issue user participation (crowd mapping) map," *Kyunghyang News*, 2012.
[11] Y. W. Cho and S. W. Hwang, "A study on LBS technique make for CRETA LBS platform service," in *Proc. ICCSP*, 2014.
[12] K. R. Lakhani and E. V. Hippel, "How open source software works: Free user to user assistance," *Research Policy*, vol. 32, pp. 923-943, 2003.
[13] T. Simcoe, "Chapter 8: Open standards and intellectual property rights," in *Open Innovation: Researching a New Paradigm*, Oxford University Press, 2005.
[14] S. R. Auer, C. Bizer, G. Kobilarov, J. Lehmann, R. Cyganiak, and Z. Ives, "DBpedia: A nucleus for a web of open data," *The Semantic Web. Lecture Notes in Computer Science*, vol. 4825, pp. 722-735, 2007.

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