Timing - Spatial Information System is Tte Information Infrastructure to Develop the Smart World

Prof. Dr. Dang Hung Vo and Prof. Dr. Pham Van Cu (Vietnam)

ABSTRACT:

Currently, in the world as well as in Vietnam, people's great efforts have been focused on moving from the "electronic" stage to the "smart" stage under the impact of 4 generations of technology to create the development of humanity: mechanization, electrification, information-telecommunication technology and artificial intelligence. This article provides an analysis of the human development under Alvin Toffler's view of three civilizations: agricultural civilization (based on manual labor); industrial civilization (using machines to replace manual labor); information civilization (using machines to replace intellectual labor).

Based on this analysis, the article points out the opportunities and challenges in the transition from "electronic" period to "smart" period. Finding the right road map of development will help countries to shorten the time and distance to the destination of a "smart country", especially for developing countries. In a "smart country", the development scenario achieves the optimal plan, the cost of development is minimal, the benefits are maximal, and the people are most satisfied with all public utilities. Artificial intelligence will help people always to find the best solution when information is full, correct, continuously updated and all entities are connected in real time. Therefore, it can be said that artificial intelligence is only a means and essence of development is based on the decisive role of information.

All types of information have spatial and temporal attributes. In other words, information must be determined at a specified location and at a specified time in a timing-spatial reference frame of the real-world. Thus, to create a complete information system, the first thing to do is building timing-spatial information systems of the real-world. That is the real-world model that artificial intelligence needs to be aware of to analyze and to propose decisions for development. Unlike human intelligence based on qualitative thinking, artificial intelligence must always be based on quantitative thinking, that is, based on the quantitative analyses of data from the real-world model. The real-world is not static but always changing. Unmanned entities controlled by artificial intelligence must also know where they are, at what time and the timing-spatial relationship with other entities. All entities must be positioned and connected in a timing-spatial information system of the real-world. Thus, the timing-spatial information system always plays the role of information infrastructure in the information civilization.

I. TREND OF WORLD DEVELOPMENT

Recently, it has been emphasized that four important steps of technological invention have created changes of the world: the first is the steam engines; the second is the electricity; the third is the electronic machines and the fourth is the artificial intelligence. Such classification is only technically meaningful, it is not critical to human development. Similarly, when technology has not yet been strongly developed, philosophers around the world only saw the development process of humanity based on socio-economic forms. Both views lead to certain defects.

From 1970 to 1990, Alvin Toffler, an American writer, wrote three books about forecasts of the world future based on analyses of the human civilizations. They are "The Future Shock" (1970); "The Third Wave" (1980); and "The Power Shift" (1990). The civilizations have been identified in accordance with socio-economic forms impacted by the technological development. Three civilizations of mankind include the "agricultural civilization" developed by manual labor, the "industrial civilization" developed by replace of the manual labor with mechanical machinery, and the "information civilization" developed by replace of the intellectual labor with information machinery. The technological development is the key factor that makes mankind shifted from one civilization to the next.

Based on Alvin Toffler's view point, mechanical machinery has made the shift from the agricultural civilization to the industrial civilization, in which the first step is steam engines and the next step is electric engines; then electronic machinery has made the shift from the industrial civilization to the information civilization, in which the first step is electronic machines and the next step is artificial intelligence. Of course, artificial intelligence can only work effectively while it has full needed information about all related things that are connected in on-line and real time mode. At the world-wide scale, the electronic machines have created the "electronic world" with e-commerce, e-administration, e-citizen, e-society, e-government, etc. and the artificial intelligence has created the "smart world" with smart-house, smart-transportation, smart-city, smart-administration, smart-society, etc.

Each civilization has its own driving force. In the information civilization period, the key driving force is information that has created very high value added for all commodities produced in agricultural, industrial and servicing sectors. From the other side, information has also changed the way of life, the way of production of human society. In terms of managing and providing the public utilities, information and artificial intelligence have made the cost much lower with the highest quality.

From the above arguments, one immediately poses an essential question: what do smart-things? Of course, the goal is not for displaying the beauty of technology, but rather the essential

goal is for bringing higher efficiency and effectiveness in human life, in order to create greater people's benefits and satisfaction with low cost.

The concept of "smart" has newly been adopted during some last years, that is associated with the fourth technological generation. Currently, people's efforts have been focused on development of basic elements of the "smart" generation, such as producing artificial intelligence (AI), linking related things by Internet (IoT - Internet of things), archiving and processing big data, and providing pilot construction of "smart" objects at small scales, such as smart house, smart airport, smart city, etc. Until now, there are no any criteria, indicators to rate the "smart" level of certain object. Of course, to get the goals of the fourth technological generation, every country should stand on high level of the electronic generation (the third technological generation).

To assess where Vietnam is in the world map of the electronic generation, we can use the results from United Nations' survey on construction and operation of e-government for 193 countries/economies in the world in 2016 and 2018[1]. The surveyed results are presented in the Table 1 below, in which there are 5 countries at the top positions of the world, 5 countries at the bottom and 10 countries of ASEAN community. The table 1 displays the rating score of e-government development indicator and the rank of countries. In 2016, Vietnam has the score of 0.5143 (in the world, the highest score is 0.9193 and the lowest score is 0.0270) with the rank of 89, and in 2018, the score is 88 (in the world, the highest score is 0.9150 and the lowest score is 0.0566) and the rank is 88. Seeing whole picture, it can see that Vietnam belongs to the middle group of the world as well as of the ASEAN region.

Results from United Nations' survey on e-government in the world

Country	**Score of E-Government Indicator**		**Rank of Country**	
	2016	**2018**	**2016**	**2018**
Denmark	0.8510	0.9150	9	1
Australia	0.9143	0.9053	2	2
Republic of Korea	0.8915	0.9010	3	3
United Kingdom	0.9193	0.8999	1	4
Sweden	0.8768	0.8882	6	5
Singapore	0.8828	0.8812	4	7
Malaysia	0.6175	0.7174	60	48
Brunei Darussalam	0.5298	0.6923	83	59

[1] Every two years, United Nations conducts survey to rate 193 countries in national achievement of e-government. The survey is conducted based on 3 groups of indicators: "On-line Services", "Telecommunication Infrastructure" and "Human Capital".

Thailand	0.5522	0.6543	77	73
Philippines	0.5765	0.6512	71	75
Vietnam	0.5143	0.5931	89	88
Indonesia	0.4478	0.5258	116	107
Cambodia	0.2593	0.3753	158	145
Myanmar	0.2362	0.3328	169	157
Lao PDR	0.3090	0.3056	148	162
Eritrea	0.0902	0.1337	190	189
Chad	0.1256	0.1257	188	190
South Sudan	0.1791	0.1214	183	191
Niger	0.0593	0.1095	192	192
Somalia	0.0270	0.0566	193	193

II. OPPORTUNITIES AND CHALLENGES OF THE SHIFT FROM THE "ELECTRONIC" GENERATION TO THE "SMART" GENERATION

As mentioned above, the information-communications technology (ICT) has created a new kind of servicing commodities with adjective "electronic" stood before the old name such as "e-commerce", "e-administration", "e-payment", etc. and since then, social entities have also been changed electronically such as "e-government", "e-society", "e-business", "e-citizen", etc. When it comes to the use of artificial intelligence, this "electronic" adjective is practically changed to the adjective "smart". It can be said that the first idea was proposed by Bill Gate while he built him smart home based on creation of conveniences by application of ICT to accommodation. Since then, the "smart" concept has been used quite popularly such as "smart shopping", "smart city", "smart administration", etc. Some scientists have also proposed using the adjective "information" stood before the traditional names to call goods, activities, entities in the fourth technological generation such as "i-administration", "i-business", "i-society", "i-government", etc[2]. This proposal mostly did not get consensus for two reasons: firstly, the "i" was used by Apple to refer to its products such as "iPhone", "iPad", "iOS", etc.; secondly, the adjective "smart" is closer to the understanding of real life (adjective "information" means more scientific manner but far from the reality).

So far, there has not been a definition of typical products in the fourth technological generation and how to call them accordingly. In fact, it is creating a habit of calling these elements associated with "smart" adjective. We can take an example of "smart city", each group

[2] Prof. Dr. Jan Williamson in analyses of development process of land administration.

of people on their post has a specific perspective on smart city and gives definition of "smart city" in accordance with that perspective. The urban manager has an understanding of smart city different than urban service providers. Almost all of them have a common understanding of "smart city" that ICT technology has a very strong impact to make fundamentally changes of the way of human settlement in urban areas so that to get more benefits and lower cost for people.

The nature of "smart" adjective is referred to that the artificial intelligence gradually is replacing the human intelligence in management work for all human activities, creating a system with some characteristics as follows:

1. The system is operating with the participation of artificial intelligence automatically handles and decides within the scope permitted by people, without the need of human decision. For example, a smart transportation system is itself operating to issue its own decisions on guiding all entities participating in traffic to go along the road without traffic congestion. Certainly, this system is smarter than the system directed by human intelligence while the smart transportation system is linked to a full, accurate and updated geographic information system with the detailed transportation network and connected with a digital cameras system for capturing the actual transportation activities. The human intelligence cannot immediately find the optimal way from the start to the destination while at some points there are traffic congestion. In contrast, artificial intelligence is easily and immediately enabling to find the optimal way. That means artificial intelligence associated with a timing-spatial information that is connected in on-line and real-time mode to actual information capture system enables to make optimal decisions that people cannot do.

2. Human thinking is based on qualitative considerations, but on the contrary, the thinking of artificial intelligence is based on quantitative considerations resulted from quantitative analyses of related data. Thus, in order to use the superiority of artificial intelligence, it is necessary to have a fully, accurate and updated information system referenced to the real-time geo-spatial information system to analyze needed data for making reasonable decisions. The timing-spatial reference system here is a GIS which is updated continuously over time and plays the role of real-time model of the real world. Thus, in the fourth technological generation, the traditional GIS will be shifted to the form of Virtual Reality (VR) linked in on-line and real-time mode with Real Reality (RR). From this view point, there are many points of artificial intelligence that cannot get the effectiveness of the human intelligence, such as decisions that need humanistic sensitivity, or decisions that require human senses. On contrary, the artificial intelligence can issue optimal decisions based on qualitative analyses of data that the human intelligence cannot do it.

3. Using artificial intelligence will reduce the human capital in management works and achieve optimal decisions with very high quality. The inevitable consequence is low cost and high benefits. Of course, the initial investment cost will be higher than the one implemented by

the traditional way based primarily on human intelligence. Thus, looking at the initial stage, the costs can be higher than the benefits, but under the mid-term and the long-term vision, the benefits will be much higher than the costs. The story of investment to "smart" objects story is similar as the investment to "green" objects under the view point of the green development philosophy. More extensively, many people predict many shortcomings that people will be faced in development of the fourth technological generation. That is the problem with jobless, while the human labor will be greatly replaced with information machines. Of course, in current time, it is too early to say about how the world will be changed in the information civilization. We can be sure that the social structure as well as the measure of social benefits distribution will totally be changed.

Thus, the transition from the "electronic" stage to the "smart" stage is a transition from the early stage (ICT plays a central role and information plays a supporting role) to the final stage (information plays a central role and ICT plays a supporting role) in the information civilization. This is a great opportunity to complete the full information civilization, to create excellent benefits from development, to change the social structure of labor, employment and the human enjoyment. The shift from the industrial civilization to the information civilization will bring huge benefits to humanity in comparison with the one from the shift from the agricultural civilization to the industrial civilization. People will work less and enjoy more.

Opportunities are like that, but challenges are also very important factors, especially for countries that have not completed the industrialization stage, specifically below:

1. Finding a specific way to move from the "electronic" stage to the "smart" stage is not an easy way. In general, what road map for building a smart country or a smart society is always a big question. In developed countries, people have tried to build "smart" objects at small scale only, such as smart airport or smart island of tourism. This is a big challenge on finding the right way to build smart objects at large scale.

2. The technological factor still needs further development to solve the issue of big data from the real-time and on-line capture of data related to all human activities, that must be referenced to the timing-spatial information system. The geo-spatial information concept organized based on the traditional GIS technology must be transferred to the concept of timing-spatial information system. This is a big challenge on archiving, managing and processing big volumes of data.

3. The move to the "smart" generation requires a huge initial investment, but the current financial capacity of both the public and private sectors is not enough. Moreover, the initial investment also needs to create a synchronous program with the participation of many sectors. The synchronization should include investment to completion of the technological infrastructure, to the information infrastructure and to high-quality human resources. Any asynchronous investment or improper investment leads to waste and does not lead to the goal

of "smart" generation. This is a big challenge on enabling financial capacity for initial investment and suitable methods for infrastructure investment.

Vietnam has the idea on development of the fourth technological generation (called in Vietnam technology 4.0) in a direction of finding the shortcut way, but it is not clear how to do it. Several concepts related to the "smart" term are not well defined, such as the "information infrastructure", "block-chain technology", etc. It is a lack of financial resources for investment, especially for investment to technological and information infrastructure as well as for investment high-quality human resources. In general, Vietnam has already introduced a great ambition to develop the "smart" generation to catch up with developed countries by a shortcut way. From good practices in the world, this shortcut way can be found thanks to quick development of high-quality human resources. It is no any shortcut way to the "smart" generation while the "electronic" generation has not been completed.

III. TIMING-SPATIAL INFORMATION IS THE INFORMATION INFRASTRUCTURE FOR DEVELOPING THE "SMART" GENERATION

The "smart" generation is organized likely the human body, in which artificial intelligence is regarded as the brain; the timing-spatial databases integrated with the social-economic-environmental data are considered as information stored in the brain; capture of the information about all human activities by auto-sensors located where necessary is understood as human senses; and telecommunications network plays a role of human nervous system to transmit data between the brain and other parts of the body. From this description, we can see that for building a certain "smart" system, it is necessary to follow the specific steps as follows:

1. Building a network of telecommunications for on-line connection of all entities participating in the system. This is the technical infrastructure for information transmission between entities so that we can know all activities of the system. All types of information captured from the system are data input for processing by AIs to issue decisions.

2. Installing specialized AIs in accordance with the system management function to make appropriate decisions. This is the brain of the system, automatically making decisions in operating the system.

3. Constructing the timing-spatial information system to accurately and completely describe the current status of the system in operation, thereby the system enables integration of all information about the human activities into the timing-spatial information system to create the integrated on-line and real-time database of the systems. In principle, any information must have spatial and temporal attributes; i.e. we should know where and when that information occurs. From a different perspective, information shall be fully valued if that is tied to real-time geographic information. Because of this, the timing-spatial information system plays the role of timing-spatial information infrastructure.

4. Installing system of auto-sensors to capture all real-time changes of the geographical space and the human activities as a requirement for real-time updates of the entire system. In this perspective, the traditional GIS will be replaced with the real time GIS integrated with all real-time information about human activities to create an information system for operation of the "smart" system.

The above talks about the general concept of a certain "smart" system's operation. In fact, every system is tied to the real earth. In other words, the spatial information system here is the GIS, i.e. the real world model. In terms of the timing factor, traditionally it is called as the spatial factor promptly updated. According to the modern concept, geographical updates have been replaced with the concept of on-line and real-time connection. The concept of geographically updated GIS shall be shifted to the GIS depending on time or timing-spatial information system T-SIS.

Coming back to the development process of the real world model. An idea from the past, people really want to realize clearly where they are living. On a large scale, people want to find ways to build a real world model. While this model contains full and accurate information, people can be fully aware of the whole place where they are living and can find ways to make changes for development (called as planning) to get more benefits. A common model in the first and second technological generations is that people have created a real world model in the forms of maps. Due to a poor nature of information, a lack of accuracy and a slow updates, maps presenting the real world model did not meet people's requirements of information.

Since the "electronic" technological generation began to develop, the real world models have been developed in the form of GIS, instead of traditional maps. GIS has a large capacity to store information, and it can integrate all data associated with all human activities in every geographic location. GIS contains not only spatial information, but also timely updated spatial information.

In the "smart" technological generation, GIS is the timing-spatial information system, that is linked with all data collected from all human activities in the real world. The real-time GIS can be considered as a chain of traditional GIS at the moments t_1, t_2, ..., t_n. From the reason of timing dimension, the real-time GIS contains a huge volume of data. The concept of big data is formed and becomes a big challenge for technology.

The following is an example of the technology and information infrastructure for operating a system as a smart city. In order to build a smart city, we must firstly build a real-time GIS (a timing-spatial information system) integrated with all information about citizens, organizations, transport, economy, society, environment and all urban activities, etc. This real-time GIS is connected by on-line and real-time mode to all entities of the city, all urban activities. From the other side, the real-time GIS is also connected to the CORS system and all remote sensing ground stations for geographical updates.

In this context, the timing-spatial information system (real-time GIS) that fully describes all urban activities will become a virtual reality presenting the real reality happening on the ground. On-line connectivity has led to the development of GIS to become a virtual reality that connects on-line with the real reality.

Timing-spatial information system serving for smart city operation

Thus, it can be seen that the timing-spatial information system is the information infrastructure for building complete information system in the "smart" generation for the following reasons:

- Every information has sufficient spatial and temporal attributes because each one is attached to a specific location in the timing-spatial information system.

- "Smart" system is operated on real world. The timing-spatial information system of the real world is a model of the real world on which people are possible to perceive and find ways to form reasonable scenarios for development.

- Artificial intelligence has no qualitative thinking as human thinking based on human senses, but it requires sufficient and accurate information to create quantitative thinking based on analyses of data for issuing decisions.

- All decisions on management and development management for a concerned system are based on AI's analyses of data taken from the timing-spatial database of the system.

From the said above contents, it can be seen that the most important thing for building and operating any "smart" system must start with building the timing-spatial information system as information infrastructure of the system.

IV. OPPORTUNITIES AND CHALLENGES FOR THE FIELD SURVEY AND MAPPING

In the "electronic" generation, the field of survey and mapping has made great strides when taking advantages of satellite technology and information-communication technology. Since then, the concept of "3S" including GNSS (satellite navigation satellite system), RS (remote sensing) and GIS (geographic information system) have created 3 key pillars of technology for development. The concept of kinematic survey and mapping has been formed.

Geodetic networks have changed from static triangulation network to static GNSS networks, and then continued to move to the CORS network (Continuously Operating Reference Station). Since then, real-time kinematic GNSS technology has enabled precise positioning of all objects mounted with a GNSS receiver.

Remote sensing data collected by a variety of cameras with many types of waves that are mounted on flying vehicles, water or land transport means allow to record details of land surface, sea surface, and seabed. This remote sensing technology has ensured the acquisition of detailed spatial information associated with recording the real time. Currently, the accuracy of detailed points is not very high, but it can be reached much higher in near future. In ground survey, modern total stations enable collection of real-time-based spatial information.

The technology of spatial information systems including geographic information systems (GIS) and land information systems (LIS) in the static manner have fully been solved. For the concept of timing-spatial information system, the timing dimension has been regarded in the technical standards of geo-spatial data, but there are several problems with big data processing in modeling the on-line and real-time based real world. From the other side, the issue of big data processing is also happened in linkage between the timing-spatial information system and the social-economic-environmental data collected in on-line and real-time mode.

The opportunity for the field of survey and mapping has already been identified as an important role in the production of information infrastructure for "smart" systems. It is the timing-space information system. In this opportunity, the kinematic positioning technology by

GNSS and detailed information collection of the Earth by RS and ground survey technology have fully been solved. The next development should be concentrated on further technological upgrade to have better, stronger, faster and more accurate data. In contrast, establishment of the timing-spatial information system as an on-line and real-time model of the real world is being defined as a huge challenge in archiving, managing and processing big data with participation of the time dimension in the information system. This challenge is not only happened in the field of survey and mapping, but also it is a major challenge in the fourth technological generation.

V. CONCLUSIONS

In general, development of the "smart" generation is being formed as a key trend in the world. In Vietnam, the State has decided to build the needed infrastructure for development of the "smart" generation. It is a great opportunity for the field of survey and mapping, that also faces great challenges.

From theory as well as practice, the timing-spatial information system plays the role of an information infrastructure for developing "smart" generations. On the one hand, timing-spatial information is the basis for determination of the spatial and temporal attributes of all information. On the other hand, the timing-spatial information system is the real world model that can be connected to all human planning and activities. Thanks to the IoT, the timing-spatial information system enables us to introduce the scenario of development, to play the role of monitoring and evaluation tool, and to provide input data for AI to make decisions. Of course, the timing-spatial information should be worked based on the on-line and real time connection with all types of sensors for collection of data.

The field of survey and mapping plays a large role of modelling of the real world from human needs, but from the history, technology did not allow to satisfy the needs. Since information - communication technology and satellite technology have been operated, the field of survey and mapping has created strong and approachable steps to satisfy all the human needs. Entering the "smart" generation, the field of survey and mapping has the main task of producing timing-spatial information, creating information infrastructure for "smart" world development.

REFERENCES

[1] **Alvin Toffler**, 1970, The Future Shock, Bantam Books of US.

Alvin Toffler, 1980, The Third Wave, Bantam Books of US.

Alvin Toffler, 1990, The Power Shift, Bantam Books of US.

[2] **Ian Williamson**, 2008, Global Challenges for Land Administration and Sustainable Development, Proceedings of Conference "Toward a 2015 Vision of Land", held October 24-25, 2007, at the International Center for Land Policy Studies and Training in Taiwan.

[3] **Peris-Ortiz Marta, Bennett Dag R., Yábar Diana Pérez-Bustamante**, 2016, Sustainable Smart Cities: Creating Spaces for Technological, Social and Business Development, Springer.

[4] **United Nations**, 2016, E-Government Survey 2016, New York, UN Public Administration.

United Nations, 2018, E-Government Survey 2016, New York, UN Public Administration.