National Information Technology Infrastructure and Spatial Data Management

G. O. Ajayi*

Abstract

Geoinformation has become an indispensable tool in planning and decision-making worldwide. As a result of the convergence of information, telecommunications, broadcasting and computers, the ICT sector now embraces a large range of industries and services. Hence, National Information and Communication Infrastructure must be developed for integration into the Global Information Infrastructure (GII). Obviously, telecommunication infrastructure constitutes a major backbone of the GII. Information and Communication Technology has now provided unprecedented facilities and opportunities to developing countries to leapfrog into the knowledge-driven global economy and enjoy the benefit for socio-economic development offered by the information age.

1.0 Introduction

Nigeria is fast moving into being an information and knowledge-driven society – especially with the current emphasis on Information Technology. Recent initiatives by the Federal Government, including the approval of the national IT Policy by the Federal Executive Council in March 2001, the establishment of NITDA as the implementation body of the IT policy in April 2001 as well as seeing Information Technology as a national priority, make it clear that within a few years an unprecedented capability will exist for sharing of data. Also, the awareness and utilisation of the advanced

*Late Professor Ajayi was the Director General of NITDA before his death in 2004.

technologies viz. Advanced Computers, High Resolution Satellite data, GPS, GIS, etc., and the power of Spatial Information System oriented towards decision-making and resource management, is growing rapidly in the country.

The task of organising a national infrastructure for the maintenance of structured geospatial datasets in a large country like ours is a challenging one on account of its data-generating agencies in the public and private sectors being widely distributed at various levels of administrative zone. The endeavour, besides laying down the policies and technologies, has also to concentrate on bringing the stakeholders (agencies and institutions) together to share their data and identify opportunities for integrated planning of sustainable development. The major goal of National Surveying and Mapping Infrastructure (NSMI) or National Geospatial Data Infrastructure (NGDI) will be to improve the ability of geospatial information acquisition, processing, storage, management, distribution and utilisation.

2.0 Geoinformatics

Geoinformatics represents today the most efficient tool for managing data in space and time. Geoinformatics data can describe all natural and artificial objects being on the earth's surface, as well as any natural, cultural and human phenomena, referring to a given geographic location. Reliable and sufficient geoinformation has become the fuel driving the engine of growth and sustainable development of any nation. In many developed countries, over 80% of planning and decision-making are based on geoinformation.

The geoinformatics data is a special sort of information data that describes spatial relations of the local, regional or global environment: What is where? Where is what? Today, technical level in the country, most especially with the launching of Nigeria Sat-1, enables us to achieve intelligent connection; efficient acquisition, processing, analysis and display of map reference data. The geoinformatics data created this way is able to satisfy the users' demands in wide circles, using information technologic elements. The geoinformatics data represent one of the most valuable sorts of data because of their strategic character, wide applicability in public administration, local governments and business life. Most of the massive socio-economic

problem normally associated with rapid urbanization could be solved using spatial data to make broad based decisions.

The most fundamental elements of spatial data are those that are used for creating the highest number of further datasets called basic data. Those basic data represent the data-infrastructure, which naturally includes the system of standards, regulations, and services. In the most developed countries – based on a strategy developed as a result of wide agreement – defining the know-how of production, the servicing fields are mostly the following:

- Reference, reference system data,
- Public administration borders,
- Aerial photos, orthophotos,
- Relief, terrain relations,
- Traffic network,
- Hydrography,
- Cadaster,
- Surface cover and its subsystems,
- Demographic survey and tourism,
- Environmental protection,
- Geology,
- Eco-system, and
- Others.

3.0 Information Technology and National Geospatial Data Infrastructure (NGDI)

Information Technology has already conquered almost all fields of life, supporting private sphere, business world, public administration and governmental sections, increasing the efficiency of information procedures. The information revolution is changing everything about the world we live in, including the practice of development. ICT has the potential to create jobs, improve access to basic services, and increase the sharing of information between people living in different parts of the world.

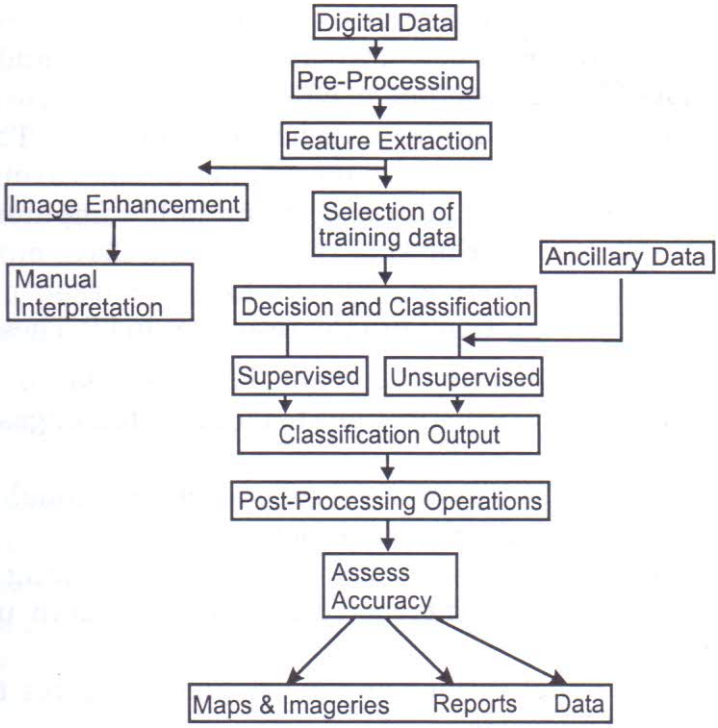
One can see explosion-like development in the fields connected to geoinformatics data. Currently in this country, the efficiency of applications stays much behind the level offered by technology in many application fields. This is because of unsolved economic, organisational and legal questions. Considering the complexity and expenses of geoinformatics data production, the increase of efficiency of

geoinformatics information procedures and also the regulation of the procedures, are basic governmental tasks. A good National Geospatial Data Infrastructure (NGDI) will therefore aim at:

- providing easy, consistent and effective access to geo-referenced
- geospatial information for promoting economical development and to foster environmental sustainability;
- formulation of common solutions for discoveries access and use of geospatial data in response to the needs of diverse user groups;
- building relationship among data-generating agencies by co-ordinating the production and sharing of geoinformation;
- standardisation of data exchange formats, meta data and policies of desensitisation of data;
- saving duplication of efforts by various data- generating agencies thereby removing unnecessary overlap.
- ensuring continuous support for the development of NGDI by increasing awareness and understanding vision, concept and benefits of NGDI.

A functional NGDI cannot be achieved without an efficient national ICT Infrastructure. ICT component of NGDI will ensure a co-ordinated effort in the production, management, sharing and use of reliable/standardised geoinformation at the various levels of government local, state, national and international-with linkages with the private sector. For instance, the high-resolution data made available from Nigeria Sat-1 require a high-capacity computer system for analysis. Therefore, the development of hardware and software, data processing and data interpretation, as well as the possibility of merging satellite data with additional topographical or geophysical and thematic information, are required to make satellite remotely sensed data an extraordinary tool for decision processes.

Typical GIS combines data from many sources.



4.0 NITDA Strategies and Plans

NITDA has become a clearinghouse for Information Technology in Nigeria with the mandate to implement the National IT Policy and regulate IT activities in the country. Within two years of its establishment, NITDA has embarked on laudable programs that will leapfrog the country into becoming an information technology-dependent society thereby utilising the latest IT advancement for the economic development of the nation. In line with the above-mentioned objectives of NGDI, NITDA strategies are in three major areas:

- Human Resource Capacity Building,
- Infrastructure Capacity Building, and
- Institutional Capacity Building.

4.1 Human Resource Capacity Building

Qualitative manpower is one of the most important determinants of viable and sustainable economies. Developing quality manpower in IT and related disciplines will help the nation develop a pool of scientists, engineers, technicians and software developers. These human resources will advance the country technologically to be able to

employ new and advanced computing technology emanating globally in various applicable areas geoinformatics inclusive. In addition, this will bring a lot of foreign exchange, which will give our currency, the naira a lot of stability in the international market. The foreign exchange that can be realised is comparable to our earnings on oil exploration. India, for example, exports annually computer software valued at US $20 billion. Knowing that IT could drive our economy better than natural resources, NITDA has embarked on various projects to enhance the nation's human resources in IT. These include:

(a) Developing and updating relevant IT curricula for primary, secondary and tertiary institutions to face the challenges of today's application of ICT;
(b) Making IT mandatory at all levels of education through adequate financial provision for tools and resources;
(c) Establishing facilities for electronic distance learning networks and ensuring effective Internet connectivity of both urban and rural communities;
(d) Empowering IT institutions and development centres to develop IT capacities at all levels.

Human Capacity Building is a major focus of NITDA. It is one of the prongs on which the IT Policy is based. We have made tremendous progress in the realisation of items (a)-(d) above, such as:

4.1.1 Establishment of Centre of Excellence

This is in collaboration with the ETF with a view to improving the quality of IT graduates from our tertiary institutions through Train-the-Trainers programme for lecturers. This will help to uplift the quality of IT professionals from our institutions so as to cope with the latest development and challenges in Information Technology. The programme is being carried out in partnership with Hewlett Packard (hp) and other private companies. Six centres of excellence will be established in the six geo-political zones of the country.

These centres, which will be located in the major cities, will, amongst others, provide specialised training in many areas of IT such as:

- Data Communication and Information Engineering,
- Systems Engineering,
- Software Engineering,
- Database Technologies,

- Super Computing Architecture,
- Open Source Software Development and Web Technology.
- This action will help build the required expertise for the ICT industry, produce world class professionals for both local and international markets and also facilitate the development of software that will earn Nigeria foreign exchange.

At present, NITDA is collaborating with ETF in carrying out a needs' assessment prior to the setting up of the centres.

NITDA has also collaborated with several multinationals and international organizations to deliver specialized training in some train-the-trainer workshops. These institutions include UNESCO, International Centre for Theoretical Physics (ICTP), Cisco Systems, etc. For instance, NITDA collaborated with ICTP by hosting the first African Workshop on Open Source and Web Technologies for Development earlier in the year 2003. There has also been some collaboration with UNESCO on the Virtual Library and Virtual Laboratory projects for Nigeria. The Train the Trainer programme for university lecturers on open-source, web-enabled technologies and others has just been concluded at NITDA.

4.1.2 Establishment of Enterprise Technology Centre (ETC)

As part of its human resource development strategies, NITDA, in partnership with the private sector, has established an Enterprise Technology Centre (ETC) at the Federal Secretariat for the training of federal civil servants. This will enhance the computer literacy level of the civil servants thereby increasing their productivity through the ability to use IT and resources provided by IT-related fields. Training for Heads of Service (HOS), Permanent Secretaries (PS), Directors General (DGs) and Directors in the public service, has been carried out.

Furthermore, capacity building in the fields of teaching and research is necessary in order to meet the challenges in important sectors of the society. Capacity building at universities and other tertiary universities is obtainable through partnership with neighbouring countries' universities and research institutions. ICT will be used to achieve these goals because it enables the sharing of information worldwide, which serves an educational purpose and provides opportunities for communication between experts wherever they may be in the world.

4.2 Infrastructure Capacity Building

The nation requires an information infrastructure backbone as the gateway to the Global Information Infrastructure (GII), which is highly essential for economic development and sustainability in this information age and the global knowledge-driven economy. The government, through the National Information Technology Development Agency (NITDA) in collaboration with the private sector, is creating a National Information Infrastructure Backbone that will interconnect with state and local information infrastructure. National ICT infrastructure include:

- Networks;
- Link: Bandwidth, Availability, etc.;
- Servers for distributed computing;
- Software, e.g. Geographical Information System (GIS).

Information Infrastructure, among other things, will:

- Create a ubiquitous and affordable technology with an open standard approach, scalable and capable of adapting to changes.
- Provide a reliable and secured gateway to the Global Information Infrastructure.
- Stimulate the creation and sharing of national and international knowledge.
- Encourage private sector investment in IT, particularly in the design, deployment and operation of independent information infrastructure.

4.2.1 Ideal ICT Infrastructure for NGDI

An optical fibre network remains the ideal network for an efficient NGDI. An optical fibre network has bandwidth of the order of gigabytes-per-second (Gbps) as opposed to the megabytes-per-second (Mbps) range of the next fastest type of network. SAT-3/WASC/SAFE Submarine Cable System, Communication Satellites are good options.

Pending the availability of the ideal which might not be immediately available partly due to the high cost of implementation, the good compromise could comprise the following:

- RADIO Links from Broadband Wireless Access (BWA),
- Very Small Aperture Terminal (VSAT),
- Leased Line Circuits, or
- A combination of these.

In line with the above, NITDA has initiated the following projects:

4.2.2 Public Service Network (PSnet)

The Public Service Network (PSnet) provides the much-needed National Information Infrastructure Backbone (NIIB) for the e-government programmes and data sharing nationwide. The PSnet will also facilitate the optimal functioning and better interaction of all the institutions attached to the three major wings of government (executive, legislative and judiciary)

The Information Technology backbone includes transmission, routing, switching and collaboration. The PSnet involves the deployment of:

(i) a VSAT hub at NITDA's head office;
(ii) VSAT Remote terminals in all 36 states of the federation;
(iii) Broadband Wireless extensions in all the states; and
(iv) Routing and switching facilities at NITDA's Head office and in all the states.

The Presidential Network is already integrated into NITDA's VSAT node.

4.2.3 Nigeria's Communications Satellite (Nigeria Sat2)

At present, there is a strong collaboration between NITDA and National Space Research and Development Agency (NASRDA) to launch Nigeria's communications satellite (Nigeria Sat2). This will grant the nation a fast and direct access to the global network. A survey recently carried out revealed Nigeria as one of the lowest users of the Internet. This is basically due to the expensive nature of Bandwidth and lack of awareness among the populace. The launching of Nigeria Sat2 will provide the much-needed Broad Bandwidth for information transfer. The impasse that had bedevilled the management of the country's Top Level Domain **(.ng ccTLD)** was resolved by the former President, His Excellency Chief Olusegun Obasanjo. Directives were given to the effect that **.ng ccTLD,** being a national asset, should be handed over to NITDA which will ensure that it is put to use in the best public interest. **.ng ccTLD** is the representation of the country's traffic on the Internet. The local hosting of the Domain Name System will increase the resolution speed of local addresses and give the nation a presence on the global network. A Non-Governmental Organisation (NGO) is to be formed to run the management of the domain under the control and supervision of NITDA. This will ensure the utilisation of the resources for growth and development of the country and the global Internet community.

4.2.4 Rural Internet Resource Centre

Rural Internet Resource Centres (RIRCs) are intended to provide services to farmers, health workers, teachers, etc., in the rural communities. Each RIRC is a telecentre equipped with Local Area Network (LAN) of computer systems (workstations and servers) as well as VSAT for Internet access, multi-media facilities, printers and photocopying machines. This program will among others,:

1. create new jobs in the rural areas and reduce rural to urban drift;
2. empower farmers by giving access to global price information for their products and providing them access to accurate and timely weather forecast;
3. give access to updated and comprehensive information on plant protection strategies, methods of improving food production and information on food security;
4. give opportunity to exchange information with other farmers or agricultural experts; and
5. provide direct communication with and opportunity to access both domestic and export markets.

RIRCs have been established in Jigawa and Bayelsa states.

4.2.5 Mobile Internet Unit

The Mobile Internet Unit (MIU) is a locally made bus that has been converted into a mobile training and cyber centre. Its interior has 10 high-tech workstations all networked and connected to the Internet to facilitate access to several IT resources. It is equipped with printers, a photocopier and a number of multi-media facilities. Internet access is provided via a Very Small Aperture Terminal (VSAT) equipment with a 1.2m dish mounted on the roof of the bus.

The unit is also equipped with a small generator to ensure regular power supply. The MIU provides everything you will need in a high-tech cyber centre and it has the added advantage of being mobile. It takes the Internet to places that have no other means of access e.g. the rural areas. It has also been deployed to various schools (primary and secondary) and the plan is to get all states and possibly Local Government Areas (LGAs) to have their own MIUs so as to facilitate the penetration of the Internet and ICT around the country. Mr. President commissioned the MIU on the 10th of September 2003. The MIU was also demonstrated to the Council of States towards the end of 2003.

4.3 Institutional Capacity Building

Implementing the National IT policy also involves the building of institutions that would aid the process. NITDA has made remarkable progress in this area. Some of the activities include:

- The setting up of a regional CISCO Network Academy as well as several local academies in Nigerian universities nationwide. These academies have been involved in the training of human personnel in the areas of network engineering, design and support, amongst others;
- The establishment of an Enterprise Technology Centre (ETC) located at the Federal Secretariat complex in Abuja. The carries out training on various IT applications. The same centre was used in the training of the Head of Service and some other senior public officers;
- Ongoing efforts to establish NITDA's zonal offices in the country's six (6) geo-political zones;
- Proposals for the establishment of IT departments in all ministries and parastatals, in addition to encouraging states to establish their own IT agencies that will co-ordinate IT deployment and development in their respective states;
- Collaboration with some institutions, namely, Centre for Management Development (CMD), Microsoft, UNDP, NYSC, ITF and ASCON;
- Commencement of standardization and harmonisation of IT projects in government establishments to enhance inter-operation of IT processes and sharing of data. This will help to curtail unnecessary duplication of expensive project, e.g. the Microsoft licence agreement that has saved Nigeria millions of Naira;
- Interaction of NITDA with the states, which has resulted in the establishment of IT institutions in some states, such as State Ministry of Science and Technology, State IT Agency, Office of the Special Adviser to the Governor, etc.;
- The encouragement of Public-Private (sector) Partnership (PPP). This is evident in NITDA's collaboration with four local computer assembly companies - Zinox, Beta, Omatek and Unitec. The Enterprise Technology Centre (ETC) was also

established in partnership with SAA Technologies / YOSCO and Microsoft Corporation to create Centres of Excellence.

4.3.1 Baseline Study and ICT Inventory

The baseline study involves the gathering and compiling of relevant data on key Information and Communication Technologies (ICTs) and socio-economic indicators within the economy and society. The study would serve as the basis for future ICT and national development plans. The database to be set up would provide ready answers to mostly ICT-related questions that must be addressed. It would provide necessary inputs into the development of the ICT Strategic Action Plan for the implementation of the National ICT Policy.

4.3.2 Development of the Strategic Action Plan

The world is fast moving into a knowledge-based economy that is heavily driven by ICT. Nigeria must therefore position herself properly to take advantage of this new development. The Strategic Action Plan Development (SAPD) is a very important programme aimed at translating the National IT Policy into specific projects that focus on ICT for national development. ICT is cross-cutting, in the sense that its application cuts across every sector of the economy. In order to ensure that our socio-economic development is properly driven by ICT, the Strategic Action Plan to be developed shall involve all the stakeholders in the various economic sectors. It must also relate specific ICT policy statements with planned national development programmes and provide the necessary guidelines for crafting specific ICT projects that would drive and enhance the realisation of the national development plan.

The eleven sectors to be covered are:

(i) Human Resource Development,
(ii) Infrastructure,
(iii) Research and Development,
(iv) Health,
(v) Agriculture,
(vi) Urban and Rural Development,
(vii) Trade and Commerce,
(viii) Fiscal Measures,
(ix) Arts, Culture and Tourism,

(x) National Security and Law Enforcement, and
(xi) Legislation.

The Strategic Action Plan to be developed therefore would guarantee the realisation of the sectoral applications of ICT, including geospatial, for sustainable national development. This is in line with the trend all over the world.

5.0 Challenges

Other existing and new challenges to ICT development identifiable include local manufacture of components and equipment, coupled with the need to position for industrial take-off and development of the country in view of the large consumer base.

6.0 Conclusion

The information age has changed the focus of every economy. Development and economic viability are no more measured on the scale of the human resources possessed but on the state of information technology infrastructure, human resources and institutions. This is a knowledge- driven age, dominated by high technologies such as information technology, space technology, biotechnology and material science. It is high time the nation started making IT more than just an important venture to invest in but a truly national priority. The situation is that the world has moved from the reliance on natural resources to a new knowledge-based foundation, where the wealth and powers of nations are directly dependent on the strength of their information technology and associated human capital.

The revolutionary changes taking place in the industry have led to the development of new technologies. The convergence in the IT sector has led to new services and goods. This situation offers countries like Nigeria the opportunity to leapfrog into the modern information age. The successful implementation of IT policy holds a great hope for the sustainable economic development of Nigeria. All hands (both government and the private sector) must be on deck to ensure that Nigeria fully transforms the digital divide into digital opportunity.

I wish to state that a host of the existing contributions and future contributions from government to the national ICT development require insightful articulation and consideration to ensure that ICTs can play their appropriate roles in the national development of the

country in view of the anticipated roles of ICT in emerging information society and economy.

References

ANZLIC. (1996). Australia/New Zealand Land Information Council, Spatial Data Infrastructure for Australia and New Zealand, A Discussion Paper.

Branscomb, A. (1982). 'Beyond Deregulation: Designing the Information Infrastructure.' *The Information Society Journal,* 1/ 3: 167-190.

Groot R. (1998), Spatial Data Infrastructure (SDI) for Sustainable Land Management; *ITC Journal* 19997- 3/ 4, pp. 287- 294.

Mapping Sciences Committee. (1993). Towards a Co-ordinated Spatial Data Infrastructure for the Nation. Report of the Mapping Sciences Committee, Board on Earth Sciences and Resources, Commission on Geosciences, Environment and Resources, National Research Council, National Academy Press, Washington, DC, USA.

Onsrud,H.(1999).URL http://www.spatial.edu/harlan /gsdi/GSDI.html

Rhind, D. (2000). "Funding a National Geospatial Data Infrastructure." In Groot, R.and McLaughlin, J. D. (eds.), Geospatial Data Infrastructure: Concepts, Cases and Good practice. Oxford University Press, pp. 48- 51.
A GIS Schematic: The Major Functions of a GIS. Collect. Manage. Spatial. Data Base. Non-Spatial. Resource. Data Base. Manipulate and Analyse. Spatial. Processing. System. Data Base. Management. System. Display. MAP OUTPUTS.

Composite Maps deathstar.rutgers.edu/courses/geomatics_ Info/tsld010.htm