# GLOBAL BROADBAND AND INNOVATIONS PROGRAM

## REVIEW OF USPF GIS DATABASE REPORT

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# 1. Introduction

This report has been prepared by the USAID Global Broadband and Innovations (GBI) program on behalf of the Universal Service Provision Fund (USPF) of the Nigerian Communications Commission (NCC). This work has been undertaken as part of GBI's technical assistance to USPF in support of the Fund's efforts to enhance and expand access to Information and Communication Technologies in Nigeria.

The objective of this document is to provide an objective and critical analysis of a Geographic Information System (GIS) database project conducted for NCC and USPF in 2009 by FullPlan Associates (Nig.) Ltd. That project, part of an overall assignment for FullPlan to conduct data collection, database development, and market analysis for USPF, specifically focused on creation of a national GIS database consisting of relevant geographic, demographic, and ICT market data. The purpose was to help USPF staff to understand the current status of ICT network coverage and access in Nigeria, in support of planning efforts for utilizing the Fund to help expand such access.

GBI's experts have reviewed the FullPlan report and supporting materials, from the perspective of GBI's role in assisting USPF, and our experience with data collection, analysis, and strategic planning with similar Funds around the world. The discussion, analysis, and recommendations herein provide GBI's views on the materials developed by FullPlan Associates as they most directly relate to USPF's mission. GBI will provide further clarification, advice, and assistance in relation to this report, as needed.

# 2. Summary of GIS Database Report

This section provides a synopsis of the information contained in the FullPlan Associates' report on the GIS database project (entitled "Final GIS Database and Maps"). It briefly summarizes each chapter of the report, giving the main highlights and key examples, with particular attention to the elements of greatest interest in the context of the USPF's mission and objectives.

## 1.1 Chapters 1 to 4: Introduction, background, core database structure and features

The first four chapters of the FullPlan Associates GIS Database report provide an introduction to the project and the report, and to the methods, data sources, and tasks utilized.

Chapter 1, Introduction, describes the Terms of Reference for the project, and the contents of the report.

Chapter 2, Framework for GIS Database Development, provides a basic conceptual basis for the establishment of a GIS database. It explains the general concepts of Data Resource Management, Database Management Systems, and Database Administration. It then provides a description of the Geodatabase Model utilized in the project, which employs ArcGIS software, a well-respected platform for GIS database implementation. The diagrams and tables in this chapter are extremely helpful in understanding the methods utilized by the consultants.

Chapter 3, The Spatial Data for USPF, essentially describes the core elements of a GIS mapping system, and that used in developing the baseline maps for Nigeria. Spatial data represent points, lines, or polygons which can be identified and represented on a map. The spatial data used in the study are based on existing databases at the National Bureau of Statistics, National Population Commission, Federal Services and the Office of the Surveyor General of the Federation of Nigeria (OSGOF) & NASRDA, as well as other sources. Analog maps have been digitized and in some cases five-year old digitized maps have been revised/updated to eliminate errors.

With the help of 1:2,000,000 maps from Federal Surveys Department, the database identifies a total of 1,945 settlements made up of the 36 state capitals plus Abuja, 774 Local Government Headquarters, and 1,134 other towns and settlements. In addition, streams and river systems, roads, railways and the Nigerian coastline have also been presented in digitized form. The results of a delineation study which was carried by NCC in 2005, classifying 3,229 communities into urban (0.5%), semi-urban (1.37%), and the remaining as rural, have also been included in the report.

Chapter 4, Attribute Data in the USPF GIS Database, describes the nature of attributes which are used to populate the database. The attribute data have been collected from the National Bureau of Statistics which includes Core Welfare Indicator Questionnaire Survey (CWIQ) 2006,

and the 2004 Nigerian Living Standards Survey (NLSS) by NBS. Also used are 2004 Nigeria DHS EdData Survey (NDES) and 2003 Nigeria Demographic and Health Survey (DHS). Estimates of population are based on projections on the 1991 survey, several other surveys and studies of National Bureau of Statistics and National Commission. All these sources are officially recognized by the government.

These introductory sections offer a valuable and clear understanding of the background and approach to the database's development, and demonstrate that the report authors are highly competent in this field. As an introduction to the purposes and methods of GIS database development for ICT sector analysis, this portion of the report represents an excellent resource, which should be available to all NCC and USPF staff involved with these matters.

## 1.2 Chapter 5: ICT Infrastructure

This chapter of the report summarizes the state of the Nigeria ICT sector, particularly telecommunications networks, operators, and infrastructure, as of the time period when FullPlan Associates conducted their study (2009). The information provided is mainly in the nature of catalogues and statistical summaries of operators and infrastructure deployments. The most important and useful results are contained in the maps near the end of the chapter. The main data included in each subsection are summarized below:

### Section 5.1. Introduction

This section lists the types of "basic" ICT infrastructure as defined by USPF:

- VSATs
- All telephony networks (fixed and mobile)
- Wireless and fibre-based backbone networks
- Switching/interconnection centres
- Wire line and wireless broadband networks
- ADSL/DSL networks/infrastructure
- Cybercafés
- Other key ICT infrastructure

It goes on to describe the data collection methods and sources of FullPlan Associates, including information from the ICT industry and from NCC. The report notes that the data sets used are generally current through December 2008, and in some cases March 2009.

### Section 5.2. Companies Licensed by NCC for ICT Service Provision

This section provides extensive lists and tables of licensed ICT companies in Nigeria. These include 24 categories of licenses and some 1,664 companies. It also includes more detailed contact information on 36 of the most prominent ICT firms.

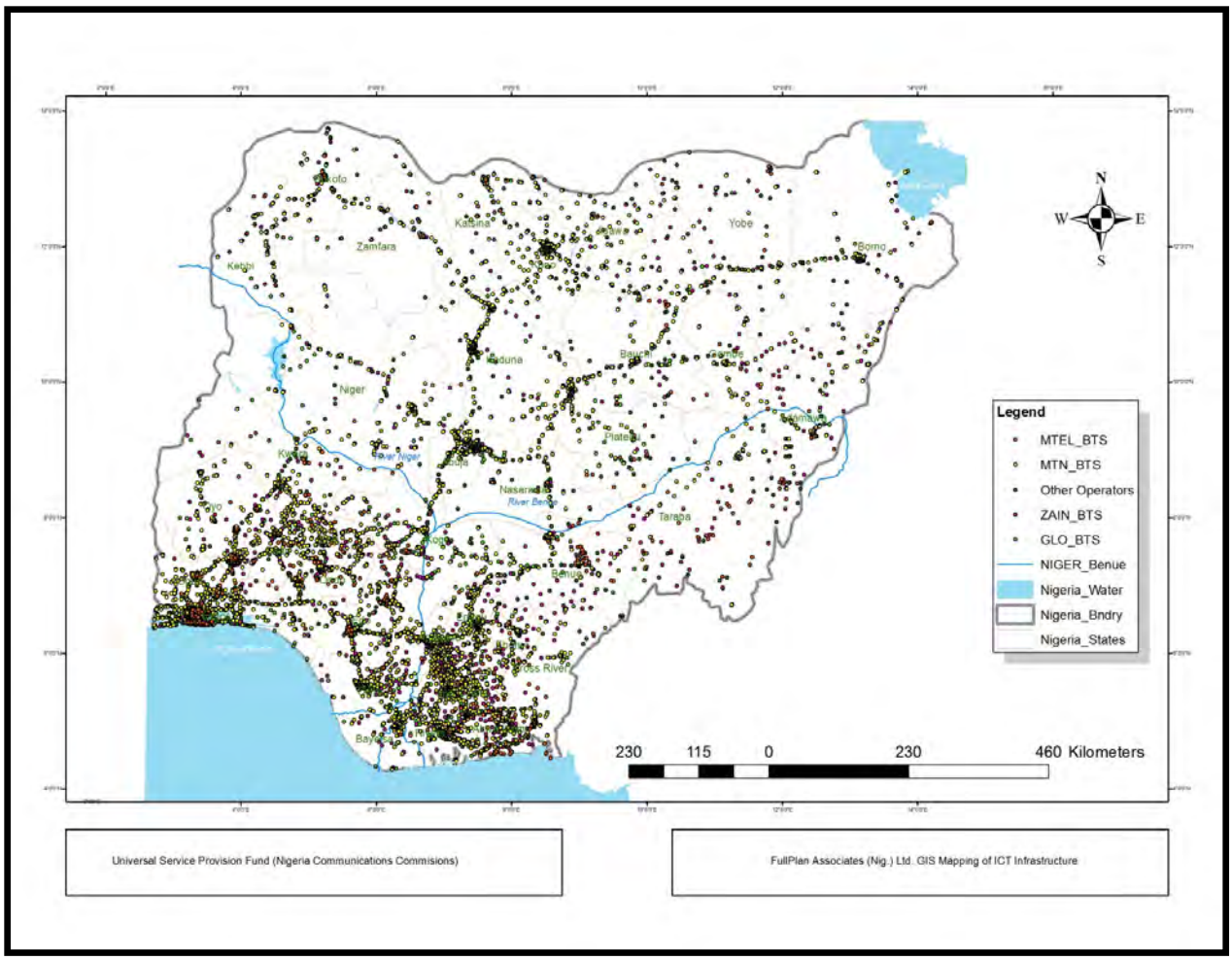
## Section 5.3. Current Providers and Distribution of ICT Infrastructure in Nigeria

Although this section refers to distribution of "ICT infrastructure" in Nigeria, in fact it provides information exclusively on one component of infrastructure: Base Transceiver Stations (BTSs) of cellular mobile network operators. On this subject, the data provided are very extensive. It covers the ownership and location of over 13,000 BTSs throughout the country, and provides detailed breakdowns on their distribution, by service provider and by state.

This information reveals, for example, that three companies (MTN, Glo, and Celtel) own by far the majority of BTSs (or "masts") in Nigeria, while a few others (EMTS, Nitel, Visafone, Mtel, and Multilinks) own most of the rest. Lagos has far and away the most BTS's of any state (2,262, or 16% of all BTSs in the country). This information feeds into the geographic coverage and location data provided in the next subsection.

## Section 5.4. The Location of ICT Infrastructure

This section provides some of the most important and useful information in this report, as it details the precise locations of all BTSs in Nigeria in a series of maps. It includes breakdowns of BTS coverage by individual operators as well, showing the relatively overlapping coverage of these networks, and revealing the common areas where no operators have established network infrastructure. The overall map for the entire country, including identification of each operator, is in Figure 5.4.2, which is reproduced here for convenience:




## 1.3 Chapter 6: Basic Maps for USPF Use

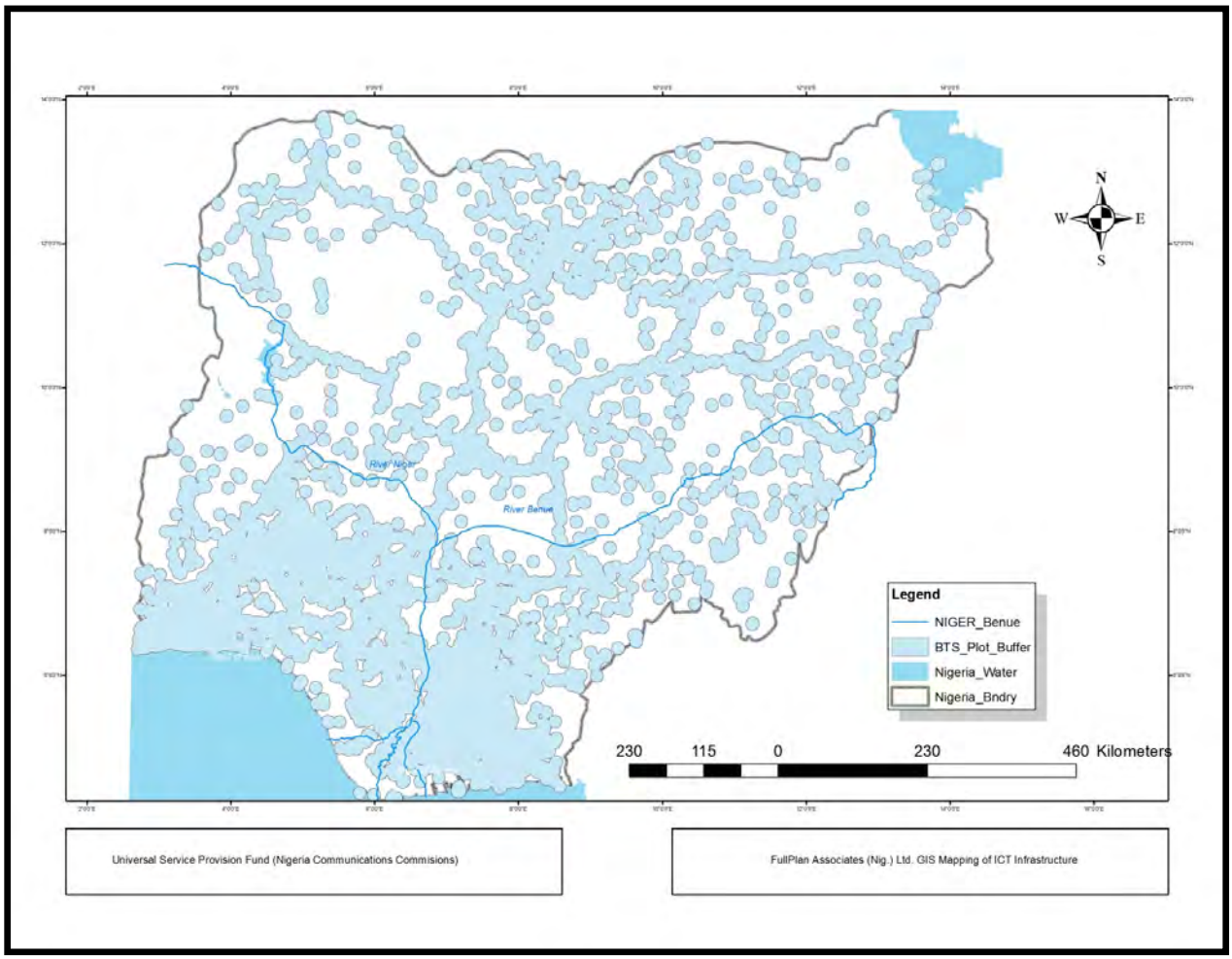
This section produces a variety of additional maps from the database of information collected by the consultants. It essentially demonstrates the range of different types of data that can be represented in maps by highlight combinations of variables. The examples provided illustrate maps on the national, state, and local government levels. Most of these sample maps are general in nature, i.e., they show distribution of various demographic and geopolitical elements for the nation as a whole. Examples include administrative boundaries, roads and settlements, physical geography, population, households, schools, etc.

Only the maps in Section 6.5 and 6.6, plus maps 6.4.1 and 6.4.2, include data on ICT infrastructure, specifically BTS locations. These latter maps are useful for understanding further the distribution of towers/BTS's in Nigeria as illustrated in the basic map reproduced above. Some of the cross-correlations provided include:

6.4.2 Road networks and the location of ICT towers
6.5.1 Population distribution and the location of towers

### 6.5.2 Population density distribution and the location of BTS

In section 6.6, the consultants offer their analysis of the status of ICT infrastructure (BTS) coverage, utilizing additional data and assumptions. This section is the most relevant portion of the report from the point of view of USPF's mission and goals for closing coverage gaps. The report identifies the expected patterns, showing BTSs concentrated in major population centers and along established roads. The authors then seek to determine the full range of coverage of these services, by applying a formula which assumes, for simplicity, that each BTS/tower provides a signal that reaches a 10 km radius in all directions. The combined result of this process is given in Map 6.6.6, where all estimated coverage areas are shown together. This map is reproduced below:




The consultants calculate that mobile signals (as of 2009) covered some 457,729 square kilometers, or less than half the physical territory of Nigeria.

## 1.4 Chapter 7: Towards a Geographic Information Decision Support System

This chapter provides a set of instructions and guidelines for USPF staff to utilize the GIS database developed under this project to conduct their own research into the information contained in the database. It includes basic instructions for accessing the maps already produced, and for creating new maps utilizing the data in various configurations. It also explains how to conduct specific queries of selected information in the database, and how to compare different maps according to designated criteria.

There is also a separate section (7.6) describing how the database may be utilized to evaluate the options and potential results for implementing co-location requirements for network infrastructure. The chapter then also provides an overview of how to update the database.

## 1.5 Chapter 8: Recommendations

The final chapter of the report provides recommendations on overall NCC and USPF data collection and utilization procedures.

Regarding NCC's fundamental role in data collection and storage, the report authors make a strong case for improving and centrally organizing all data gathering functions of the Commission, as current practices result in disparate and disorganized information sources, which are difficult for any one unit or study to examine. They call for NCC to establish a single, centralized database and facility for collecting, storing, and accessing all of the various market, technical, and demographic information obtained by various Commission departments in the course of their duties. They also recommend setting standardized procedures for reviewing and managing all NCC data collection.

The authors also recommend formal establishment of a GIS system within NCC, for use by both USPF and others within the Commission. In support, they further recommend establishing a formal GIS Department. This should be augmented by extensive training for NCC staff in the purposes and use of GIS technology for data collection and decision making.

# 3. Analysis and Recommendations

As described in the previous sections, the maps and the GIS structure presented in the consultants' report provide more than enough information regarding geography and demography of the country. It also provides substantial information about existing ICT infrastructure in Nigeria. The software proposed by the Consultants (ESRI and ArcGIS) is a strong professional suite which is well-accepted the world over.

However, the data studied only go so far, and there are certain key omissions in the study and database from the point of view of USPF's mission and objectives. We discuss these below, and present specific recommendations for further development and utilization of the GIS database.

## 2.1 Backbone Networks

Perhaps the most glaring omission pertains to information about national transmission network facilities. The report does not provide any maps of inter-city optic fibre backbone cable routes - not even names of cities/towns which have optic fibre connectivity. Similarly no information is provided on microwave-based backbone or microwave terminations in cities and towns. This is surprising as USPF's basic definition of ICT infrastructure does include backbone networks.

Backbone transmission infrastructure is the first and most essential component of a country-wide telecommunication network, especially considering that one of the main targets here is to increase broadband proliferation in the unserved / underserved areas of the country. It would be absolutely essential for USPF to help enhance and expand backbone networks in order to provide connectivity for all kinds of services: voice, broadband (for businesses/households, schools), tele-centers, tele-medicine, banks, government offices, etc.

Inadequate attention to the backbone segment in Nigeria has already left it under-developed and with little competition. Consequently the inexpensive bandwidth reaching the coastal landing points of Nigeria is available to the citizens of the country only at exorbitant prices. As all future services are going to be even more highly bandwidth dependent, a robust, well integrated and well planned/secured fiber network (not microwave, save for some exceptional cases) reaching all the nooks and corners of the country, must be in place.

Against this background, it is vitally important to incorporate within NCC's and USPF's data records, and its GIS database, detailed information on the status and locations of existing (and planned) backbone network infrastructure.

## 2.2 Broadband Access

Another omission in the database and report is the lack of attention to broadband access (which is also included in the ICT definition of USPF). The GIS maps provide no meaningful information regarding existing broadband networks and related infrastructure, e.g., which cities / towns are connected to broadband transmission infrastructure. There is similarly no information on which types of broadband networks may be deployed in the country: metro fibre, fibre to the home (FTTH), cable TV (HFC), twisted pair copper/ADSL or wireless broadband including WiMax, EVDO, or even 3G cellular mobile services.

Broadband access can be identified and measured within the GIS system in a number of ways. These include, for example:

- Locations or communities in which some form of broadband access service is available;
- Communities with public access broadband sites (Community Information Centers or the like);
- Geographic areas covered by 3G or equivalent wireless signals;
- Schools, health facilities, government offices, businesses, etc., that subscribe to broadband services in various locations;
- Other broadband network deployment or service availability indicators as provided by telecom operators.

At present, it is likely that most broadband users are located only in metropolitan areas such as Lagos, Abuja, and a few others, although there may be increasing access to 3G mobile services beyond urban boundaries. In addition, public access broadband facilities, such as Community Information Centers or schools with broadband connections, are undoubtedly more widespread. Since a strong expansion of broadband access is one of USPF's central goals, it will be very important to understand both the current and future deployment of broadband-capable networks, as well as the uptake of these services by end users.

## 2.3 Recommendations

The USPF consultants, FullPlan Associates, have provided some very detailed GIS related information resulting in an excellent report, in terms of both general geographic data and mobile network BTS infrastructure in particular. The GIS database thus established represents a very valuable resource for NCC and the USPF, for purposes of understanding the development of the Nigerian ICT market. Although the input data to the database is now becoming somewhat outdated, the basic findings are likely still reasonably valid, with respect to BTS coverage and gaps.

However, as indicated above, there are some very important segments that have not been included within the GIS database so far, which limits USPF staff's ability to draw upon this resource in planning the Fund's strategic interventions under the new Strategic Management

Plan. The absence of data on national backbone networks and broadband access connectivity represents a persistent challenge.

The GBI team offers the following recommendations with respect to the GIS database and report, and USPF's and NCC's going-forward data collection and analysis functions:

1. Information on backbone networks should be added to the database and maps.

The importance of backbone infrastructure to national ICT development is so great that USPF and NCC should have complete data on the status of these networks. This should ideally include the following elements:

- Routes and locations of existing backbone transmission infrastructure;
- Identification of all network node locations (i.e., interconnection and/or termination points);
- Identification of cities and towns linked and served by backbone networks;
- Ownership breakdowns by carrier of network components and routes;
- Differentiation by type of technology, especially fibre optic, microwave, and satellite;
- Quantification of bandwidth capacity (available and utilized) and fibre optic capacity (pairs available and utilized) for each route.

2. Information on broadband access and distribution networks and services should also be studied and included in the database and maps.

Although current levels of broadband access are likely to be small and mostly limited to urban areas, it will still be important to collect this information. This will allow USPF to begin to establish an understanding of the scope of supply and demand for local broadband access in various areas of the country. Data elements relating to broadband access that should be researched and potentially added to the database include:

- Cities, towns, other geographic units in which at least one broadband service is available;
- Geographic coverage of each category of broadband service (fiber, coax, ADSL, 3G, WiMax, etc.), as well as the carriers offering each service in each location;
- Subscriber levels for each type of service, by location;
- Locations and types of public access broadband facilities;
- Locations of key institutions that are prime candidates for broadband access, and the extent to which they currently have broadband service: schools, health facilities, local government offices, etc.

This last item represents a different type of element to include within the GIS database: potential, rather than actual, ICT locations. Such information can help identify candidates for USPF assistance, and the scope of gaps for these (and other) types of priority locations.

3. NCC and USPF should take official steps to manage the GIS database and update it regularly.

The recommendations of the report regarding the need for NCC and USPF to adopt the processes and tools of GIS database management are well taken. This work by FullPlan Associates is an excellent starting point for what should become a permanent and regular feature of NCC's operations, both for supporting the work of USPF and for other essential regulatory activities. This includes establishing a Division or otherwise assigning appropriate, qualified personnel to be responsible for ongoing management of the database: reviewing information, conducting internal research, providing reports and analysis, and ultimately ensuring that the data inputs are up to date and consistently revised as needed.

It should ultimately be the responsibility of the licensed operators in the sector to provide all required data on their networks, services, and customer base, among other information. To the extent NCC already collects some of these data, NCC experts should be responsible for aggregating and standardizing this information it into the common, shared database.

The GIS database established by FullPlan Associates is an excellent starting point for ensuring that the Commission and the USPF can be consistently up to date in their knowledge of the development of the ICT sector in Nigeria. By maintaining the database and augmenting its information at least annually, NCC can optimize its regulatory functions and the effectiveness of USPF's interventions.

4. Implementation of the new USPF strategy, including backbone and broadband projects, should not be delayed, but instead can proceed even as the GIS database is expanded.

The absence of market data in the GIS database on current backbone network deployment and on the scope of broadband service access will present some challenges to USPF staff in developing Fund-supported projects to address gaps in these areas. However, there will be more than enough opportunities to determine appropriate project locations, scope, and priorities during the initial stages of strategy implementation, so that a full database of such current market information need not be a pre-requisite for creating such projects. Indeed, in the process of developing and implementing backbone and broadband projects, USPF can further the task of populating the GIS database on those topics.

In general, USPF can plan for the first stages of strategy implementation in the areas of backbone and broadband access by means of industry consultations and preliminary market research. Through such interactions, the Fund administration can determine a reasonable set of criteria and priorities for identifying initial areas to target in support of expanding these objectives. Some likely criteria can include, for example:

- Unserved areas adjacent to currently served areas should be given priority. Practical experience shows that trying to go straight to the most remote areas, leaving unserved

areas in-between, results in more complex and costly projects, which will be unattractive to operators;

- The unserved areas with higher population densities should be addressed sooner, as this approach will deliver broadband access to the highest proportion of citizens;

- Other important considerations to take into account will include the local terrain, access to transportation routes, economic and educational conditions in different areas, and such other factors as operators, government, local authorities, and other stakeholders may propose.