MOBILE SOLUTIONS

Introduction to MOBILE DATA SOLUTIONS

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OVERVIEW

Innovative uses of mobile technologies are transforming the ways in which data is collected, aggregated, analyzed, reported, and shared. The resulting information may be used for evidence-based decision-making and to improve development outcomes. This set of four guides offers an introductory exploration of mobile data solutions overall, project design, implementing mobile data collection through electronic forms, and data visualization, analysis, and sharing.

This first guide provides an overview of how mobile technology can be part of an end-to-end solution for the data needs of USAID and its partners, including citizens. For the purposes of this discussion, we will define technologies and systems that perform these functions as ***mobile data solutions.***

This guide is divided into four sections:

- Benefits of Mobile Data Solutions
- Components of Mobile Data Solutions
- Data Management, Analysis, Visualization, and Sharing
- Conclusion

Designing and implementing a mobile data solution encompasses multiple components and activities:[1]

- Defining the problem to be addressed;
- Understanding the stakeholders;
- Designing and selecting the right devices and tools to meet the need;
- Training users like enumerators and supervisors;
- Collecting data using mobile devices or via mobile phones owned by respondents;
- Managing data and in some cases aggregating from multiple sources into a database;
- Analyzing data;
- Presenting data in visually effective formats;
- Sharing the data with partners and citizens; and
- Applying the data in decision-making.

Mobile devices covered in these guides include, but are not limited to, mobile phones (basic, feature, and smart phones), tablet computers, and netbooks.[2] Mobile data collection, which is one aspect of a mobile data solution, has the potential to improve efficiency, accuracy, and timeliness of data gathering and reporting, especially for monitoring and evaluation of programs and projects. While mobile devices have been used to great effect to disseminate information, we will emphasize data collection and the use of this data for decision-making throughout this set of guides.

1 This checklist was developed from ideas presented in "Mobile Data Collection Systems: A review of the current state of the field" (NOMAD - Humanitarian Operations Mobile Acquisition of Data). Chris Jung. 16 January 2011.

2 Personal digital assistants (PDAs) can also be included in this category, but they have largely been supplanted by mobile phones and are increasingly difficult to find in the marketplace.

BENEFITS OF MOBILE DATA SOLUTIONS

Collecting, reporting, visualizing, and disseminating data electronically offers multiple advantages over traditional paper-based information processes including:

Timeliness: Data collected electronically and uploaded to a server provides stakeholders from program managers to field supervisors with real-time, or near real-time, access to information required to monitor, analyze, and understand project activities and impacts.

Dynamism: The use of electronic data allows each stakeholder to manipulate, analyze and visualize the data many different ways and as frequently as needed, from using geo-location to determine if enumerators follow a predetermined sampling scheme to creating cross-tabulations to answer specific questions following a project's close.

Transparency: Electronic data can easily be made available to implementers, governments, USAID, researchers, and the general public via the Internet, with appropriate security and privacy measures in place.

Quality: Technology allows electronic data collection instruments to be designed with mechanisms like range checks, skip logic, and calculated fields that improve the accuracy of data entry. Direct upload of data from mobile devices eliminates transcription errors that occur when data is manually transferred from paper to electronic format.

Affordability: While startup costs for the design and implementation of mobile data collection programs may be higher than those associated with paper-based collection, amortized over many applications and uses they are lower. Costs for data cleaning are significantly lower.

Aggregation and Scale: Data collected electronically can be shared across projects, and within and between countries, and analyzed at this scale.

Impact: Real-time data (during projects/activities), visualized data, reports on demand, and information shared with citizens contributes to more informed decision-making about project activities, program design, and more.

COMPONENTS OF MOBILE DATA SOLUTIONS

There are four major components that are common to the mobile solutions discussed in this guide: mobile devices, mobile data collection clients, data transfer methods, and server-side administrative components.

Mobile Devices

Mobile phones, tablets, and netbooks are used to input and transfer data. When using electronic forms, short message service (SMS), or Interactive Voice Response (IVR), digital data can be input to a database hosted on a computer server. Mobile phones are available in a wide range of functionalities and capabilities; they are generally categorized as basic, feature, or smart phones, although the differences are not always clearly defined. In general, the term basic refers to phones that allow the user to make and receive voice calls and SMS, but do not provide Internet access. Feature phones are cell phones that provide a fixed set of functions ("features") beyond voice calling and text messaging and can run third-party applications, most written in the Java programming language.[3]

3 Feature phones typically utilize the Java Platform, Micro Edition (J2ME or JME), a robust, flexible environment for applications running on mobile and "embedded" devices, e.g. mobile phones, set-top boxes, Blu-ray Disc players, digital media devices, printers and more.

However, the number and complexity of these functions are not as extensive as those available on smart phones, which have more advanced features and applications. Examples of smart phones include the iPhone and Android devices. Increasingly, however, this distinction is blurring as many mid-priced feature phones adopt the more advanced features.

Mobile Data Collection Client

There are various ways in which data can be captured. It is important to note that not all data collection methods will work with all types of mobile devices.

SMS or text messaging is a mobile service using standardized communications protocols that allow the exchange of short text messages between mobile phone devices. It is the most widely used data application in the world, with 3.6 billion active users, or 78% of all mobile phone subscribers. [4]

Electronic forms are data collection tools that exist on computers, online ("web-based"), and on mobile devices such as a feature phone, smart phone or tablet. Data collected on computers or mobile devices may be stored "locally" on the device until it is uploaded to a database, though not all solutions support offline data entry. Completed forms can be aggregated for data analysis, visualization, report generation and dissemination.

Sensors and instruments can interface with mobile devices. For example, sensors measure a wide variety of indicators (blood sugar, heart rate, or smoke particulates), scanners capture a range of data types (bar codes, RFID, or biometric data such as fingerprints), and GPS receivers record location information. Devices also can collect photos, videos, and other multimedia.

This set of guides will focus primarily on these three modes of data collection.[5] However, it is important to note that mobile data collection may not always be the best option to address a problem. Voice, i.e. a phone call, or IVR (both described below) may be better suited in cases where literacy levels are low or certain types of data are required. Indeed, sometimes data collection on traditional paper-based forms is the most efficient, cost-effective method. The process for defining and evaluating a project's data needs—and deciding which data collection method is most appropriate—is discussed in the Introduction to Project Design guide and in several of the highlighted resources.

Voice, although not a mobile data collection tool per se, is one way to collect data remotely, i.e. via voice calls. Given the increasing penetration of mobile phones, interviews may be conducted by personnel in a call center with respondents using their personal mobile phones or ones that have been distributed by an organization specifically to facilitate gathering data. See the World Bank Report, "**Challenges and Opportunities of Mobile Phone-Based Data Collection: Evidence from South Sudan**," for an assessment of one such project.

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4 Ahonen, Tomi. "Time to Confirm some Mobile User Numbers: SMS, MMS, Mobile Internet, M-News." 13 January 2011. **http://communities-dominate.blogs.com/brands/2011/01/time-to-confirm-some-mobile-user-numbers-sms-mms-mobile-internet-m-news.html**.

5 Other technologies exist but will not be discussed in these guides, like Unstructured Supplementary Service Delivery (USSD) and the SIM Application Toolkit (STK). USSD can be used for a wide variety of services including mobile-money, location-based content, menu-based information, and data collection. You may know this as the service that provides you with your minutes used on your mobile phone by entering a code like *MIN# or *BAL#. USSD creates a real-time connection that remains open, allowing a two-way exchange of a sequence of data, making USSD more responsive (i.e., able to validate data entered and respond based upon this data) than services that use SMS. The need to engage a network operator as a partner in any project using USSD makes this technology more difficult to implement. A couple companies like **Jana** and **Cell-Life** have successful solutions in operation. STK is a standard of the GSM system which enables the Subscriber Identity Module (SIM, the integrated circuit or "chip" that securely stores the international mobile subscriber identity and the related key used to identify and authenticate subscribers on mobile telephony devices) to initiate actions which can be used for various value-added services where a menu-based approach is required, such as Mobile Banking and content browsing. The STK allows for an interactive exchange between a network application and the end user. Especially suited to low level applications with simple user interfaces, the STK enables the handset to display menus and/or ask for user input.

IVR allows a computer to interact with humans through the use of voice and input via keypad. An example you may be familiar with are customer service centers where you enter a number on the keypad or a say a short phrase to select your choice and navigate to the information you need. IVR systems can respond with prerecorded or dynamically generated audio to the respondent's answers. See "**Evaluation of IVR Data Collection UIs for Untrained Rural Users**" for more information about an IVR implementation. This article is useful not only for understanding issues and advantages of IVR, but more broadly for thinking about user interface design.

Data Transfer Method

Data collected on a mobile device must be transferred from the device to a server. The most widely used data transfer mechanisms include the following:

Direct transfer or synchronization: Data can be transferred by connecting the mobile device to another computing device using a data cable, SD card, infrared beaming Bluetooth, or Wi-Fi connection. This approach is common when transferring data from devices without Internet capabilities or in areas where there is no cellular network.

Over the cellular network: Data from mobile devices (other than voice) can be transferred to a server using communication protocols. The most common are:

- SMS or text messaging, as noted above, is a mobile service using standardized communications protocols that allow the exchange of short text messages between mobile phone devices.
- GPRS / 3G / 4G are different generations of packet data technologies; each represents advances over the one before it, most notably in terms of the speed at which data is transferred. An advantage of packet-based technology is that if there is a problem with one piece of equipment in the network while a message is being transferred, packets can be routed around the problem ensuring the delivery of the entire message.

The table below offers a brief comparison of data collection and transfer using SMS versus GPRS / 3G / 4G.[6]

Feature	SMS	GPRS/3G/4G
Nearly all phones support the protocol	**Yes**	No
Protocol available wherever there is cellular coverage for voice call	**Yes**	No
Each message is limited to 160 characters[7]	**Yes**	No
Message charges are based on a fixed unit cost vs. quantity of data transmitted	**Yes**	No
Guaranteed timely delivery	No	**Yes**
Possible to encrypt data	No	**Yes**

6 For a more detailed comparison of the strengths and limitations of SMS, GPRS/3G/4G, and other approaches to mobile data collection, see the World Bank Report, "Challenges and Opportunities of Mobile Phone-Based Data Collection: Evidence from South Sudan," referenced above.

7 SMS messages are limited as to the number of characters allowed. Messages using Western alphabets can contain 160 characters. Other alphabets are encoded differently and allow fewer characters, for example Arabic, Chinese, Hindi, or Cyrillic alphabet languages (e.g., Russian, Serbian, Bulgarian, etc.) can have a maximum of 70 characters per message. Depending on the mobile network operator and the type of phone on the receiving end, it is possible to send a single message which gets forwarded as multiple SMS transmissions. This needs to be ascertained before using SMS for longer messages.

Server-side Components and Other Applications

For a mobile data solution to work, a project will need one or more server-side components, which are software applications that run on a web-server, and other applications like the software or cloud-based application to design a survey. The server and applications may be cloud-based or owned and managed by the project. How tasks are handled and what components are required differs between solutions. See Figure 1 below for a graphic representing a mobile data solution. Server-side components include:

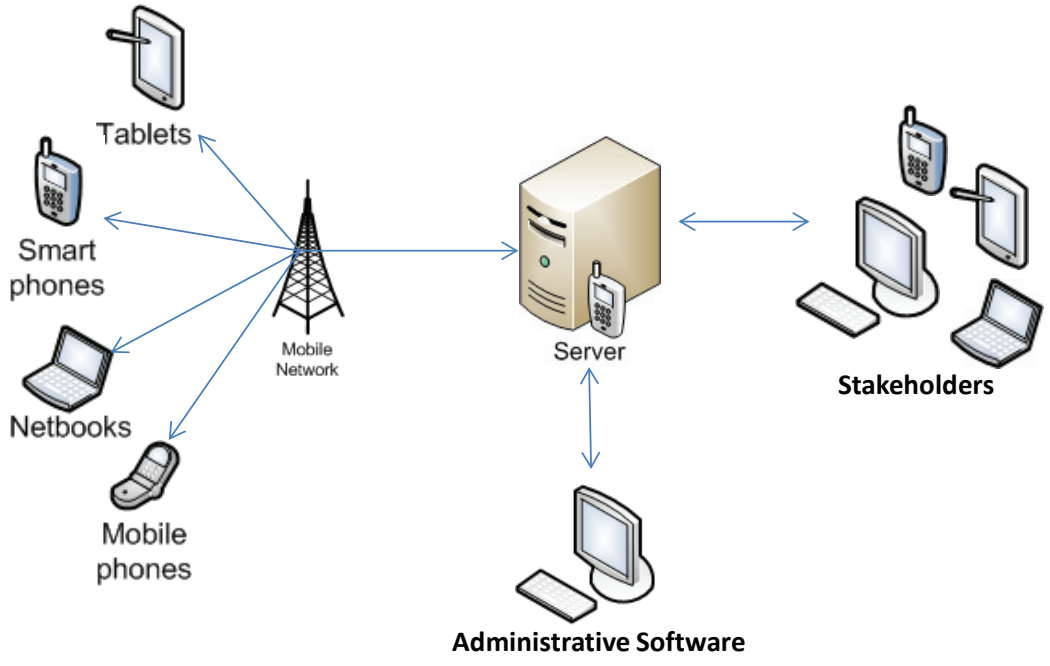
- A component that receives the submitted data, checks for it for errors and then either rejects the data and sends an appropriate error message to the data collector, or inserts the data into a database.
- A database system to store the data.
- In some cases, solutions may include one or more interfaces that facilitate linking the server to other, external software systems.

Other applications may include:

- A software application for the creation of electronic forms or SMS messages, where these are part of the solution.
- In some cases, solutions may include one or more software applications that facilitate data analysis and visualization, and the generation of reports by various system users.
- Administrative software to manage the mobile data solution.

Details on the components included in various products and or required for diverse approaches will be presented throughout this set of guides.

FIGURE 1: Example of mobile data solution components and their connections.



DATA MANAGEMENT, ANALYSIS, VISUALIZATION, AND SHARING

The end goal of mobile data solutions is making accurate, timely data available to those who need to make decisions. Mobile data collection may be conducted to support research undertaken to inform strategy, assessments prior to project design, project monitoring to manage ongoing operations, and project evaluation to understand accomplishments, to plan for the future, and to apply lessons to other endeavors. It is important to consider what data will be needed, who will need it, and how it will be used as a project is being conceptualized. Planning to meet your data requirements early in the project design process will ultimately yield better data at lower cost.

To turn data into useful information, it must be made available to users. Data management refers to this process, that is, the organization, security, storage and retrieval of data. Data management technology encompasses a wide range of techniques and database systems that bring a unique set of challenges when incorporating them into mobile data solutions.

Data analysis is the process of inspecting, cleaning, transforming, and modeling data with the goal of highlighting useful information, suggesting conclusions, and supporting decision-making. Data are frequently presented graphically in order to communicate information clearly and effectively; this process is called data visualization. An ideal visualization will communicate information clearly, catch the viewer's attention, and stimulate engagement.

Planning for data management, analysis, and visualization needs to occur during the process of designing a project. A clear definition of goals and objectives will determine what needs to be accomplished and the kinds of data that will need to be collected. Asking the right questions is a critical step toward gathering the data that a project requires and directly affects the ability to analyze and present data that guide decision-making.

CONCLUSION

The body of knowledge and experience amassed over the last decade on implementing mobile technologies to solve data challenges is considerable. As a rapidly evolving and dynamic field with an ever increasing variety of technology platforms, tools, and applications, mobile data solutions are presenting organizations with an opportunity to actively address key development issues related to human resources, sustainability, going to scale from pilots, conducting more rigorous evaluations of projects, and increasing the scope of data dissemination and sharing. By facilitating accurate, reliable, timely, and cost-effective end-to-end responses to the need for relevant, useful information, mobile data solutions can help us promote evidence-based decision-making and improve development outcomes.