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BHUVAN

MOBILE APPLICATIONS

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Indian Space Research Organisation**
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	Abstract (with Keywords): Bhuvan Mobile Applications have been instrumental in serving the field data collection needs of various programs and initiatives undertaken by NRSC/ ISRO in collaboration with diverse user organizations and government departments. Each field data observation is tagged with geo-location information and field photos along with configurable project-specific attributes/ parameters and values. These applications are developed in-house using open source cross-platform technologies and leverage the use of recent trends in technology encompassing smart phones, cellular networks, web services and geo-visualization. The developed applications run on Android OS based smart phones and facilitate the users to collect field data and transmit to Bhuvan platform servers in near real time or in deferred mode for centralized data organization, utilization, visualization and management. This document describes the mobile applications architecture, developed applications and operating procedures.			

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1. Introduction

Field data collection is a mandatory process for the classification of remote sensing data many application projects. Traditionally, the collection of data is a manual process with the project scientists visiting the planned sites, noting down the parameters of interest, taking photographs as required and incorporating the collected information in the final application after returning to office. However this manual entry is not only error prone but also consumes significant time and efforts.

Disaster management activities also rely a great deal on field information for making geo-spatial database of infrastructure facilities like hospitals, relief shelters and godowns. Even during disaster-time there is need for communicating emergency messages and field situation from disaster affected areas in near real time to operation centres for making appropriate decisions and providing quick response.

The recent advances in the field of mobile devices, communications and global positioning systems have made it possible to design and build innovative and effective methods of field data collection and management. Now-a-days mobile devices are equipped with the features like integrated GPS receiver, photo camera, GPRS/3G/4G/Wi-Fi connectivity, feature-rich OS, etc., which can be leveraged to implement highly productive applications.

In most cases, data collection is not just limited to non-spatial data but also collecting spatial data features e.g. line, point and polygon features using the inbuilt GPS device. The utility of data collection process is further enhanced with the incorporation of geo-tagged field photographs and other audio/ video/ multimedia content. Mobile technology can be used extensively to collect field information by means of crowd sourcing.

Data collection alone is not adequate to fulfil the requirements of most applications, which also demand near real time transmission to an operations/ management centre with subsequent organization and management of the collected data in a central repository. With this approach, organizations like NRSC can effectively contribute and provide support to various operational, scientific, and societal-benefit programs via the in-house developed smart phone-based mobile tools and the Bhuvan platform's infrastructure & services.

By implementing a mobile device based solution to streamline the data collection and utilization process, some of the achieved benefits are given below:

- The collected data is authenticated since the user invariably has to visit the site to capture location (latitude-longitude), photographs and mandatory field attributes
- Attribute values can be edited prior sending to Bhuvan Server.
- Near real time visualization of the location based field data on web browser. Since the entire process of receiving, organization of datasets and visualization datasets on the satellite image map are automated.
- Very useful for disaster mitigation, damage assessment, infrastructure periodic monitoring projects, scientific geo-information science projects (natural resources), etc.

2. Components of the Bhuvan Mobile Applications

The following are the main components of the mobile applications/ solution:

- Mobile device - smart phone or tablet with 4" or better display, camera, GPS, GPRS/ 3G/ 4G/ Wi-Fi, Bluetooth, mini-USB OTG, internal/ external SD card, Android O.S.
- Cell phone provider network with data connectivity gateway for near real time data transfer from field.
- Mobile application on the device to enable user to collect field information.
- Bhuvan server infrastructure and services to handle field data reception and repository organization.
- Bhuvan portal applications for field data geo-visualization, query and reporting.
- Various users/ organizations/ stakeholders: Field data collectors, data managers, software developers, moderators, data/ application end users, project managers, general public.

3. Bhuvan Mobile Applications - Requirements and Design Description

The mobile applications development is initiated with an assessment of the felt needs of the NRSC scientists to streamline the ground truth data collection process for scientific studies. Towards this, it was envisaged to make effective use of the emerging trends in information technology, especially those related to mobile devices, cellular network connectivity, Internet prevalence, server-side web technologies, etc. Later, such mobile applications were found equally useful for a host of other end-use applications like disaster management, infrastructure facilities inventorying, crowd sourcing, activity monitoring, incident reporting, etc.

The originally envisaged mobile device based solution was conceptualized and brought out in a technical document in June 2007, wherein the software requirements specifications, design considerations and architecture details were clearly brought out, and most of them are still relevant. The initial implementation was cantered around Windows CE framework and C# development environment. However, with the advances in technologies and maturity of the developed application, the development efforts were renewed and enhanced to cater to the new smart phone environments like Android. The software requirements specifications are enclosed in Annexure-1.

4. Bhuvan Mobile Applications Architecture

The mobile applications architecture is designed with an integrated approach involving the various components as described in section above. The architecture leverages the complementary nature of the different components and provides clear interfaces for data exchange. The architecture brings in an ordered approach to the field data collection process with benefits like: enhanced ease-of-use, geo-tagging, authenticity/ integrity of collected information, enabling near real time data utilization, data management and protection at 24 x 7 data centre facility.

The mobile applications solution architecture is depicted in the following figure:

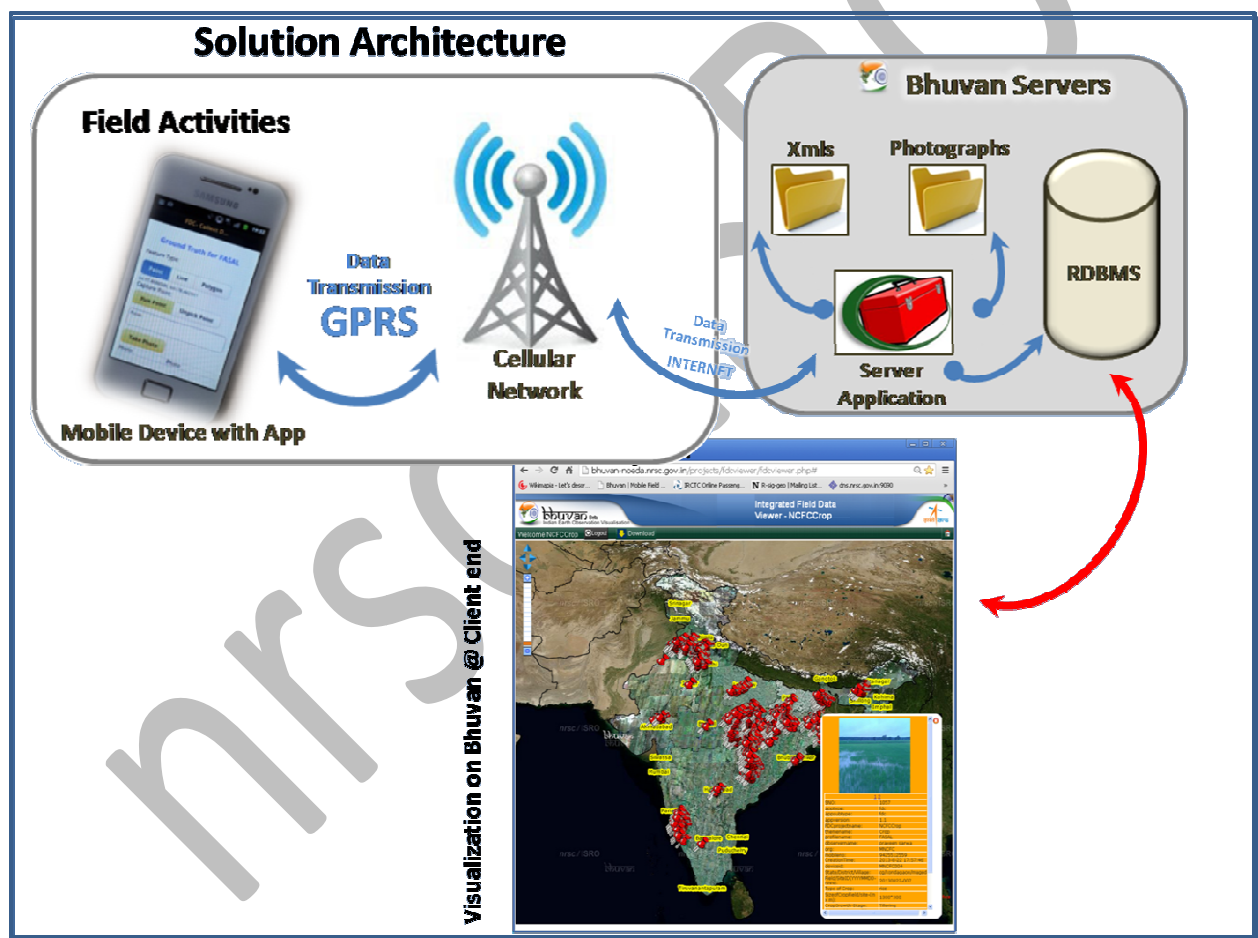


Figure 1: Bhuvan Mobile Applications solution architecture

Each field observation comprises of the geo-location (latitude-longitude) coordinates, multiple field photos and a set of configurable attributes/ parameters with values. The collected data is encapsulated in the form of an XML-encoded document along with the field photos in jpeg format. The data can be sent from field in near real time to Bhuvan server via the network connectivity available on the smart phone like GPRS/ 3G. Alternatively, the saved data sets can be transmitted to the server subsequently as and when network

connectivity is present. Deferred sending is also essential, when multiple attempts to send data in near real time fail due to communication errors. The user is also provided with a choice to edit the attribute/ parameter values (but not the geo-location or the photos) prior to the sending the observation.

A handler programs on Bhuvan servers receive the field data from the various mobile applications on smart phones distributed across the country under various projects. Bhuvan is deployed in a load-balanced configuration to enable smooth data transfer and processing. The received data is immediately organized in the respective folders and also in a spatially enabled RDBMS.

A set of Bhuvan servers, which are responsible for geo-visualization portal services, cater to the needs of the users and managers of each project. Each project having a mobile application component is assigned with the necessary user profiles and roles. Appropriate role-based access control is implemented for providing the various portal services like data visualization on Bhuvan WMS layers, query, data download, etc. Bhuvan also enables authorized users to access the field data from client applications in the form callable Web Services.

5. Bhuvan Mobile Applications - Features

The mobile applications are intended to serve multiple users/ projects/ organizations/ departments for a number of different end-use domain requirements. In such a scenario, the design and development was guided by the requirement to provide good support for configurability and customization. The application's code base is largely retained across various deployments. This is true not only for the common features like GPS coordinates acquisition, photos capture and data save/ send/ edit, but also for the varying set of attributes/ parameters and their values for each specific application. This is ensured by implementing a dynamically rendered GUI based on XML configuration files.

Some of the salient features of the mobile applications are described below:

User Profile: The mobile application encompasses the feature of User Profile, which consists of values for User ID, Name, Mobile number and Organization. The user profile entry is a onetime activity during first time execution of the app. Thereafter, each observation collected by the user using the app will be tagged with the user profile.

Other meta-values associated with observations:(a) Each smart phone device carries a unique device identifier called Universally Unique Identifier (UUID), which can be accessed via programs in Android environment. The mobile application incorporates the UUID in all the field observations collected and sent so as to facilitate tracing of the source device. (b) the timestamp indicating the details of the data collection time is also embedded into each record transmitted to server, (c) the project name and attribute profile name associated with the deployed app is also part of each transmitted record.

Data collection: The information collected is location info (latitude-longitude), geo-tagged photographs and attributes data and these dataset is tagged with user profile info and UUID of the device. The location info has latitude, longitude, altitude and positional accuracy in meters using GPS sensor in the mobile. This helps in precisely locating the point/ object of data collection/ observation. The photographs are taken from a distance of the object with again latitude-longitude and direction from the North orientation using compass sensor in the mobile. The rich OS enables us to design and develop user friendly Graphical User Interface (GUI) for collection of attribute data. The collected data can be stored in the mobile without sending it to server and the attribute values can be edited except location data, photographs and time-stamp.

Data reception and visualization: The collected field data is received at the Bhuvan server facility, where multiple application servers run in load balanced configurations to handle the incoming data loads. The received data is immediately organized into appropriate files/ folders as well as in spatial RDBMS. The Bhuvan platform's visualization servers pick up the field data from the repositories and facilitates their visualization on the satellite image map and base vector layers via the client's web browser in near real time.

End-to-end solution: The differentiating factor in the NRSC developed and deployed mobile application solutions is the end-to-end systematic process flow. The process originates with the data collection activity on field but there is huge value addition as a result of its tight coupling with the 24x7 Bhuvan platform services, which helps in realizing significant benefits like centralized & consolidated repository management, protection from data loss, high availability, visualization with spatial imagery/ vector layers, etc.

Security and authentication features: Different applications have different requirements with regard to security. The UUID information associated with each observation record can be used to control data flow into the server. Initially all the users are marked as non-authentic user (crowd sourced). Later with the help of web based application disintegration of users are classified define dataset received from authentic user (Responsible personal from the user department) or non-authentic user (crowd sourced).

6. Development Environment

The mobile applications architecture was guided by the design goal of ensuring the use state-of-the art as well as proven technologies in the development process. At the same time, it was envisaged to enable cross platform deployment in view of the popularity of diverse environments like Android, iOS, Windows, etc. In view of this, the selected development environment is based platform-independent technologies derived from Web standards like HTML, JavaScript and CSS. The leading and proven platform conforming to this is the free/ open source Apache Cordova, which consists of native device plug-in for all the mobile OSs. This approach facilitates the application development to be common up to 90%, but there is still a small amount of dependence and need for platform-specific devices and development tools/ operating systems. In view of this, the development is carried out

with higher priority for Android platforms, which support easier development and deployment options.

On the server side, the primary technologies used are Apache web server, PHP application server and Postgres/ PostGIS DBMS. Both the device-side and server-side development follows the W3C guidelines.

The following table summarizes the various development tools and technologies used:

Table 1: Development tools and technologies used for Bhuvan Mobile Applications

Sno	Activity	Tools & Technologies used
Mobile Apps		
1	Graphic User Interface	HTML5, CSS, Javascript, JQuery V 2.0.3, JQuery V1.8.3-min, JQuery Mobile 1.3.2 min
2	Map visualization	Leaflet API
3	Hybrid Mobile API	Apache Cordova version 3.6.4
4	Database	XML Version 1.0, JSON Version 2.0
5	Mobile SDK	Android 19
Server Apps		
1	Web/ Application Tier	PHP 5.3.25, Apache Web Server 2.2.22 (
2	Database Tier	PostgreSQL 9.1, Post GIS 2.0

7. Mobile Device Specifications

The developed mobile applications are designed to work on Android based smart phones. They are compatible with a range of OS versions from Android version 2.3 to the latest 5.1 and further support beyond. However, for reasons of feasibility, actual testing is performed only on a limited set of models. The following are the standard set of specifications for the target mobile devices:

Mobile device specifications - Android OS with version 2.3 or above, GPS sensor, Compass Sensor, Internet connectivity (WiFi / GPRS / 3G / 4G), 1 GB memory or above and SD Card – 2 GB.

8. Bhuvan Mobile Applications Developed

The following table gives the details of the mobile applications developed for various users/ organizations/ departments.

Table 2: Catalog of Bhuvan Mobile Applications developed

Catalog of Mobile apps developed by NRSC						
Sno	Release Date	Name of App	Version	Features	User	Distribution Mechanism
PMO						
1	15-Apr-15	Bhuvan Pragati	1.1	location, photos and send or send later	Prime Minister's Office	Bhuvan Portal and proposed on Google play store
Ministry of Agriculture						
2	5-Aug-13	FASAL FDC App	1.1	Opens in start page, Data collection - location info, photographs, attributes, Data structure were in separate folders and files provided.	MNCFC	Task Team
3	18-Feb-15	FASAL FDC App	1.2	location, photos and send or send later - schema v-2 and option changes	MNCFC	Classified Bhuvan Users
4	29-Sep-14	Crop Cutting Experiment	1.1	location, photos and send or send later - version-1 schema	MNCFC	Task Team
5	8-Oct-14	Crop Cutting Experiment	1.1a	location, photos and send or send later - version-2 schema with specific option	MNCFC	Task Team
6	12-Nov-14	Crop Cutting Experiment	1.1b	location, photos and send or send later	MNCFC	Classified Bhuvan Users
7	19-Feb-15	Crop Cutting Experiment	1.2	location, photos and send or send later - schema v-2 and option changes, edit of attribute for Jowar crop	MNCFC	Classified Bhuvan Users

8	30-Mar-15	Crop Damage	1.1	location, photos and send or send later, Android-L supported and schema V-2	State RS Punjab	Classified Bhuvan Users
9	9/20/2013	EOAM-Horti	1.1	location, photos and send or send later	RRSC-S	Classified Bhuvan Users
10	22-Dec-14	ChamanApp	1.1	location, photos and send or send later	MNCFC	Classified Bhuvan Users
11	19-Jul-15	BhuvanChamanapp	1.2	location, photos and send or send later, Android-L and New GUI	MNCFC	Classified Bhuvan Users
Ministry of Science and Technology						
12	26-Sep-13	MANU app	1.1	Opens in start page, Data collection - location info, photographs, attributes, Data structure were in separate folders and files provided.	Department of Science & Technology (Technology and Capacity building from NRSC, SOI and IIRS)	Task Team
Ministry of Water Resources						
13	19-Dec-13	AIBP	1.1	Multiple profile, location, photos and send or Send later	CWC	Bhuvan
14	28-May-14	AIBP	1.1a	Multiple profile, location, photos and send or Send later Collection page	CWC	Bhuvan
15	11-Jul-15	BhuvanAIBPapp	1.2	location, photos and send or send later, Android-L supported and schema V-2	CWC	Bhuvan
16	26-Feb-15	Bhuvan Ganga	1.1	location, photos and send or send later, Schema v-1	NMCG	Bhuvan
17	12-Mar-15	Bhuvan Ganga	1.2a	location, photos and send or send later, Android-L supported, edit feature and schema V-1	NMCG	Bhuvan
18	19-Mar-15	Bhuvan Ganga	1.2b	location, photos and send or send later, Android-L supported and schema V-2	NMCG	Bhuvan
19	1-Jul-15	Bhuvan Ganga app	1.2c	Improved Help	NMCG	Bhuvan and Google Play store

Ministry of Rural Development						
20	27-Jan-14	IWMP app	1.1	location, photos and send or send later - version-1 schema	DoLR	Bhuvan
21	16-Sep-14	IWMP app	1.1a	location, photos and send or send later - version-2 schema	DoLR	Bhuvan
22	28-Jan-15	Drishti app (IWMP)	1.1b	location, photos and send or send later - version-2 schema and GUI changed	DoLR	Bhuvan
23	8-Apr-15	Drishti app (IWMP)	1.2	Supporting Android L	DoLR	Bhuvan
Ministry of Panchayat Raj						
24	8-Nov-14	Bhuvan Panchayats	1.1	location, photos and send or send later , edit of attribute, login, Map view, etc	Panchayat Raj Dept	Bhuvan Panchayatsportal & Proposed Google Play Store
Ministry of Petroleum and Natural resources						
25	9-Dec-14	GAILapp	1.1	location, photos and send or send later	GAIL	Bhuvan
Ministry of Communication & Information Technology						
26	20-Feb-15	Bhuvan IndiaPost	1.1	location, photos and send or send later	Department of Post	Bhuvan
27	10-Mar-15	Bhuvan IndiaPost	1.2	location, photos and send or send later, Android-L supported	Department of Post	Bhuvan
Ministry of Labour and Employment						
28	30-Jan-15	MoLEapp	1.1	location, photos and send or send later - schema v-1	Ministry of Labour and Employment	Bhuvan
29	12-Feb-15	MoLEapp	1.2	location, photos and send or send later - schema v-2	Ministry of Labour and Employment	Bhuvan

Ministry of Environment, Forest and Climate Change						
30	5/1/2013	CAMPA	1.1	location, photos and send or send later	FEG	Task Team
Ministry of Home Affairs						
31	13-Dec-14	NDRFapp	1.1	location, photos and send or send later	NDRF	Bhuvan
32	15-Oct-13	Phailin app	1.1	Same as earlier, automatic folder generation developed	General Public	Bhuvan
33	12-May-15	BhuvanEQ	1.1	location, photos and send or send later	NDRF	Bhuvan
Ministry of Statistics and Programme Implementation						
34	14-Jul-15	NSSOapp	1.1	location, photos and send or send later	National Sample Survey Office	Bhuvan
UNESCAP						
35	13-Jun-14	ADA-Srilanka	1.1	location, photos and send or send later, specific to point/line/polygon	Govt. of Sri Lanka	Bhuvan
Government of Andhra Pradesh						
36	29-Oct-14	HouseGeoTagging	1.1	location, photos and send or send later - uneditable user profile,	APSHCL	Bhuvan
37	12-Nov-14	HouseGeoTagging	1.2	location, photos and send or send later	APSHCL	Bhuvan
38	7-Feb-15	HouseGeoTagging	1.3	One time editable user profile	APSHCL	Bhuvan
39	2-Apr-15	HouseGeoTagging	1.4	Supporting Android 5.1, editing, view of sent points	APSHCL	Bhuvan
40	12-Oct-14	HudHudApp	1.1	location, photos and send or send later	AP Govt	Bhuvan

Government of Karnataka						
41	29-Jan-14	KFDapp	1.1	location, photos and send or send later - version-1 schema	Department of Forest, Karnataka	Bhuvan
42	22-May-14	KFDapp	1.1a	location, photos and send or send later version - 2, specific to point/line/polygon	Department of Forest, Karnataka	Bhuvan
43	27-Jun-14	KFDapp	1.1b	location, photos and send or send later version - 2, specific to point/line/polygon to attributes	Department of Forest, Karnataka	Bhuvan
44	8-Aug-14	KFDapp	1.1a	Icon changed	Department of Forest, Karnataka	Bhuvan
Election Commission of India						
45	10-Feb-14	ECI_BMFapp	1.1a	location, photos and send or send later - version-1 schema	ECI	Bhuvan
46	22-Feb-14	ECI_BMFapp	1.1b	location, photos and send or send later - version-2 schema	ECI	Bhuvan
47	27-Mar-14	ECIIRapp	1.1	location, photos and send or send later - version-1 schema	ECI	Bhuvan
48	4-Apr-14	ECIIRapp	1.1.a	location, photos and send or send later - version-2 schema	ECI	Bhuvan
49	27-Apr-14	ECIIRapp	1.1b	location, photos and send or send later - version-2 schema, SMS based sending to SMS gateway	ECI	Bhuvan
50	29-Apr-14	ECIVechileTacking	1.1	Tracking app and Authi app	ECI	Bhuvan
51	1-May-14	ECIVechile Tacking	1.1a	Tracking and Authi - ingerated app	ECI	Bhuvan

Department of Space						
52	4-Oct-13	BhuvanPOI	1.1	Opens in start page, Data collection - location info, photographs, attributes, Data structure were in separate folders and files provided.	General Public	Bhuvan
53	24-Jul-14	BhuvanPOI	1.2	location, photos and send or send later - Direct to collection page	General Public	Bhuvan
54	12-Mar-15	BhuvanPOI	1.2a	location, photos and send or send later, Android-L supported, edit feature	General Public	Bhuvan
55	6-Jul-15	BhuvanPOI	1.3	location, photos and send or send later, Android-L supported, edit feature + Icon based GUI	General Public	Bhuvan and Proposed Google Play store
56	21-Nov-13	ISRO-DOS Sports meet phase-1	1.1	Sport related attribute and photographs for Phase-1 events	ISRO	Task team
57	28-Nov-13	ISRO-DOS Sports meet phase-2	1.1	Sport related attribute and photographs for Phase-2 events	ISRO	Task team
58	2-Jan-14	FDC Geosciences	1.1	location, photos and send or send later	NRSC, Geosciences Group	Task team
59	9-May-14	FDC Geosciences	1.1	location, photos and send or send later	NRSC, Geosciences Group	Task team
60	18-Jul-14	SubsidenceApp	1.1	location, photos and send or send later	NRSC, Geosciences Group	Task team
61	28-Nov-14	EmissivityApp	1.1	location, photos and send or send later	NRSC, Geosciences Group	Task team
62	19-May-14	NLSM	1.1	location, photos and send or send later	NRSC, Geosciences Group	Task team
63	5-Apr-14	LiDARbetulApp	1.1	location, photos and send or send later	NRSC, Forestry Group	Task team
64	7-Jun-15	TraningApp	1.1	location, photos and send or send later	ASD&CIG	Task team
65	16-Jun-15	NRC LULC 250K	1.1	location, photos and send or send later	NRSC, Task Team	Bhuvan
66	11-Jul-15	BhuvanIPU	1.1	location, photos and send or send later	NRSC, Task Team	Bhuvan

9. Metadata

With the increasing popularity of the mobile applications and a rising number of newer requirements, it has become important to devise suitable mechanisms to keep track of the numerous applications deployed, including new requirements and development. Accordingly, a set of important metadata elements have been identified to manage the applications. These metadata elements are presently maintained in basic database format and updated regularly as required.

The metadata elements implemented so far are comprehensive enough to facilitate search, query and preliminary configuration control. With suitable tools, the metadata can be easily translated to the prevalent metadata standards like RDF for conformance to data exchange standards.

Major metadata elements that are important for Mobile Apps are given in the Table 3 below:

Table 3: Metadata elements maintained for Bhuvan Mobile Applications

SNo	Metadata Mnemonic	Metadata element description
1	Name	Name of the application
2	ProjectName	Name of the project given in development environment
3	PackageName	Name of the package in Java naming convention
4	InitiationDate	Date of initiation of the development
5	CompletionDate	Date of Completion of the development
6	Version	Version of the application
7	UserName	Name of the user for which app developed
8	UserProject	Name of the project under which app developed
9	UserDepartment	User department
10	UserOrg	User Organization
11	AuthorisedBy	Authorized person
12	AppSize	Application size (volume)
13	FeaturesDesc	Major features of the app
14	ChangeLog	Change in features w.r.t. version
15	AttributeNames	Attribute labels
16	AttributeTypes	Data types of the attributes
17	AttributeValues	Data values (for combo / checkbox)
18	NoOfPhotos	Number of photographs that can be captured

The advantages are that they can be easily be adopted for any new development with little effort.

10. Sample Workflow Example - Bhuvan Ganga app

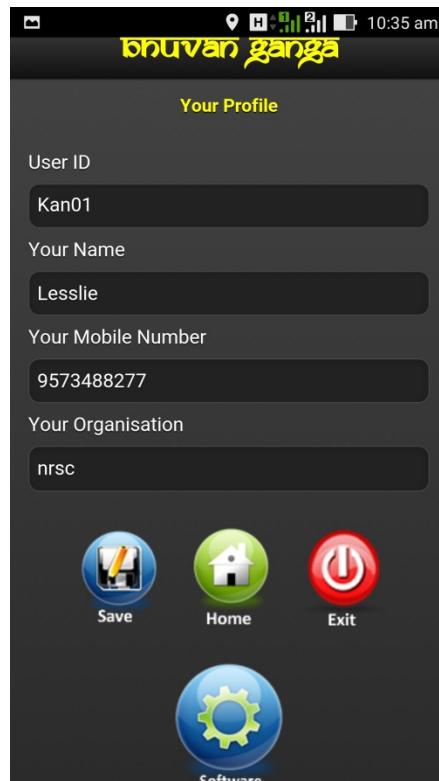
Operational Procedure for Bhuvan-Ganga App



Detailed Work Flow for Bhuvan Ganga - a mobile app for public participation in Clean Ganga Mission

Bhuvan Ganga App is a user-friendly mobile application to enable public to collect and report information on various pollution sources that affects the water quality of river Ganga. This mobile app will provide a platform for crowd sourcing to monitor pollution in river Ganga and enable decision makers to prioritize interventions.

When one opens the App for the first time, the user is required to provide profile using "Profile" icon at the bottom. The details provided will be used only for the purpose identifying the source of data and will not be shared with anyone. The details required to be entered under "Profile" are 1) User ID, 2) User Name. 3) User Mobile Number and 4) User Organisation. After making all entries, the details are saved and then the access to the Home page is enabled.



The user is advised to ensure GPS is switched-on with high accuracy before using the App for data collection.

The procedure for using the App is given below. The main tasks in this App are, 1) Collecting location information using GPS , 2) Taking photograph of the location (two photos), 3) Adding additional information about the location and 4) Sending the collected information to Bhuvan Ganga server on Bhuvan platform, either immediately or later.

Instructions

Step 1. The user is required to select any one option by tapping "Select from here" under "Select the Activity". The options available are (i) Urban Sewage, (ii) Semi-Urban or Rural Sewage, (iii) Natural drains or Nalas, (iv) Industrial Waste Water, (v) Solid Waste Disposal or (vi) Others. The relevant icons will be enabled only after this selection.

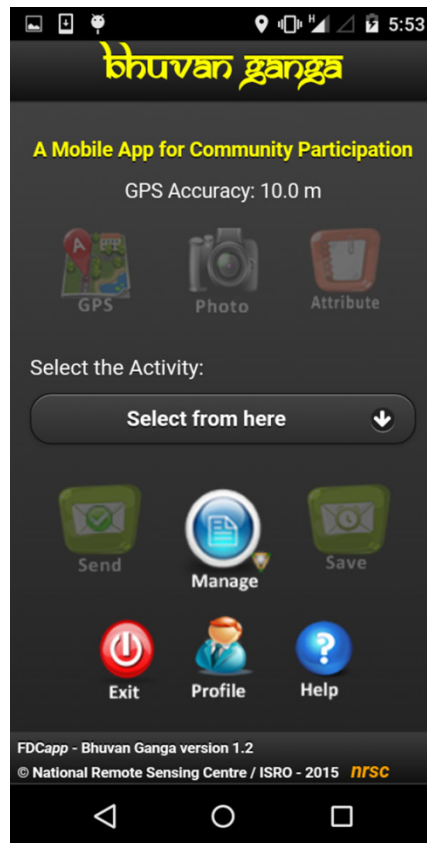


Figure 2: Screen shot of Field Data Collection page

Step 2. GPS accuracy notification on the top must be verified. If the accuracy is less than 10 m, the "GPS" icon is to be selected to collect the location (Latitude and Longitude) details. A confirmation window pops up with GPS accuracy. If the accuracy is acceptable, "OK" is selected, otherwise "Cancel" may be selected to cancel the collection of location data and to wait for some more time to get better GPS accuracy. A clear view of the sky is conducive for receiving good GPS satellite signals.



Figure 3: Screen shot of GPS option

Step 3. The app has provision to capture and upload two photographs of the location. The "Photo" icon is to be tapped to activate the mobile camera for taking photographs. After accepting the first photo, the "Photo" icon may be tapped again to take the second photograph.



Figure 4: Screen shot of Camera option

The captured photographs may be viewed by tapping the "Preview" icon that appears below the "Photo" icon



Figure 5: Screen shot of Preview of photograph option

Step 4. The user is expected to upload additional information about the location by tapping the "Attribute" icon. The information such as nearby village name, name of the industry or any other related description about the location can be uploaded using this option. In case of selecting the option "Industrial Waste Water" under "Select the Activity", the user is prompted to choose the type of Industry. The options available are (i) Chemicals (ii) Distillery, (iii) Dairy, Food & Beverage, (iv) Pulp and Paper, (v) Sugar, (vi) Tannery, (vii) Textile, Bleaching & Dyeing and (viii) Others.



Figure 6: Screen shot of Attribution option

Step 5. Once the information is collected and considered ready to upload to Bhuvan Ganga server, the "Send" icon is to be pressed. This will upload all the information collected by the user. User is advised to ensure that mobile data is switched on before tapping the "Send" icon. A confirmation message "Data sent successfully" appears once the upload is successful.



Figure 7: Screen shot of send option

Step 6. In case of non-availability of Internet connectivity, "Save" button is selected. This will store the information collected in the mobile locally. Once Internet connectivity is available, Step 7 may be followed to upload the data to Bhuvan Ganga server.



Figure 8: Screen shot of Save option for sending later

Step 7. In order to upload the earlier saved data to Bhuvan Ganga server, "Manage" icon is to be selected. Then "Send Later" icon is to be selected. This will list the data collected and stored in the mobile. The data that needs to be uploaded is selected and then sent using the "Send" icon. This will upload the data to Bhuvan Ganga server. A confirmation message "Data sent successfully" appears once the upload is successful.



Figure 9: Screen shot of sending saved observation (Manage and Send Later)

Managing data

The app provides facility for the user to manage the uploaded data. User can view the sent data and also view any data that failed to upload. This will enable user to upload the data again by tapping "Sent Failed" icon. There is a provision to edit attribute value in "Send Later" and "Sent Failed" options.

The profile information can be viewed or edited using the "Profile" icon.



Figure 10: Screen shot of User Profile option

The "Exit" icon exits the application.



Figure 11: Screen shot of Exit option

11. Planned Future Work

With the increasing number of deployments of the mobile applications and their utilization, there are many new features that are envisaged to provide better value addition to the users. Towards this, the following features are being contemplated for incorporation in the near future.

- Providing SBAS corrected location coordinates using GAGAN satellites
- Field data encryption and compression for enhanced data integrity and security
- Data uploading as background process
- Dynamic data fetching
- Offline data visualization
- Online/ offline navigation feature
- Disaster related dynamic decision support apps
- Cross-platform (iOS, Windows) porting of Android apps

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Annexure-1

SOFTWARE REQUIREMENTS SPECIFICATION

Mobile device application development

- 1) The developed application must have very intuitive and ease-of-use features
- 2) It must be deployable on a variety of device platforms – Android, Win Phone 7, Blackberry, iPhone, and on different versions of the device OSs
- 3) The application must enable the field scientist/ user to collect the following:
 - Geographical location of the point in Lat, Lon (GPS)
 - Field photographs (0,1 or more) with direction
 - Multiple parameters (attribute/ value pairs)
 - Video, audio
- 4) Must facilitate data collection for various types of end use and for different application disciplines/ themes
- 5) Within each theme, a number of profiles (differentiated by the variations in parameters of interest) must be supported
- 6) One of the profiles must facilitate simple general purpose data collection, comprising of GPS point, photo(s) and 2 parameter fields (say, Remarks1 and Remarks2) (to cater to exigencies)
- 7) Must also provide functionality to create new profiles on field and start collecting data using the new profiles
- 8) It shall allow collection of single sample or multiple samples together as a group
- 9) Must support association of main project information, field data collection project information, teams information, user information, etc in the field data collection activity
- 10) The collected sample points for a particular data collection project with the device must be numbered in sequence
- 11) The software shall enable user to select the resolution/ quality of the photos, video and audio
- 12) The captured photos for each sample point must be immediately displayed on screen before saving/ sending for checking quality and removing if necessary
- 13) It must be possible to browse the details of already collected points existing on the device with appropriate filters/queries
- 14) There must be provision for deleting one or more of the collected points
- 15) There must be provision to communicate to server to flag deletion of already sent record(s) to rectify erroneous data collection
- 16) The sequence numbers along with other information must allow for uniquely identifying the sample point at the server-side central data repository
- 17) Data and time stamping is required for each sample point and for each of the photos
- 18) The captured photos must have the geotag information along with the direction
- 19) The naming conventions for the XML files and photos must be clearly specified, which preferably includes time stamping, to aid in data organization and retrieval

- 20) The collected data must be saved on the device. Provision to be given to delete at a later stage or based on conditions like time period, successful sent event, etc.
- 21) The collected must also be organized on the device under respective folders (or any other method) as: sent data, unsent data
- 22) The unsent data must be resent based on configurable preferences: periodical retries, manual retry, etc.
- 23) It must allow transferring of collected data on the device (unsent, sent or both) to PCs or laptops or servers. It must be possible to subsequently send such transferred data to the central server via wired or wireless connectivity options
- 24) Collected data can be sent using one or more of the following selectable transmission technologies: GPRS, 3G, WiFi
- 25) Data submission options (depending on server side implementations) are one or more among the following selectable methods: web server/ service, email, ftp, sms
- 26) The application shall enable the user to display satellite images and maps in background with standard map navigation functionalities. While other map sources like Google Maps can be considered, the priority is to source the data from Bhuvan
- 27) The collected GPS points must be made visible on the image/ map with attribute information and also marker symbols where appropriate
- 28) There must be provision to filter/ query/ search on the points to limit the number of points displayed at any instant
- 29) Reverse geocoding functionality to be provided for the points collected with services invoked from Bhuvan/ other sources
- 30) The application must be highly flexible, configurable and customizable
- 31) Configurability must be provided for setting many attributes and options: web server IP address/ URL, email server address, ftp server address, SMS number, photo/ video resolution, photos/ videos path, sent/ unsent folder paths, etc.
- 32) User authentication must be provided. An admin user and a few user profiles may be configured by default. Provision to be given for creation of new users by admin, password reset by users, etc.
- 33) Provision to be made for populating default information regarding projects, teams, etc., along with facility to create/ add new values on field in case of exigencies

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