Mobile GIS - An Overview

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Learning Objectives

- Mobile GIS : Definition
- Why Mobile GIS
- Related Technologies behind Mobile GIS
- Architecture of Mobile GIS
- Functions and Application of Mobile GIS
- Approaches to develop mobile applications
- Limitations of Mobile GIS
- Mobile GIS case studies
- Some Popular Mobile GIS Apps
- How to develop a mobile GIS based application

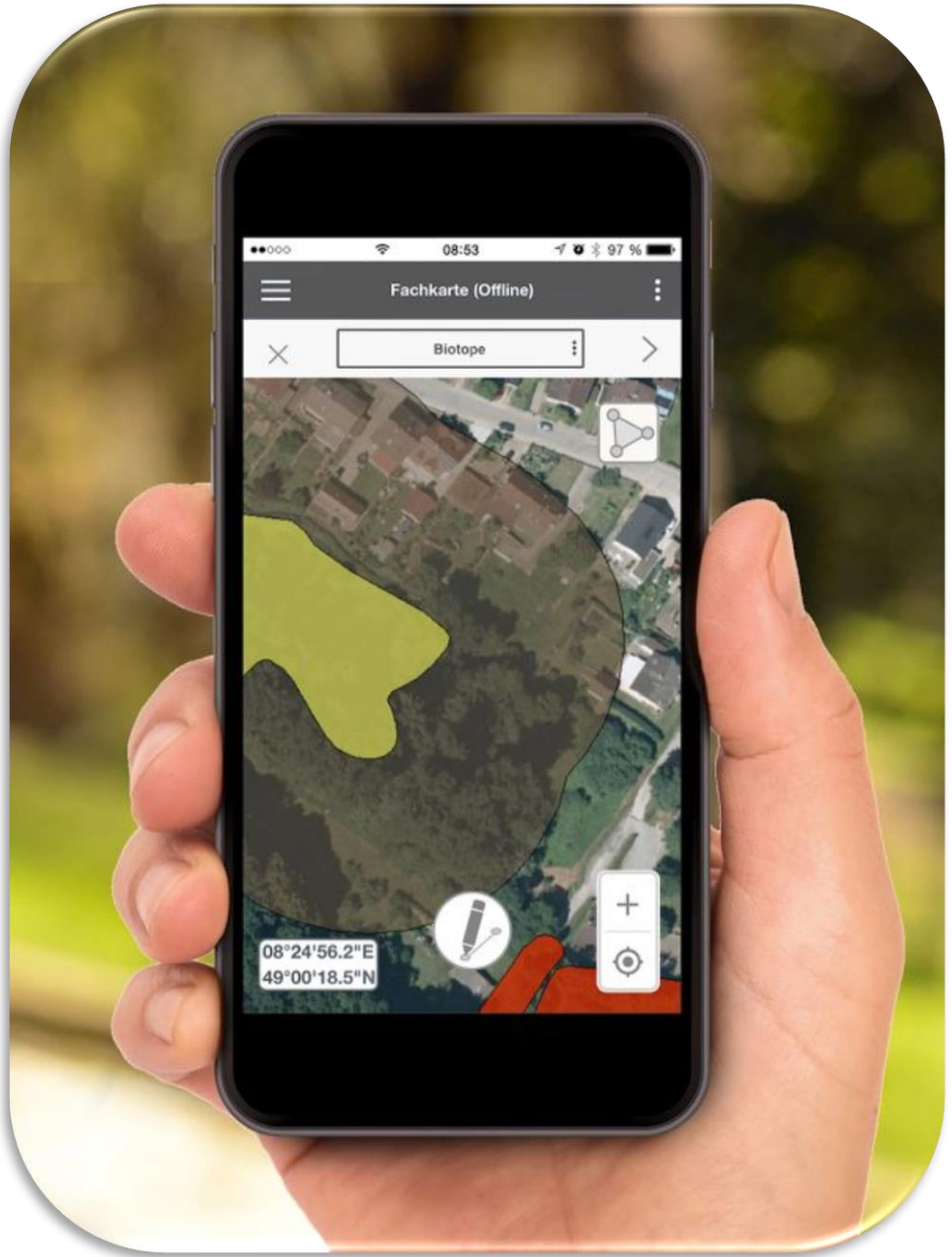
What is MOBILE GIS

GIS for use on Mobile devices
GIS on move

A mobile GIS enables field-based personnel to

- capture,
- store,
- update,
- manipulate,
- analyze, and
- display

geographic information.



Why MOBILE GIS

Some of the task which necessitates Mobile GIS in daily life

Personal Tasks

- Finding best route to places
- Finding nearest utility places like ATM, Restaurant, Hospitals etc.

Business Tasks

- Field Survey
- Product Delivery
- Power line maintenance
- Utility trouble shooting
- Emergency Response
- Geotagging field assets for inventory and monitoring

Who uses Mobile GIS and where do they use it

Users of Mobile GIS

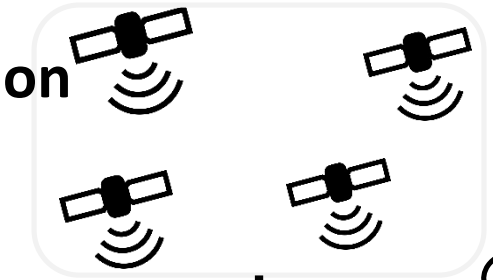
- Firefighters,
- Police officers,
- Engineering crews,
- Surveyors,
- Utility workers,
- Soldiers,
- Census workers,
- Field biologists and others
- Individuals

Tasks Accomplised through Mobile GIS

- **Field Mapping—**Create, edit, and use GIS maps in the field.
- **Asset Inventories—**Create and maintain an inventory of asset locations and attribute information.
- **Asset Maintenance—**Update asset location and condition and schedule maintenance.
- **Inspections—**Maintain digital records and locations of field assets for legal code compliance and ticketing.
- **Incident Reporting—**Document the location and circumstances of incidents and events for further action or reporting.
- **GIS Analysis and Decision Making—**Perform measuring, buffering, geoprocessing, and other GIS analysis while in the field.

Architecture of Mobile GIS

- Mobile Device
- Location Information
- Wireless Connection
- Mobile GIS App
- Web/GIS Server
- Base Map
- GIS Data
- Multimedia (Optional)



Satellite Constellation

Base Map

Wireless Connection

Web/GIS Server

Mobile Device

Mobile GIS App

Multimedia

GIS Data

Base Map

Technologies involved in Mobile GIS

Mobile GIS is built on top of the following technologies (among others):

- **Mobile devices:** Mainly smartphones and tablets
- **Mobile operating systems:** Mainly Android and iOS
- **Wireless communication technology:** Including Bluetooth, Wi-Fi, and cellular network technology, which has evolved into 4G (fourth-generation)
- **Positioning technology:** Including the navigation satellite-based approach such as GPS, cellular network based approach, Wi-Fi-based approach, and various indoor positioning technologies that are evolving

MOBILE GIS vs Traditional GIS

Mobile GIS has certain advantages over traditional desktop GIS, including:

- **Replacing paper-based workflows :** Improves accuracy of data and reduces cost of data collection
- **Mobility**: mobile devices are not hindered by wire or cable, and thus can extend GIS to areas where wiring is infeasible or costly and users most need GIS.
- **Location awareness**: GPS, Wi-Fi networks, and other technologies can be used to pinpoint the current location of a mobile device.
- **Large volume of users**: Mobile devices are creating a pervasive platform for GIS.
- **Versatile means of communication**: Integrating with voice, short message, photo, video, e-mail, and many social networking apps, mobile devices can facilitate collaboration and communication among professionals and consumers.
- **Near real-time information**: The live connection of mobile networks greatly enhances the temporal dimension of GIS. This gives mobile GIS the potential ability to monitor the spatial and temporal aspects of the world around us

Advantages & Limitations of Mobile GIS

Advantages

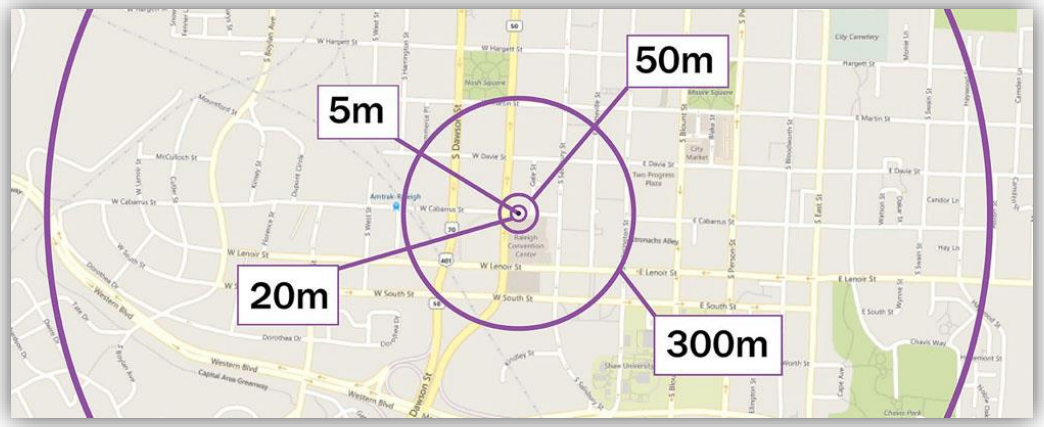
- **Information capture and updating –**
  - GPS receiver in the mobile
  - Rich geospatial information in several multimedia form
- **Dissemination**
  - Large volume of user-base

Limitations

- **Storage**
  - Limited storage. Requires synchronization with GIS server
- **Analysis**
  - Limited amount of analysis e.g. routing for vehicle navigation, nearest utility etc.
- **Presentation**
  - Limited screen size and color depth

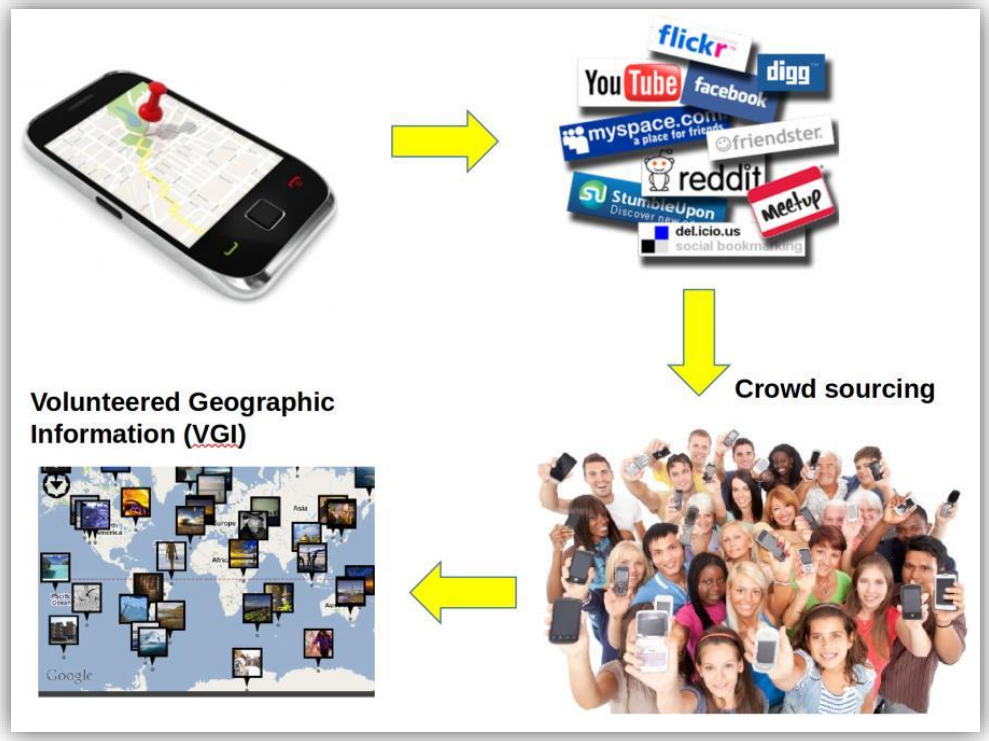
Applications of Mobile GIS

- **Location Based Services (LBS)** are services offered through a mobile device and consider the device's geographical location.
- LBS typically provide information or entertainment.
- Desktop GIS apps allow you to click a POI to get its information. With LBS, you essentially become the mouse cursor on a map of 1:1 scale—the real world.
- As you enter an area or get close to a POI, the mobile apps on your phone know where you are and push information to you about this area or POI.



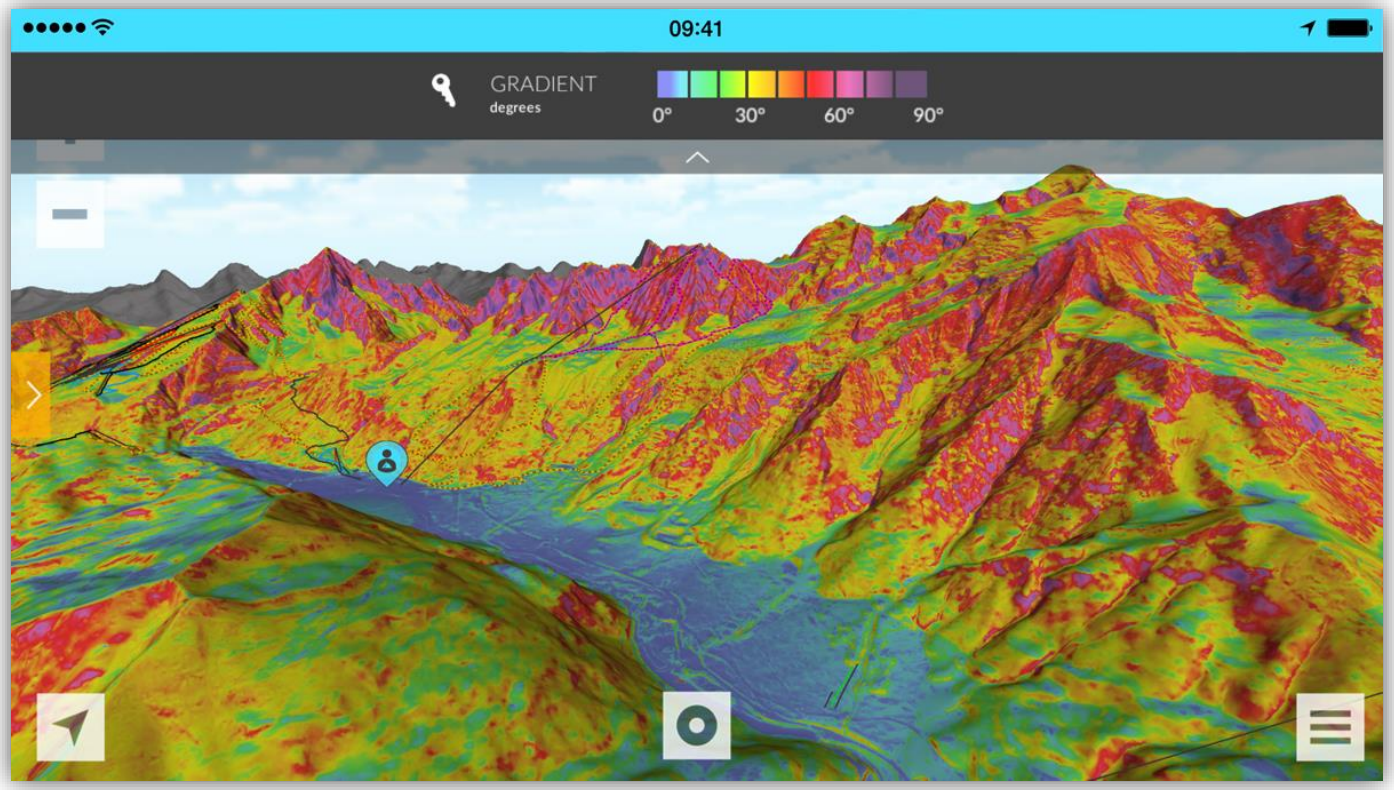
Applications of Mobile GIS

- **Volunteer Geographic Information VGI** is the digital spatial data produced voluntarily by citizens rather than by formal institutional data producers.
- The term “VGI” was coined in 2007 to refer to user-generated content in the geospatial field.
- VGI is often reported using mobile devices. Various navigation and traffic apps, for example, collect VGI about highway traffic, accidents, and police car locations that mobile users contribute voluntarily.
- Other examples of VGI include georeferenced tweets collected by Twitter and georeferenced photos uploaded to Flickr and Instagram.
- VGI marks a research frontier of significant practical value. With the help of crowdsourcing, in which large numbers of citizens act as sensors,
- VGI can enhance early warning systems for natural disasters, epidemic, or real-time social events monitoring.
- VGI is also an important source of big data and supports tremendous new business opportunities.



Applications of Mobile GIS

- **Virtual Reality VR** is the computer-generated simulation of a 3D map or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.
- Today, smartphones and VR glasses, such as VR cardboards, provide an inexpensive platform that makes the fun, immersive experience of VR available to everyone.



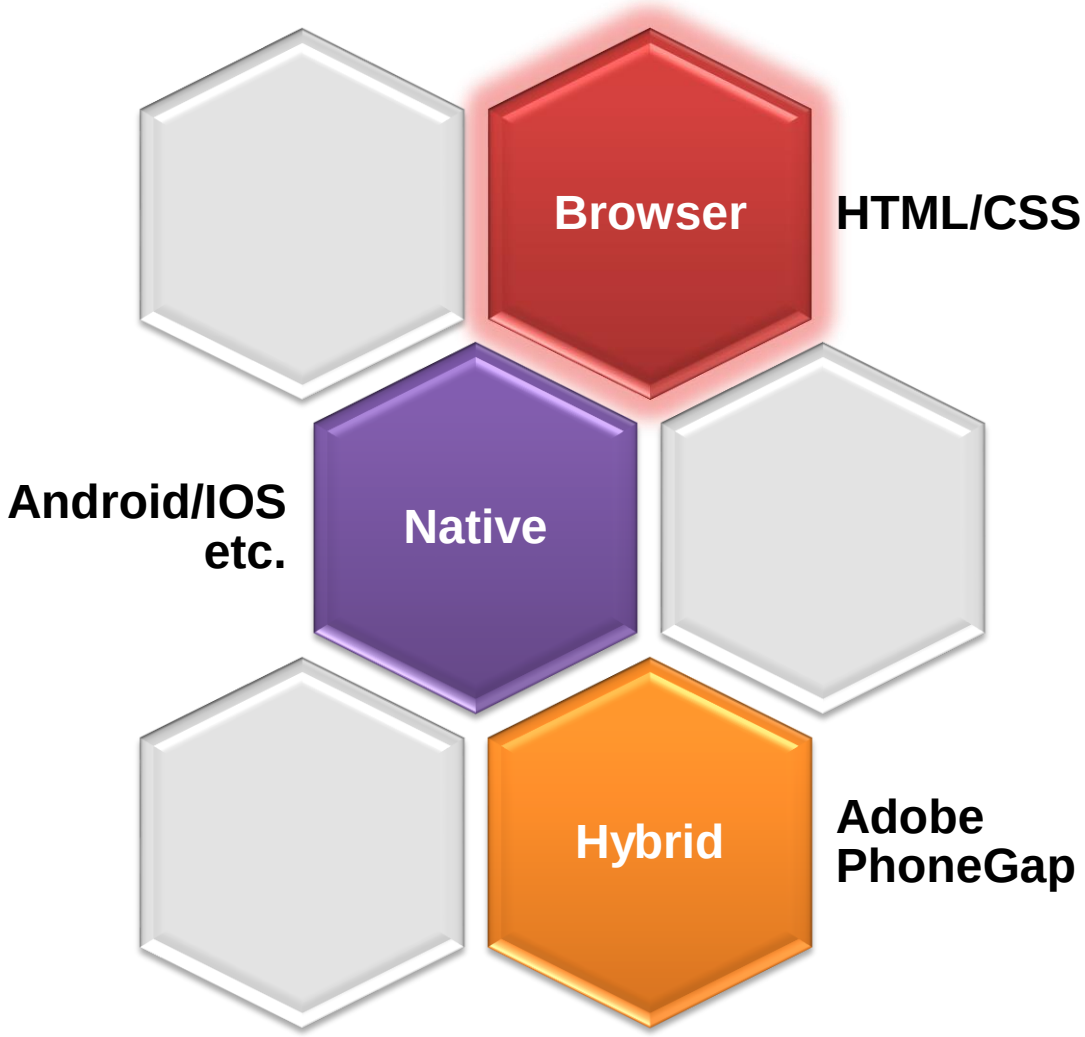
Applications of Mobile GIS

- **Augmented Reality AR** is an enhanced version of reality created using technology to overlay digital information on the view through a device, such as a smartphone or tablet camera.
- AR is often related with mobile GIS because a mobile device can retrieve information based on your location, the direction you are facing, the tilt angle of your camera, the live view in your camera, and can overlay the retrieved information in your camera view. Here are two examples of AR apps:
  - An AR-based travel app can superimpose a building's historic pictures on its current view through your phone's camera. If you point your camera to a restaurant, the app can display services, reviews, and open hours of the restaurant in a pop-up window on your phone.
  - An AR-based pipeline map that can retrieve the underground pipeline information as you hold your phone downward. The app can overlay the pipelines with what you see through your camera view and help you "see" underground.

Mobile app development strategies

1. Browser-based approach:

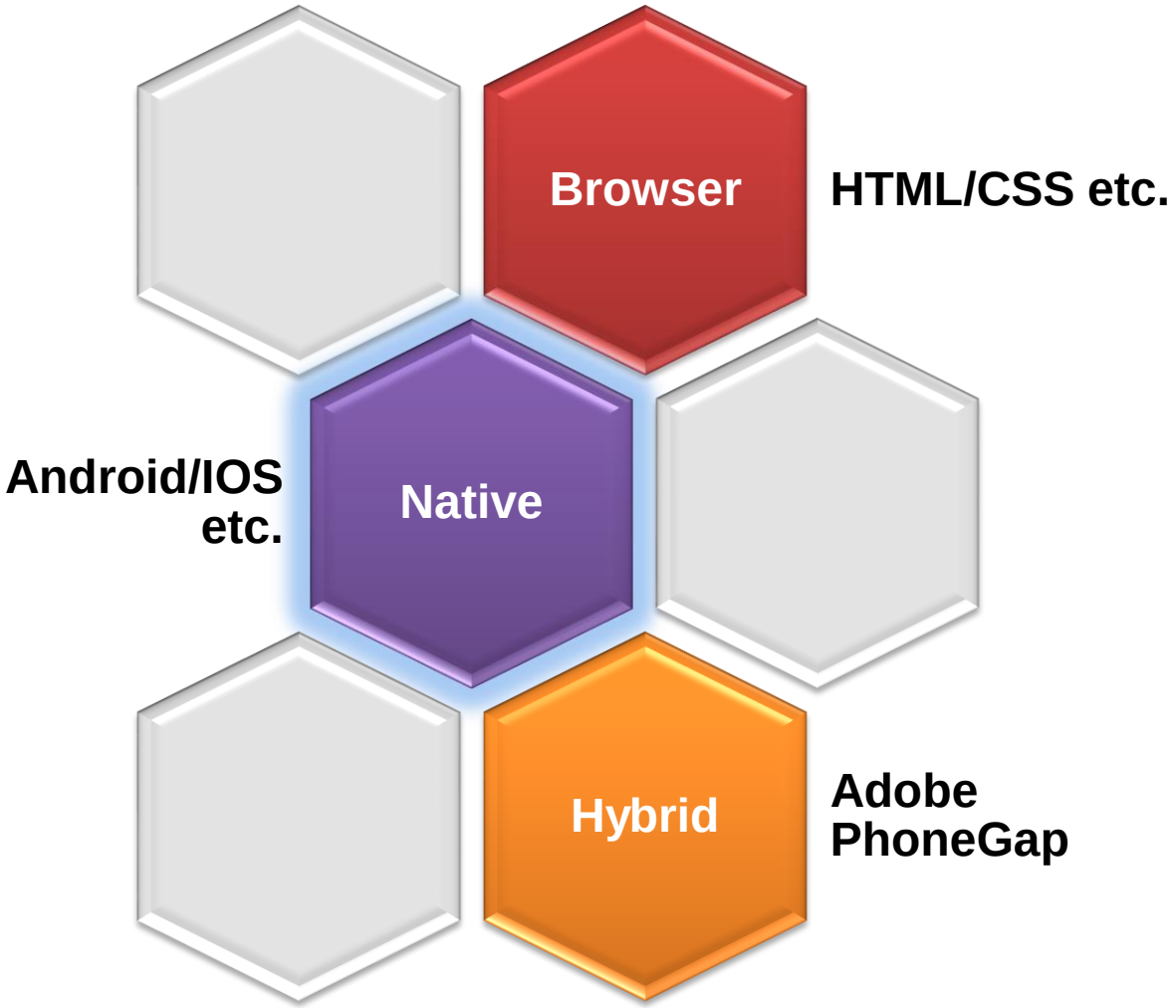
- This approach builds apps using HTML, JavaScript, and Cascading Style Sheets (CSS).
- Users access these apps via mobile web browsers.
- This strategy can potentially reach all mobile platforms.
- Browser-based apps typically are less costly and quicker to develop than native apps. **However, browser-based apps can access only a limited amount of a device's native features**.
- As such, the user experience and performance of browser-based apps typically cannot compete with the experience of using native apps, which don't have the limitation of web browsers.



Mobile app development strategies

2. Native-based approach:

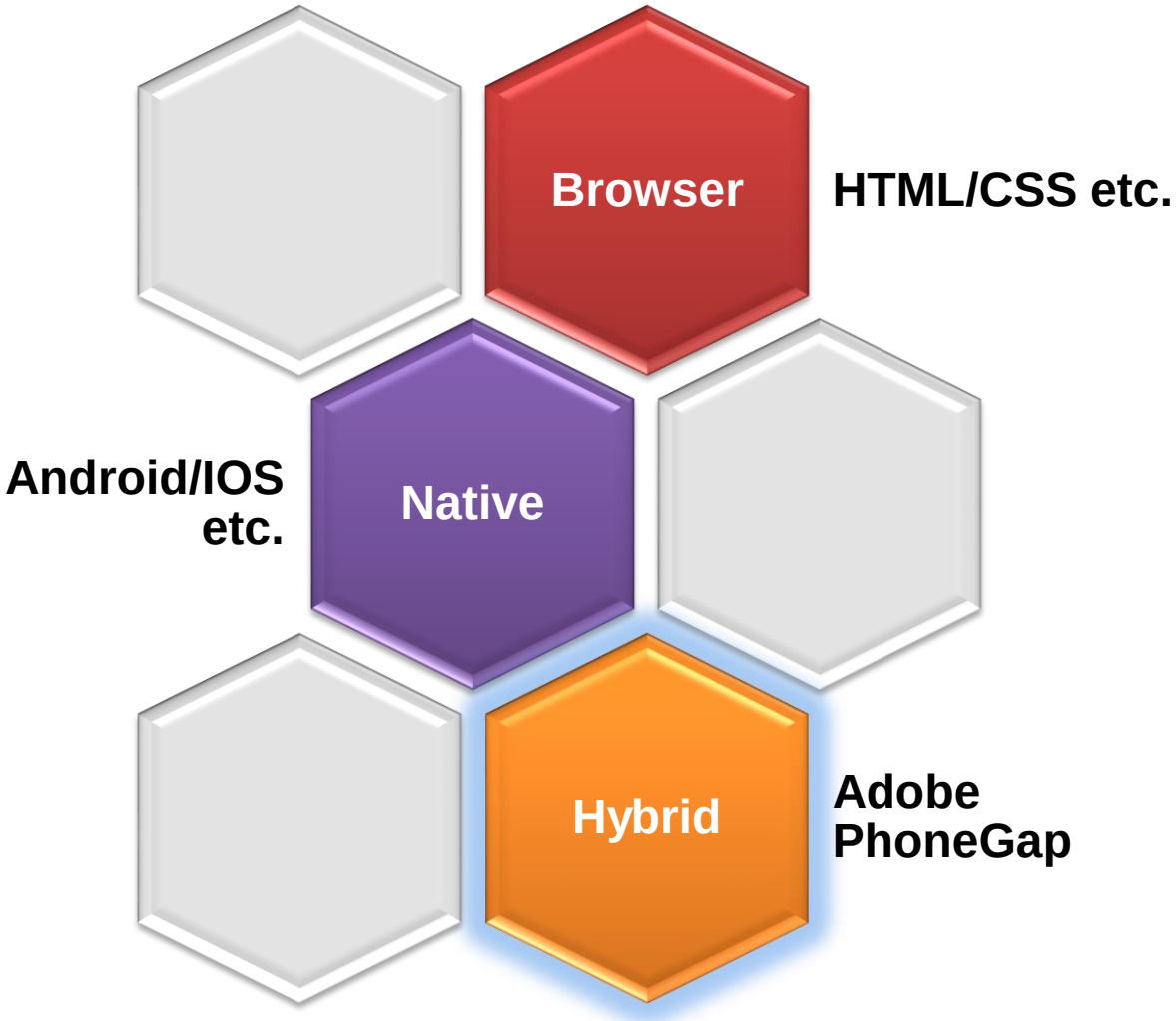
- The apps you download and install on your mobile device are native apps.
- The native-based approach requires native development skills, such as Objective-C or Swift for iOS, Java for Android, and .NET for Windows Phone.
- These apps typically have deep-level access to device hardware and other resources, and typically have better performance than browser-based apps.
- However, native apps are often more expensive to develop than JavaScript apps, and one app cannot run on multiple platforms.



Mobile app development strategies

3. Hybrid-based approach:

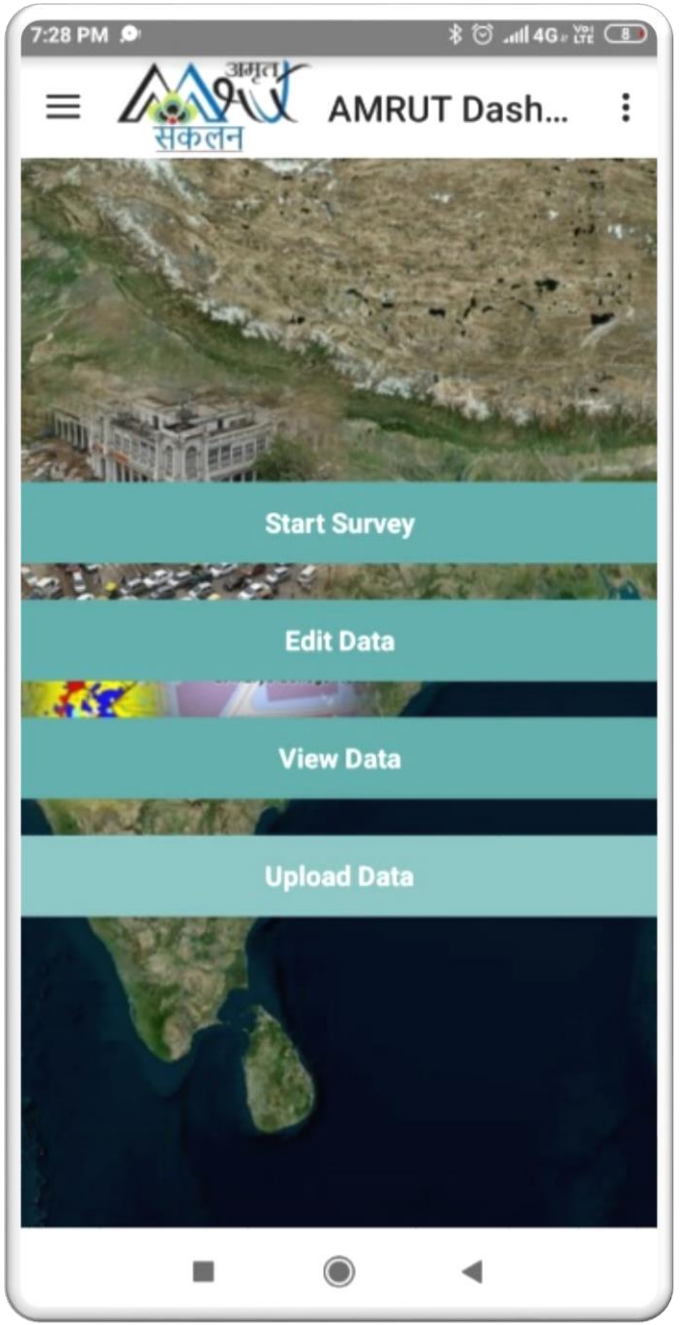
- This approach integrates native components and HTML/ JavaScript/CSS to build native applications.
- You can achieve this in many ways. The simplest way embeds a web control into a native app to load HTML and JavaScript contents.
- More advanced methods include the use of frameworks such as Adobe PhoneGap to allow for deeper integration with the native platform.



AMRUT Mobile App : Geotagging Assets

This application provides geotagging and attribution of assets identified under AMRUT program of GOI

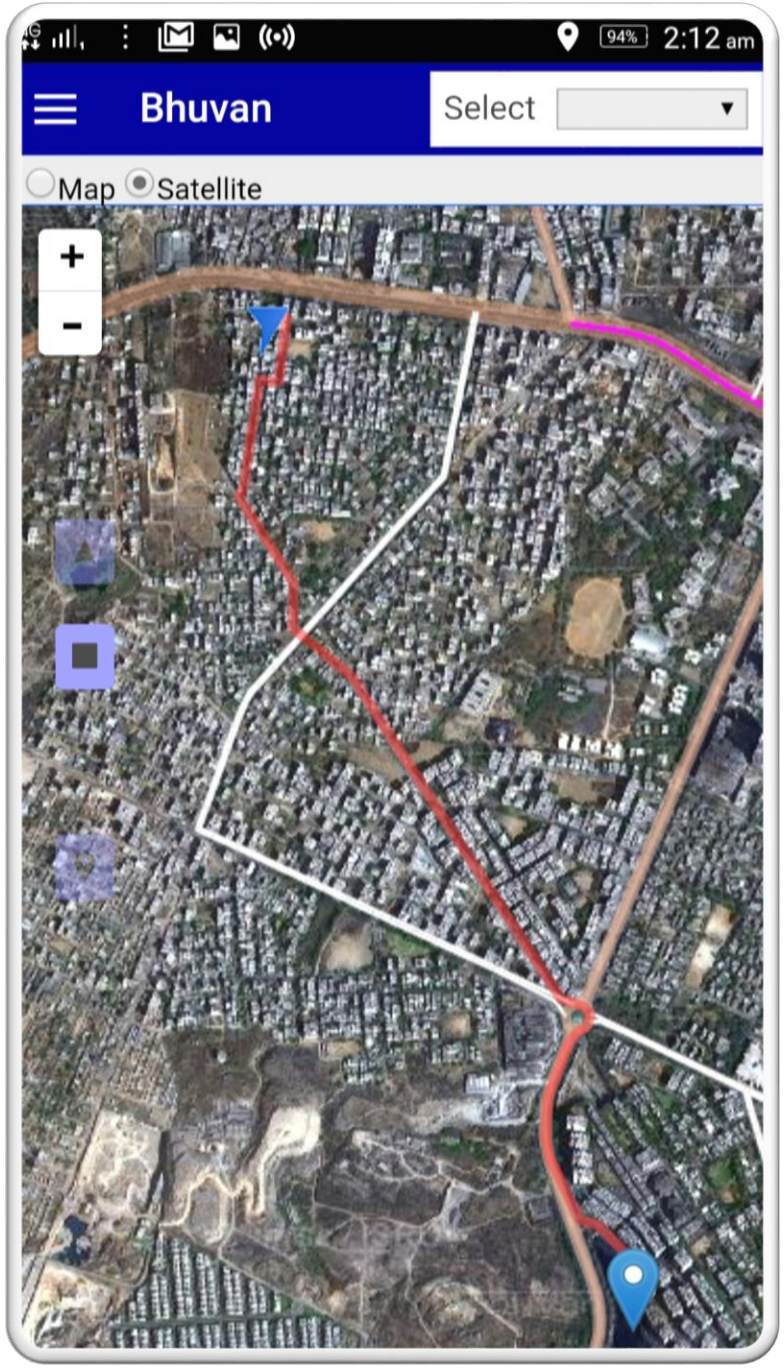
- **Attribution**: The app can be used for attribution of the spatial features, online mapping, map editing/ updation etc.
- **Web Based Dashboard:** The web based dashboard provides various software tools and utilities as per the requirements of the project to generate various spatial and non-spatial data products as a map or a report along with effective analysis and moderation of field data
- **User Friendly GUI:** Feature based data recording assisting surveyors to capture location, attribute and photograph effortlessly.



Bhuvan Locate Android Application

This application provides real time navigation and location tracking, along with finding route tables for the user

- **Location Tracking** - The user can click the location icon to track and show the user's location on the map along with the location address
- **Real time Navigation** - The user can click the navigation icon and provide the destination address which will start real time navigation to the given destination with voice advices
- **Find Route** - The user can select this option from checkbox and enter destination address to view a route table along with estimated time and distance to reach



Bhuvan Point of Interest: Bhuvan POI

This application provides real time navigation and location tracking, along with finding route tables for the user

- **Location Recording** - The user can click the location icon capture the geo coordinates of the point of interest
- **Geotagged Data Collection**- The user can click the attribute icon start real time navigation to the given destination with voice advices
- **Geotagged Photo Capture**- The user can select this option from checkbox and enter destination address to view a route table along with estimated time and distance to reach

Popular Mobile mapping apps

Collector for ArcGIS

- ESRI Product
- Anroid, iOS and Windows
- Offline and Online operations
- Line, polygon and point features
- ArcGIS online and ArcGIS Server
- Free but requires ESRI institutional account

Mapit Spatial

- Mapit GIS Limited Product
- Android
- OGC GeoPackage Encoding Standard
- Basemaps like Google Maps, OSM, BingMaps or ESRI
- Requires yearly subscription

Qfield

- OPENGIS under GPL
- Android
- QGIS Complaint
- External GNSS receiver via third party application
- No dedicated online platform for data sharing
- Free to use and modify

Open Data Kit (ODK)

- Released under Apache 2.0 License
- Android
- Suite of open-source tools for data collection and management
- Line, polygon and point features
- Fit well with google drive also
- Free to use and modify

SW Maps

- Product of Softwel (P) Ltd.
- Android
- Points, lines and polygons , tracks in terrain
- GPS status and a sky plot visible GNSS satellites
- No dedicated online platform for data sharing but support FTP and Share
- Free to Use

Locus GIS

- Product of Asamm Software
- Android.
- Connection with external GNSS receiver via Bluetooth
- Allow distance and area measurements on a map and QGIS compatible
- Free to Use

Global Mapper Mobile

- Product of Blue Marble Geographics
- Anroid and iOS
- Requires proprietary software – Global Mapper
- Allows gather data through GPS and by drawing features on a map
- Free to use

Mobile Data Collection

- Product of GIS Cloud
- iOS and Android
- Requirement of data collection is to prepare a form with dedicated Map Portal
- Free as trial, and the subscription in order to get all features.

Building a App for Mobile GIS: ODK case study

Prerequisites

- You'll need a Google Account (or create a new Google Account)
- You need an Android mobile device running Android OS of 1.6 or newer.

Step 1: **Create a form for data collection using ODK Build**
Step 2: **Deploy Your Form in Google Drive and share the link with edit option.**

- Now you will need to host the survey form you built with ODK Build in your Google Drive so that your project team will be able to download it to their Android phones.
- You'll also need to create a spreadsheet which will be where completed survey responses from your project team will be sent and stored.

Step 3: **In ODK Build, go to Edit > Form Properties. Paste the Sheet URL in the submission URL field.**

Step 4: **In ODK Build, download your form as an XML file.**

Step 5: **Upload the XML file to the google drive and share the link with edit option**

Step 6: **Install & Configure ODK Collect**

- **Download ODK Collect from Play Store and**
- Click on General Settings → Server Settings,→ Select "Google Drive, Google Sheets"

Mobile GIS - Supporting Technologies

Mobile Devices:

- Mobile Phones
- Pocket PC
- Portable PC
- Special Devices

  Embedded devices (in-vehicle GPS navigation System

***Challenge**: Many OS like Android, iOS etc. have different requirement for Mobile GIS applications*

Wireless Communications

- Bluetooth

  (10 m range – communication between mobile device and its peripherals like GPS receivers and handsets)
- WI-FI (Wireless Fidelity)

  (100 m range – data transfer rate 10-54 MBps – Wireless Local Area Network (WLAN) within a close group
- Cellular Networks

  (Long distance ranges - Radio Network-

  1G – Analog Technique and only voice Mobile GIS cannot be build on this Tech.

  2G and 2.5G Digital Cellular Network – support voice and low speed data transfer (10KBps) . 2.5G operates at 384 Kbps

  Mobile GIS face challenge of limited data transfer speeds.

  3G – Data transmission 2Mbps also supports web surfing and video streaming so integration of web services is possible.

  4G – Data transmission 100Mbps (Built on LTE, WiMax (Worldwide Interoperability for Microwave Access) and UMB(Ultra Mobile Broadband))

  5G - Data transmission 1GBps

Mobile GIS - Supporting Technologies

Mobile Positioning Technologies

- **Navigation Satellite Based Approach**
  - High accuracy is the advantage which become limitation during cloud cover and physical barriers like high-rise buildings
- **Cellular Network Based Approach**
  - Low accuracy.
  - Different Methods like
    - Cell of Origin (COO – location of origin base station is considered as location of caller)
    - Signal Time of Arrival (TOA)
    - Time Difference of Arrival (TDOA)
    - Angle of Arrival (AOA)
    - Enhanced Observation Time Difference (E-OTD)

    } Based on Triangulation of the cellular network – 100m accuracy …require directional antennas and accurate clocks in cellular network system.

- **Assisted GPS Approach (A-GPS) –**
  - Satellite based and cellular based technology
  - Accurate location
  - Can Operate in areas behind or under barriers
- **Wi-Fi Approach**
  - Based on Wi-Fi hotspot.
  - Relies on Database of Wi-Fi hotspot and the fact that device is with in 100m of range of Wi-Fi.
- **IP Address based Approach**
  - IP address of the mobile device when it connects to internet can be used to determine location.
  - Accuracy is very low usually within the range of a city.

Popular Mobile mapping apps

iNaturalist is an app which enables the identification of species from different kingdoms. Thanks to user community, the application's entries are verified. The community ensures that data is reliable, but it also gives the opportunity for fellow users to gain knowledge about species from around the world. iNaturalist is a joint initiative of California Academy of Sciences and National Geographic Society (2019). The app is available for free for Android, iOS and it is also accessible through the web page: https://www.inaturalist.org/.

Pl@ntNet (Joly et al., 2016) is a similar application to iNaturalist although it is dedicated solely to plants. Thanks to the pattern recognition, the algorithms and visual search engine, it enables automatic plant species recognition. Pl@ntNet is able to recognise a plant through a photo of an entire individual and its organs – leaves, flowers, fruits or bark. Entries are being validated through collaborative tools IdentiPlante and PictoFlora by Tela Botanica association members. Apart from recording the photos of plants, Pl@ntNet gathers the location of given registered individual. Gathered and validated data can be used to enrich other global datasets like GBIF. The platform is available as mobile app for iOS and Android, it can be accessed from desktop via: https://plantnet.org/.

Spipoll is a pollinator insects identification app, created by the French National Museum of Natural History (le Muséum National d'Histoire Naturelle) and the Office For Insects And Their Environment (Office Pour les Insectes et Leur Environnement, OPIE). The aim of the application is to collect photos of insect-plant interactions in a standardised manner. The users are asked to take pictures of flowers, leaves, entire plants and their surroundings. Photos shall be taken during 20 min time frame in order to capture flower 'visitors.' Insects are identified by the Spipoll community (de Flores and Deguines, 2012). In the event of more complicated cases, the entries are verified by the Museum staff. Currently, the application is available in French and the identifications of insects are meant to take place within France's territory. Spipoll's platform is accessible through the website: https://www.spipoll.org/.

eBird is an online citizen science project managed by the Cornell Lab of Ornithology which focuses on avians (Sullivan et al., 2009). It enables its users to document data on bird distribution, abundance and habitat use. Birders can enter the information on where, when and how they went birding, filling out the checklist of birds that they had heard or seen. The eBird mobile app allows offline data collection in the field. The website provides an exploration and a summary of data as well as data entry. eBird is a worldwide database with more than 100 million bird sightings each year entered by its users. Thanks to the data entry through the checklists, the information is gathered in a structured way and moreover, the errors are minimised because unusual entries are reviewed and validated by experts. eBird is comprised of local, national and international partners' networks, and collaborates with them for regional data entry portals, outreach, engagement and local impact. The application is available for desktop through the website: https://www.ebird.org, and for Android and iOS devices.