MAGIC

Mobile Application for Geolocation of Imagery and Collaboration

Sponsored By: Integrity Applications Inc.

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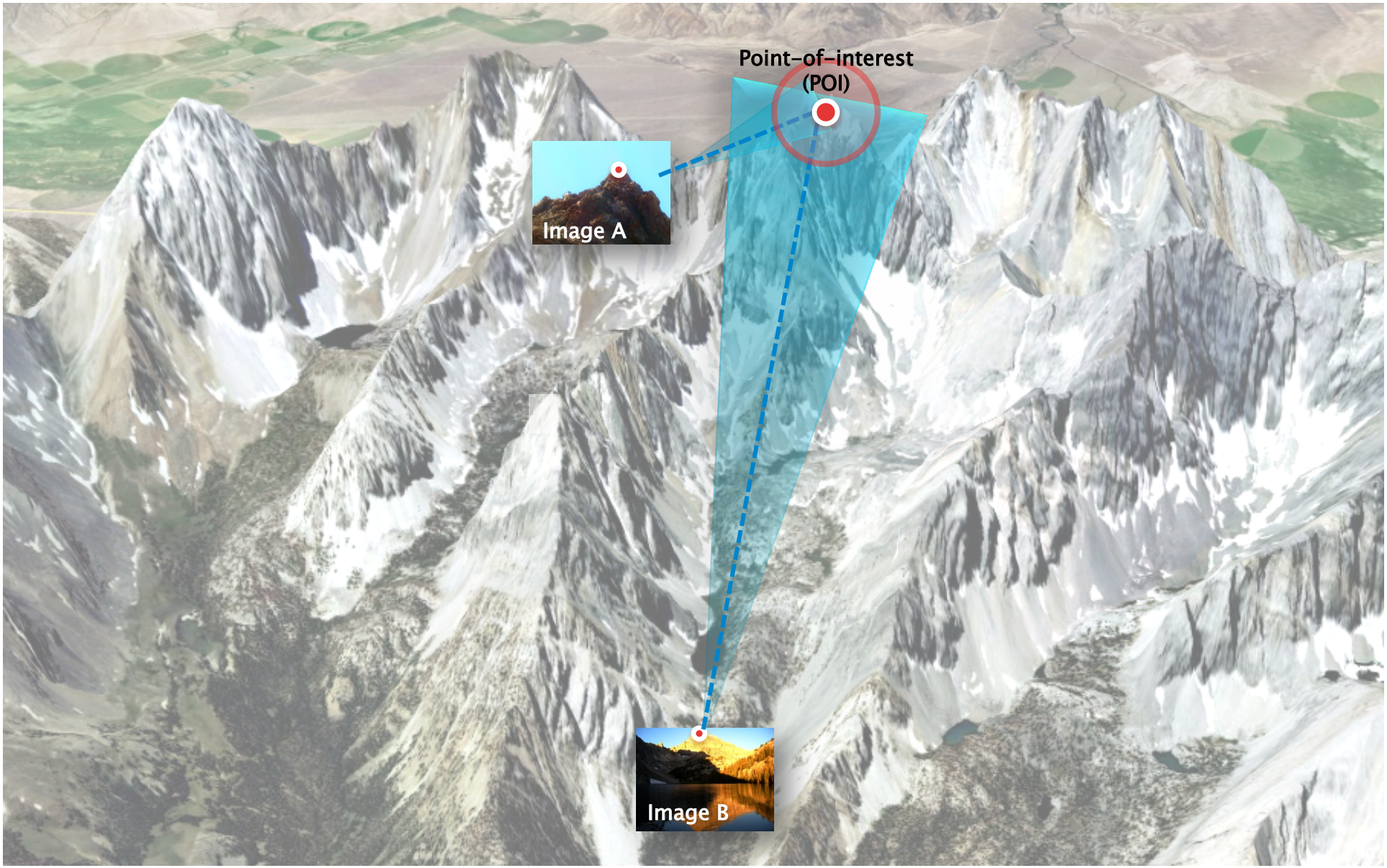
GMU Masters Project
Final Presentation
May, 6th 2011

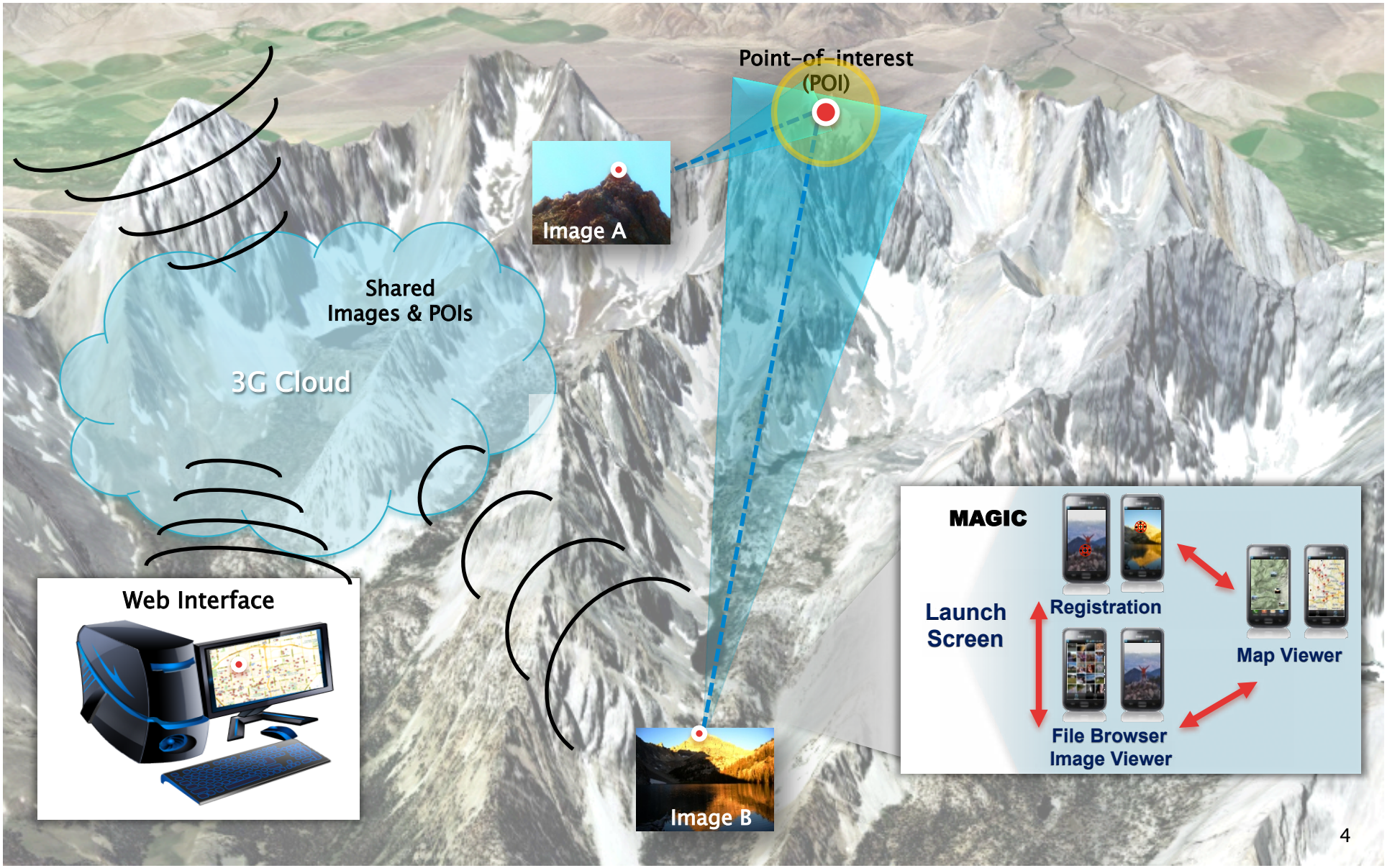
Geolocation from Multiple Images



Problem Statement

- Who would use this capability and how?
  - Concept of Operations
- Can the accuracy requirements for these users be met with existing smartphones?
  - Technical Feasibility Analysis
- What is the system required to do and how should it be designed?
  - System Description Document and Architecture
- Could developing this capability be profitable and what development path should be pursued?
  - Business Case Analysis

Scope


Point-of-interest
(POI)
Image A
Shared
Images & POIs
3G Cloud
Web Interface
Image B
MAGIC
Launch
Screen
Registration
Map Viewer
File Browser
Image Viewer

Concept of Operations

Who will use this capability and how?

- Potential User Analysis
- Use Case Analysis
- Graphical User Interface Mockup

(Kyodo News/Associated Press)

Emergency Responder

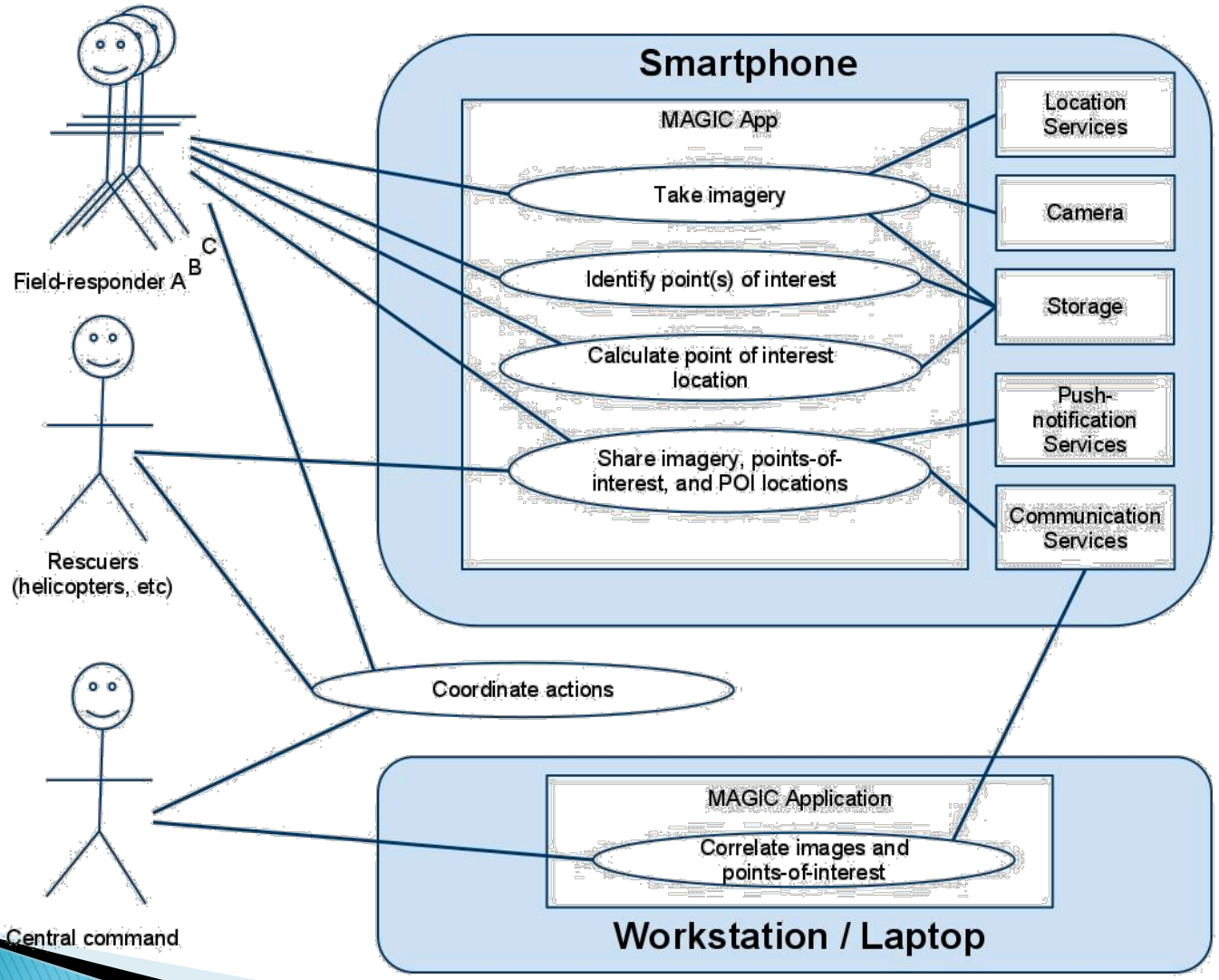
Where do you send help when continents shift and cities are erased?

(Jeff Carpenter)

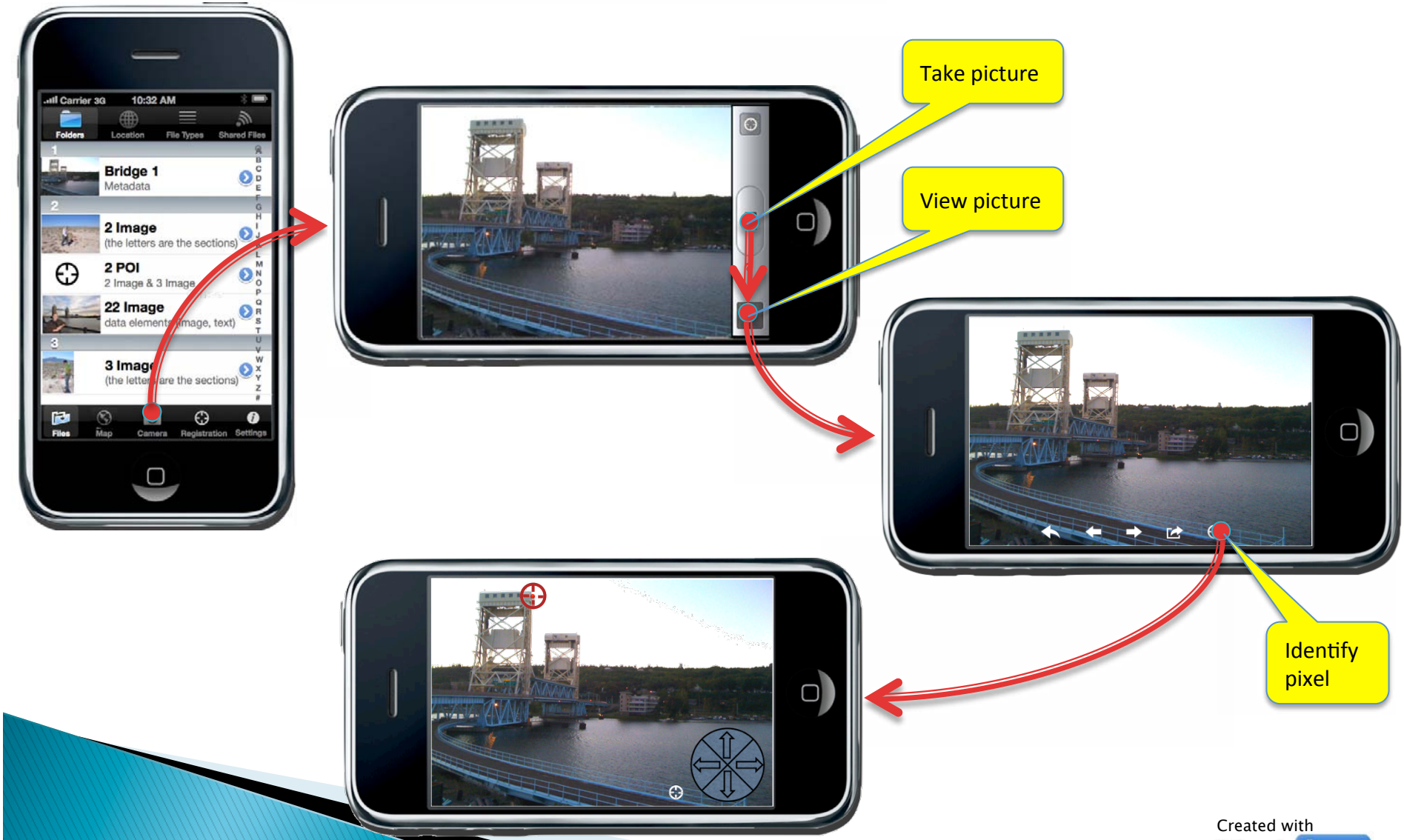
Casual User

Which lighthouse can we whale watch from?

Emergency Responder Use Case



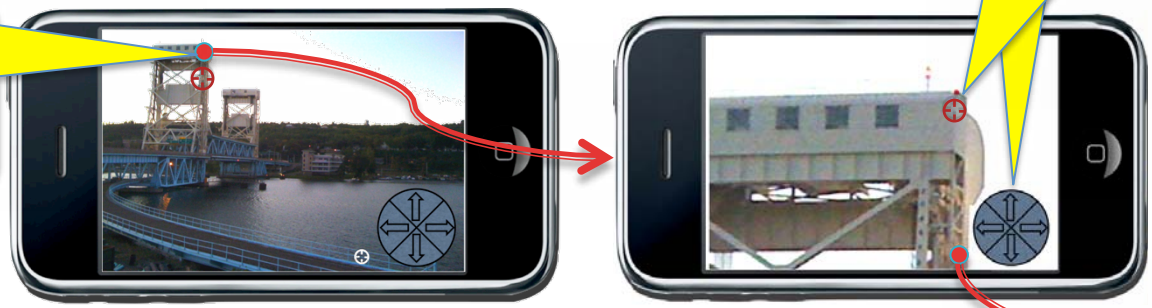
MAGIC Walkthrough

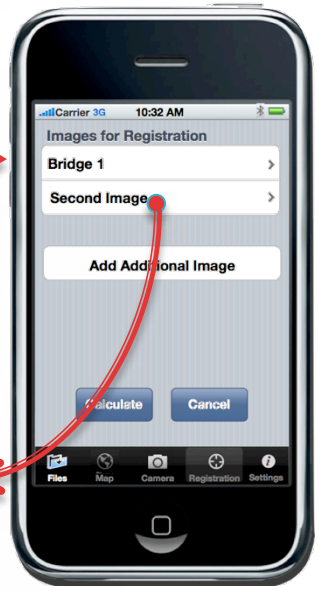


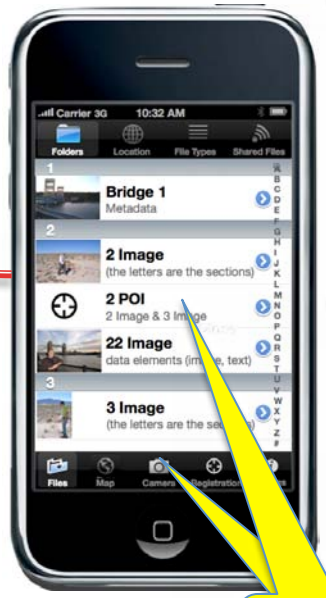
MAGIC Walkthrough

User zooms in to the area that contains the new point-of-interest using a standard 'reverse pinch' motion

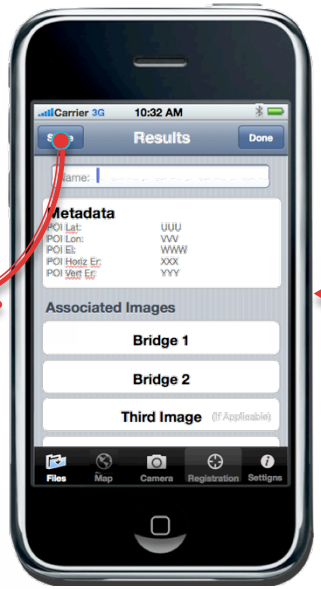
User can precisely place the crosshairs over the point-of-interest by tapping arrow-key controls

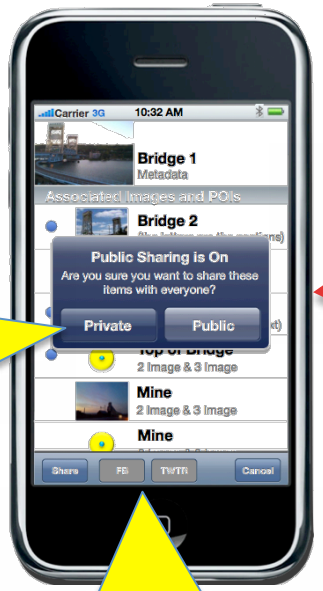






Repeat point-of-interest selection, and select 'Calculate'





Public Sharing
When it's on, users can choose to not use it for a given image / POI

Facebook and Twitter buttons are greyed out, unless:
1) the image / POI has already been Publically shared and
2) the user has authenticated with these sites

User can select a stored image, or take another picture

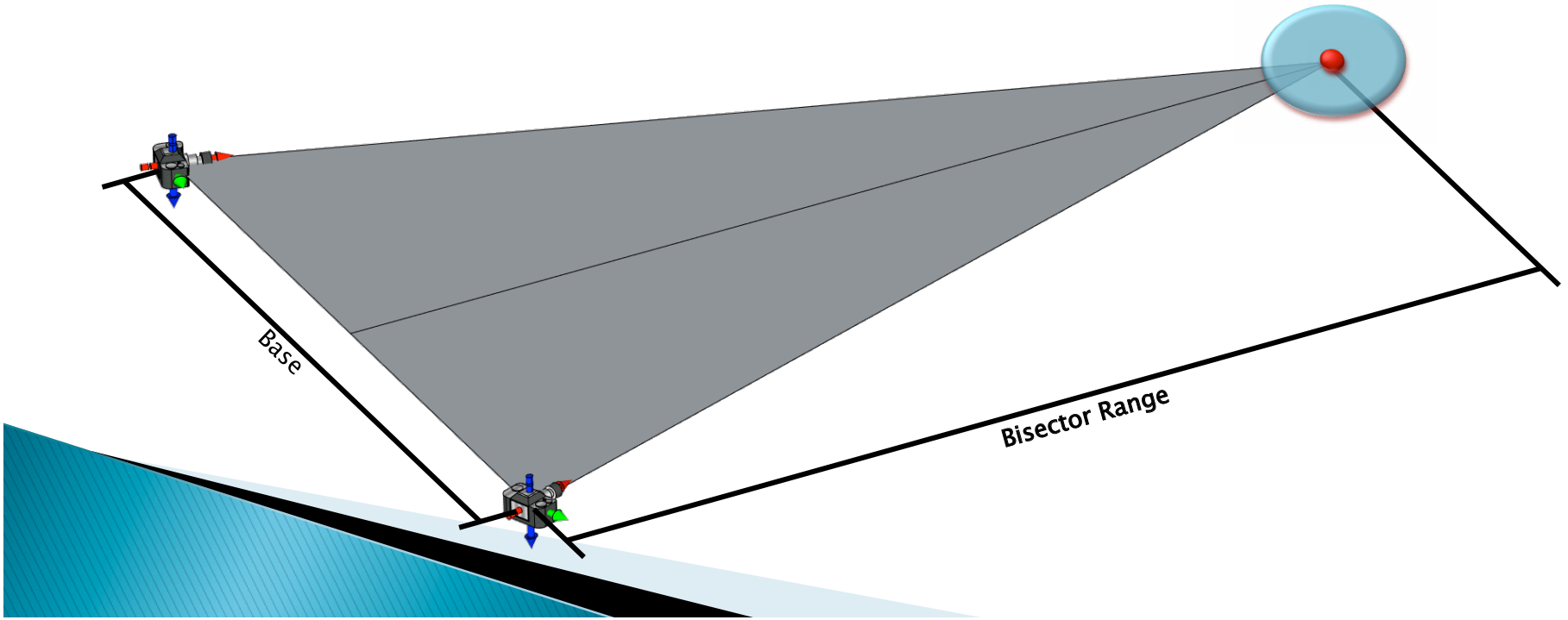
Technical Feasibility Analysis

Can user requirements be achieved?

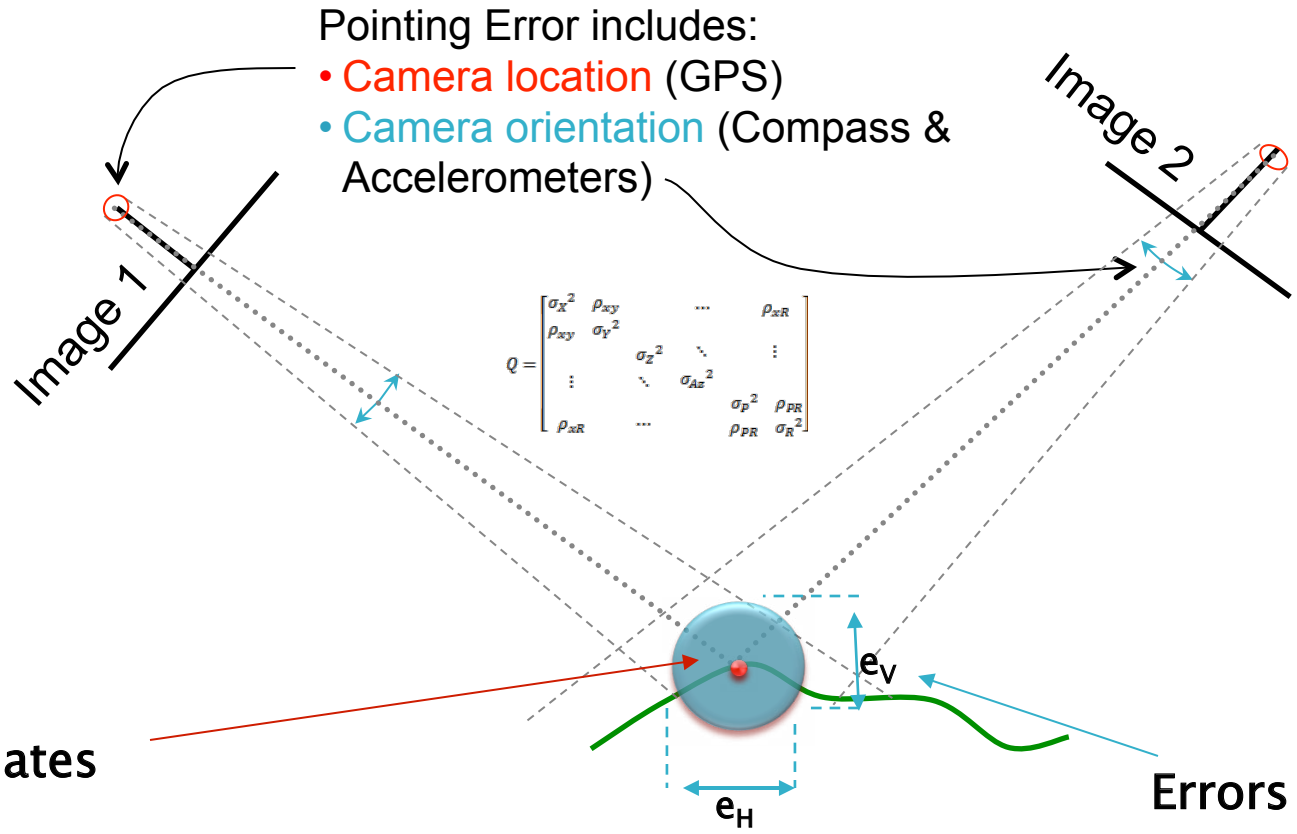
- Establish User Requirements
- Assess current smartphone accuracies
- Evaluate sharing and collaboration options

User Requirements

	Threshold	Objective
Bisector / Base Distance (m)	600	300
Accuracy (m)	50	10
Confidence	90%	50%



Geolocation from Multiple Images



Coordinates

X
Y = *F(pt. meas; EO; IO; Range)*
Z

Errors and Covariance

$$\Sigma_{XY} = J_m \Sigma_{mm} J_m^T + J_E \Sigma_{EE} J_E^T + J_I \Sigma_{II} J_I^T + J_Z \Sigma_{ZZ} J_Z^T$$

Hardware Evaluation

(Apple Inc.)

(SAMSUNG)

(HTC Corp.)

Apple iPhone 4

GPS
Compass
3-Ax Accelerometer
Time stamps
3-Ax Gyroscope

Samsung Galaxy S

GPS
Compass
3-Ax Accelerometer
Time stamps
3-Ax Gyroscope

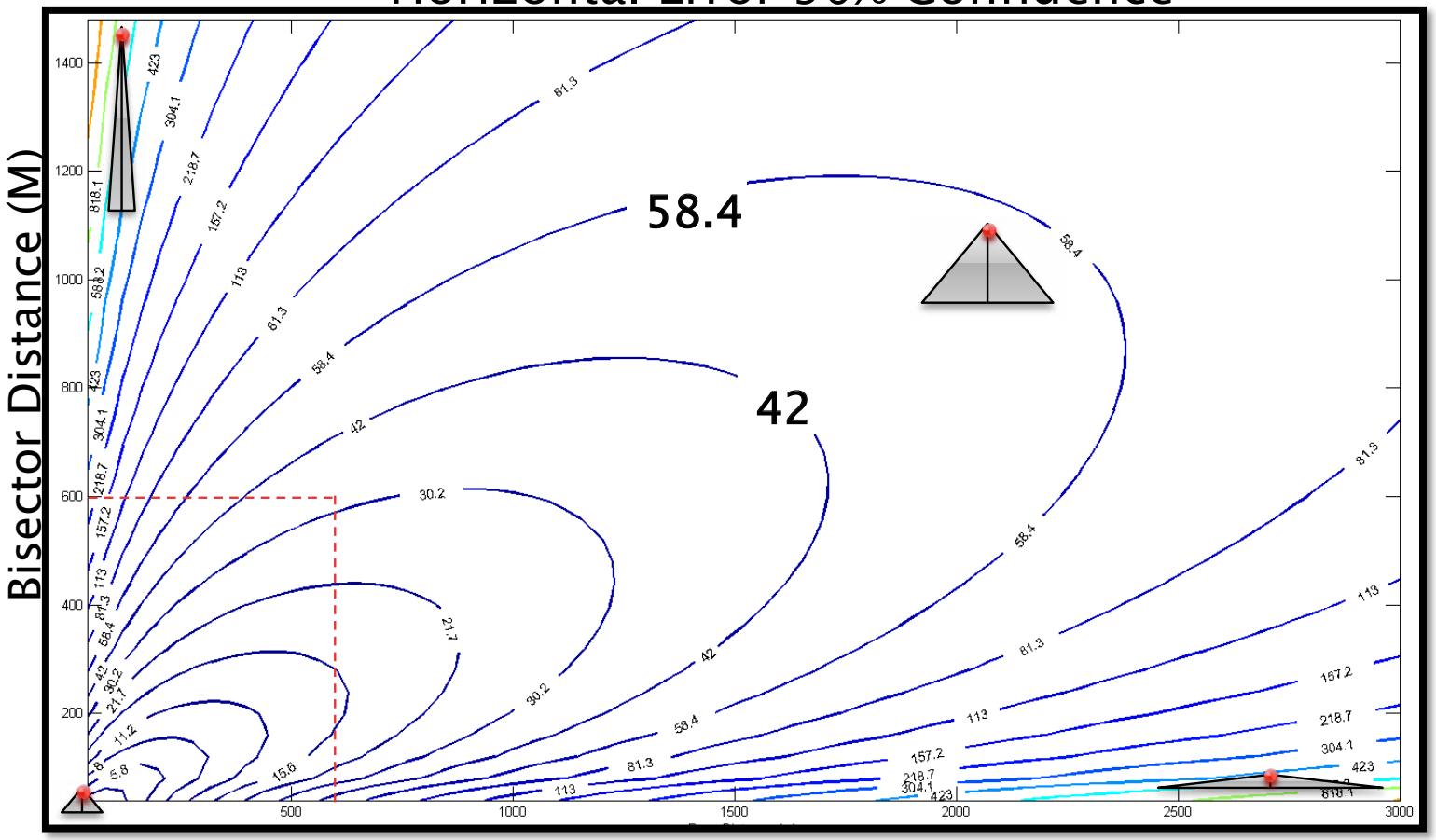
HTC Evo 4G

GPS
Compass
3-Ax Accelerometer
Time stamps

	Position Error	Orientation Error
Poor/ Uncalibrated	+/- 4 m	+/- 10 deg. Az +/- 5 deg. P/R
Good / Calibrated	+/- 1 m	+/- 1 deg. Az +/- 0.5 deg. P/R

Accuracy Results

Horizontal Error 90% Confidence



Geolocation requirements are achievable

Sharing and Collaboration

- User Collaboration Requirements
  - Sharing
    - TIFF Images & Image metadata
    - KML POIs
  - Store Data
  - Authentication
- 3rd party options

A standalone MAGIC server represents the best solution for providing sharing and collaboration capabilities.

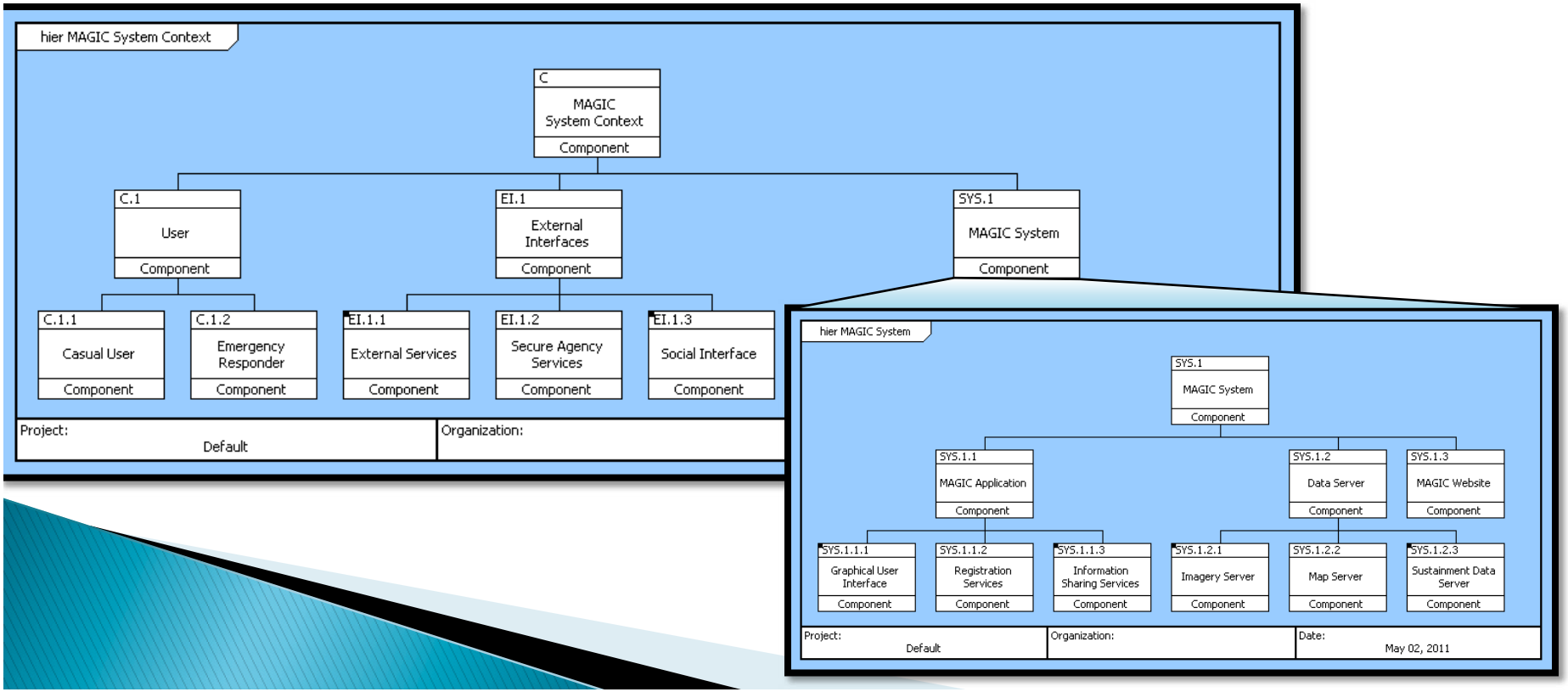
System Description & Architecture

How should the system be designed?

- Component Analysis
- Functional Analysis
- Operational Analysis

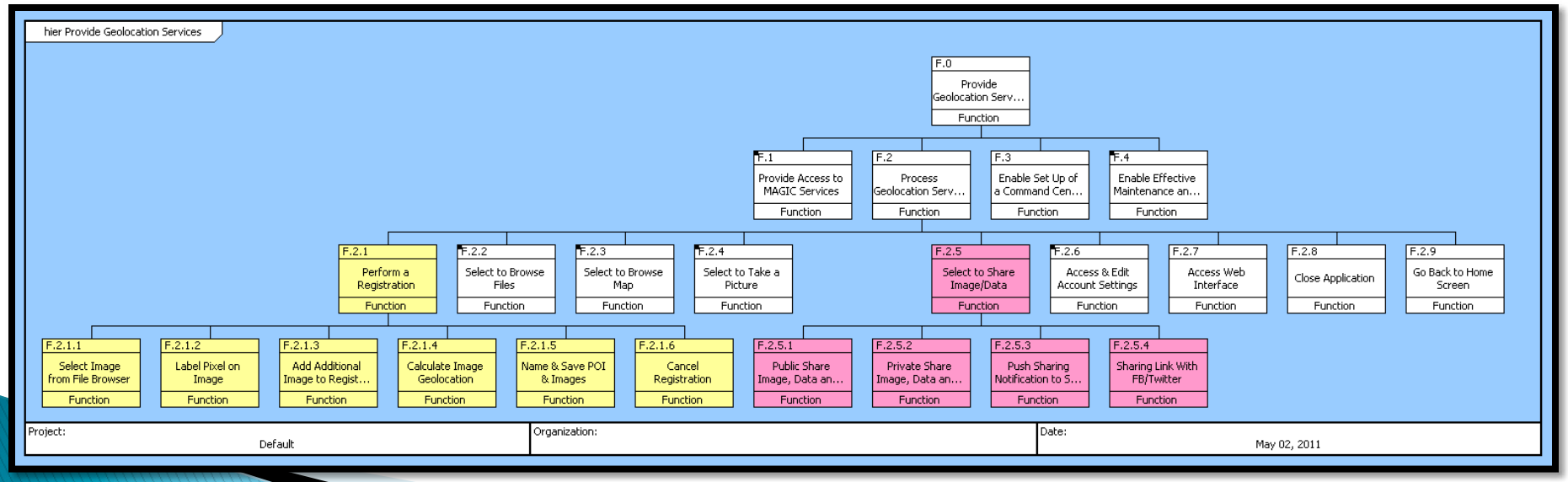
MAGIC System Components

- System Context
  - Users
  - External Services
  - MAGIC System
    - Generic Physical Hierarchy



Functional Architecture

- Top Level Functions
  - F.1 Provide Access to MAGIC Services
  - F.2 Process Geolocation Services
  - F.3 Enable Set Up of a Command Center
  - F.4 Enable Effective Maintenance & Servicing

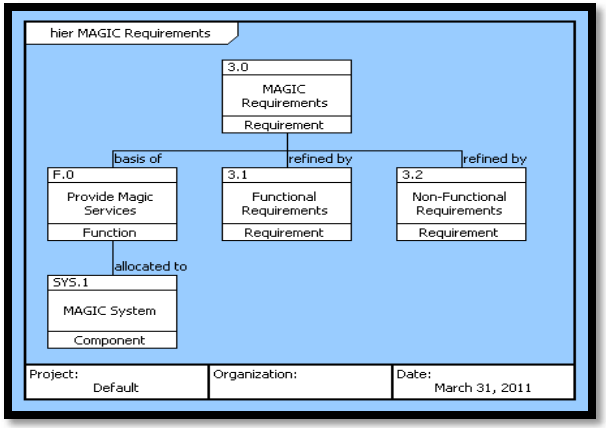


Operational Architecture

- Top level mapping

Function	Component	Requirement
F.0 Provide Geolocation Services	SYS.1 MAGIC System EI.1.1.4 Handheld Device	SR.1.0 Provide Geolocation Services
F.1 Provide Access to MAGIC Services	SYS.1.1 MAGIC Application EI.1.1.4 Handheld Device	SR.1.1 Provide Access to Magic Services SR.2 Non-Functional Requirements
F.2 Process Geolocation Services	SYS.1.1 MAGIC Application SYS.1.1.1 Graphical User Interface SYS.1.2 Data Server SYS.1.2.3.1 Update Server SYS.1.3 MAGIC Website	SR.1 Functional Requirements SR.1.2 Process Geolocation Services
F.3 Enable Set Up of a Command Center	SYS.1.3 MAGIC Website	SR.1 Functional Requirements SR.1.3 Enable Set Up of a Command Center
F.4 Enable Effective Maintenance and Servicing	SYS.1.2.3 Sustainment Data Server	SR.1 Functional Requirements SR.1.4 Enable Effective Maintenance and Servicing

- Requirements allocation



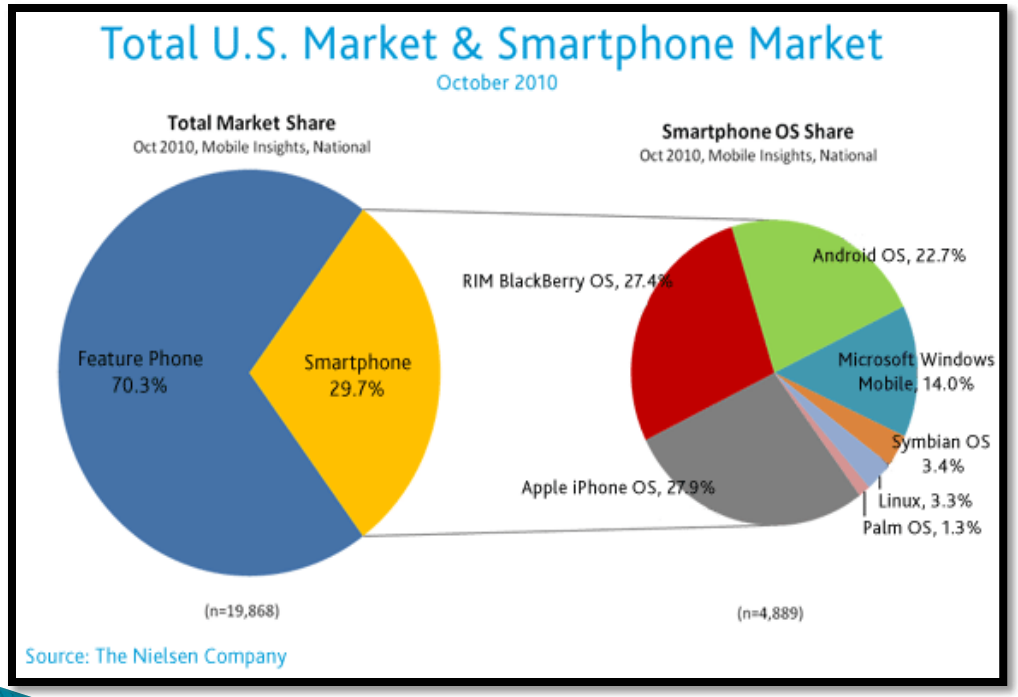
Business Case Analysis

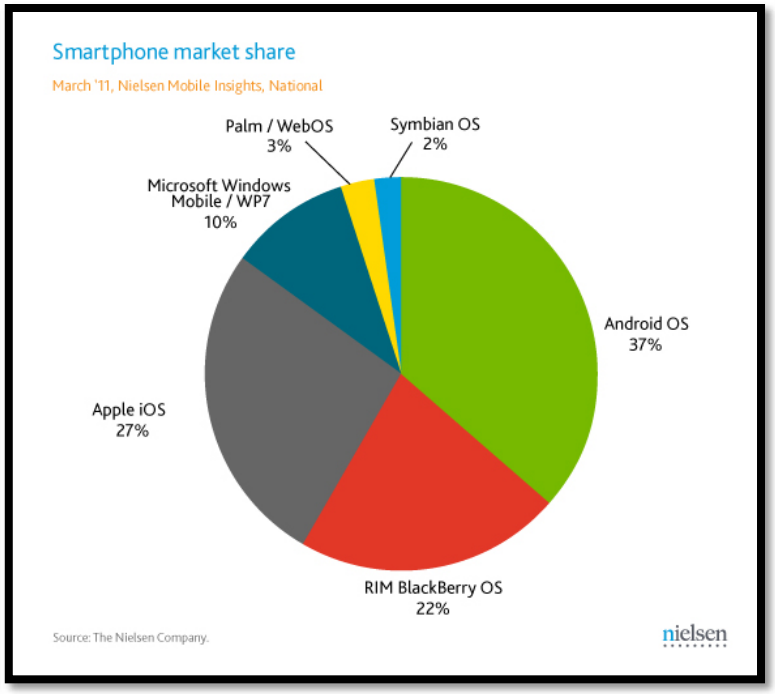
Is this capability profitable?

- Market Analysis
- Description of Options
- ROI Analysis

Market Analysis

- 70.7 MIL Smartphone Users in the US
  - 64% of smartphone market held by iOS and Android
  - Android increased market share 14% in 5 mo.





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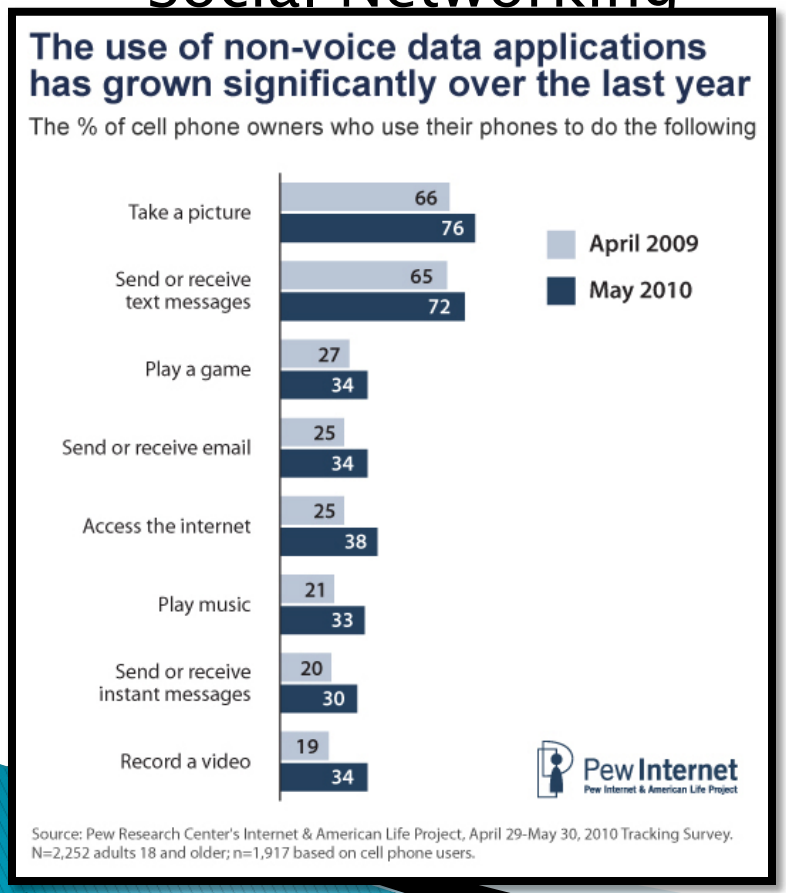
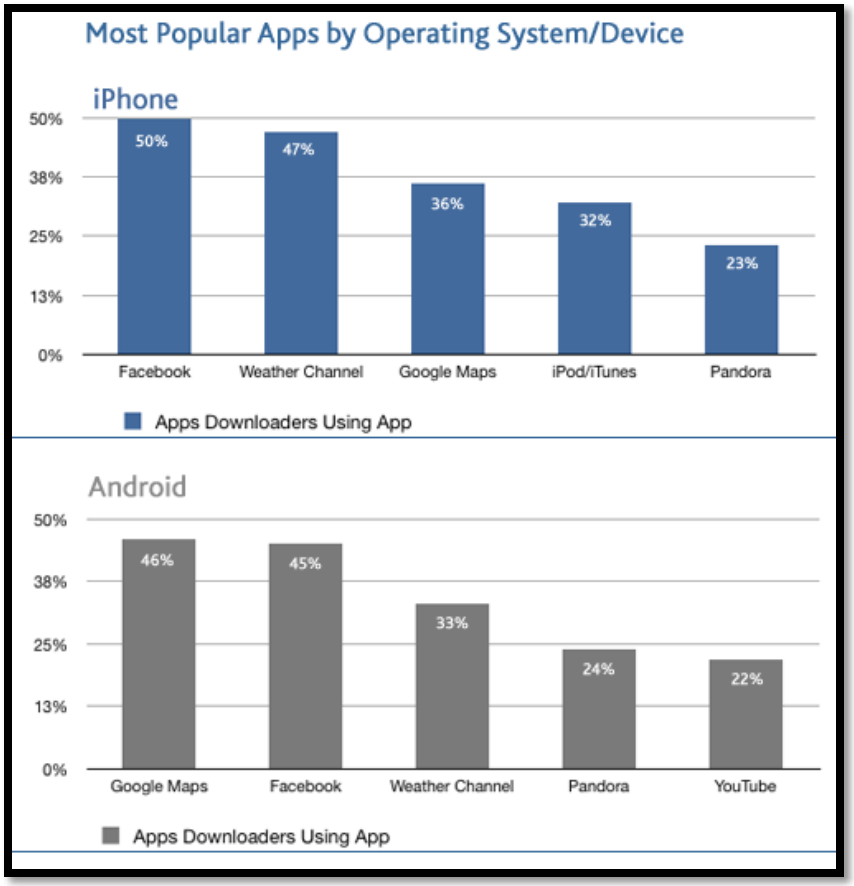
Market Analysis

- Most common smartphone activities
  - Take pictures
  - Social Networking



(http://www.pewinternet.org/Reports/2010/Mobile-/Part-2/Internet-use-and-data-applications-using-mobile-phones.aspx



(The Nielsen Company, August 2010 http://blog.nielsen.com/nielsenwire/online_mobile/games-dominate-americas-growing-appetite-for-mobile-apps/)
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Initial Development Options

Criteria	Casual w/iPhone	Casual w/Android	Emergency Responder w/Either Platform
Unique Benefits	3	3	3
Unique Risks	1	1	2
Unique Issues	1	1	0
Cost	~$840K	~$760K	~$1.2M

Initially develop for casual users on Android platforms

Return On Investment

- Free MAGIC
  - Limited capability
  - Top Free apps generate $400 – $5000 / day
  - 5 – 65 mo. to recoup development cost
- Paid MAGIC
  - $1.50 / download
  - 510,000 downloads to recoup development cost
  - Average downloads/day 300, Featured apps 1200+
  - 14 – 57 mo. to recoup development cost

A mixed Free and Paid strategy with a small marketing campaign to raise initial awareness

Recommendations

- Who would use this capability and how?
  - Casual User, Emergency Responders
  - Simple GUI for intuitive interactions
- Can the accuracy requirements for these users be met with existing smartphones?
  - Yes, Calibration is necessary
  - Additional camera modeling may improve results
- What is the system required to do and how should it be designed?
  - Image & metadata capture, registration calculations and sharing
- Could developing this capability be profitable and what development path should be pursued?
  - Yes, Initially target Casual Users on Android platforms
  - Best ROI likely a combined strategy

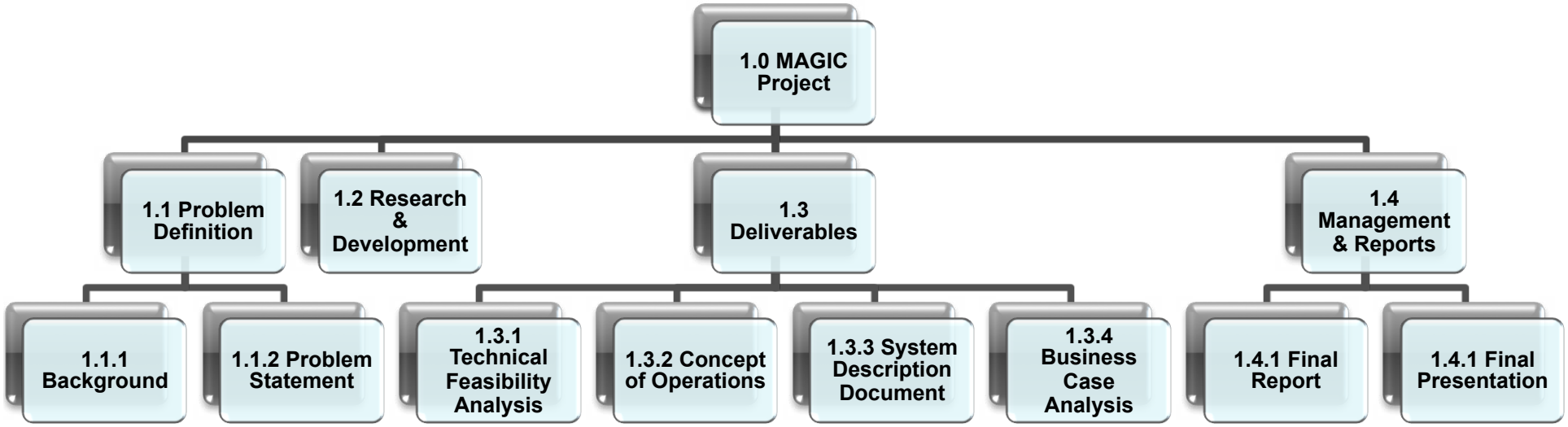
Future Work

- Detailed SE analysis of selected option
- SE analysis of MAGIC server
- Additional sharing options
  - Anonymous
  - Individual contacts
- Non-center pixel analysis
  - Internal camera calibrations
- Application improvements
  - Video / 3D capabilities
  - Assisted second image selection
  - Proximity notifications
  - Disaster response integration

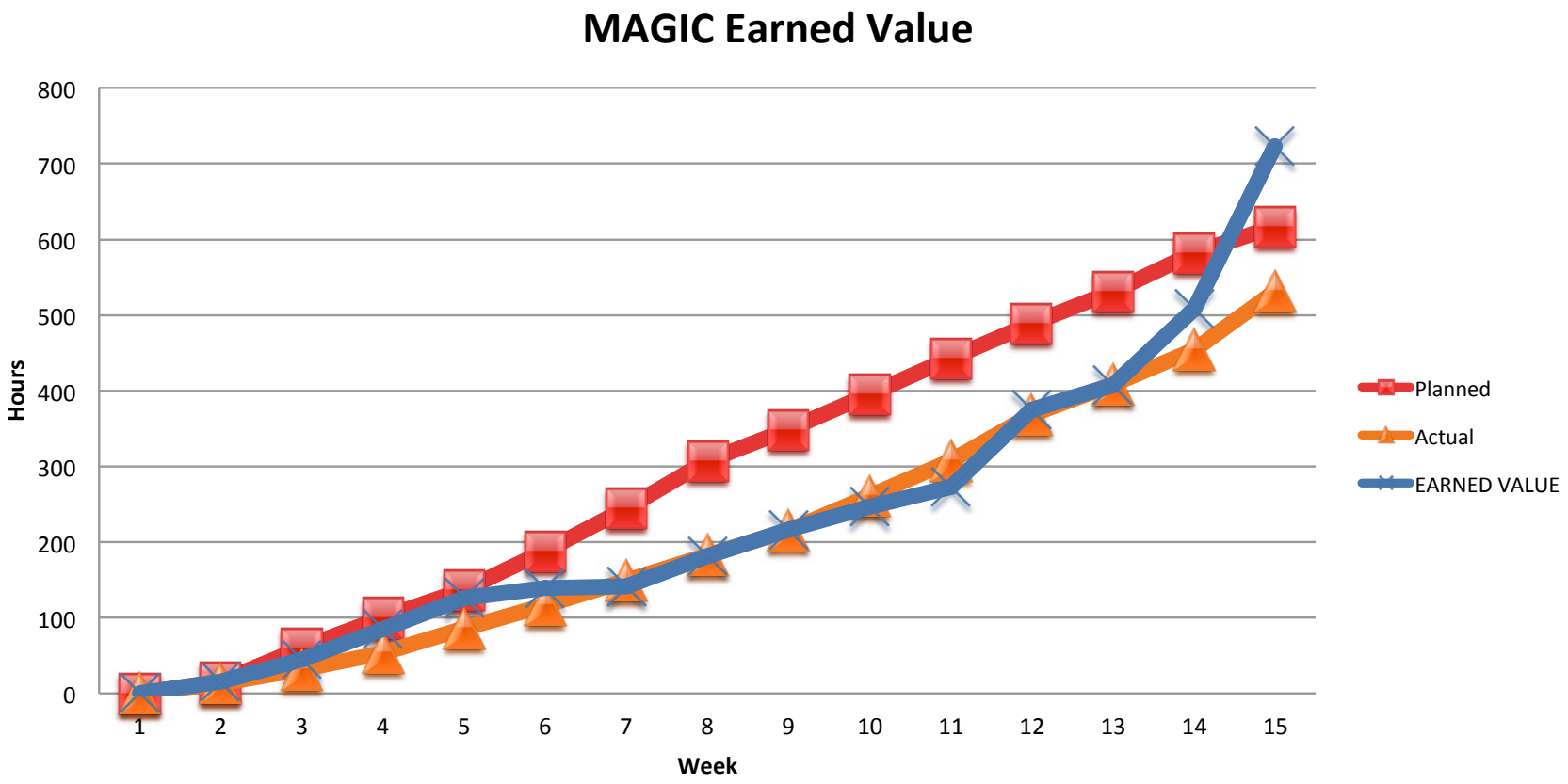
Questions / Comments

» Thank you

WBS


1.0 MAGIC Project
1.1 Problem Definition
1.2 Research & Development
1.3 Deliverables
1.4 Management & Reports
1.1.1 Background
1.1.2 Problem Statement
1.3.1 Technical Feasibility Analysis
1.3.2 Concept of Operations
1.3.3 System Description Document
1.3.4 Business Case Analysis
1.4.1 Final Report
1.4.1 Final Presentation

EVM

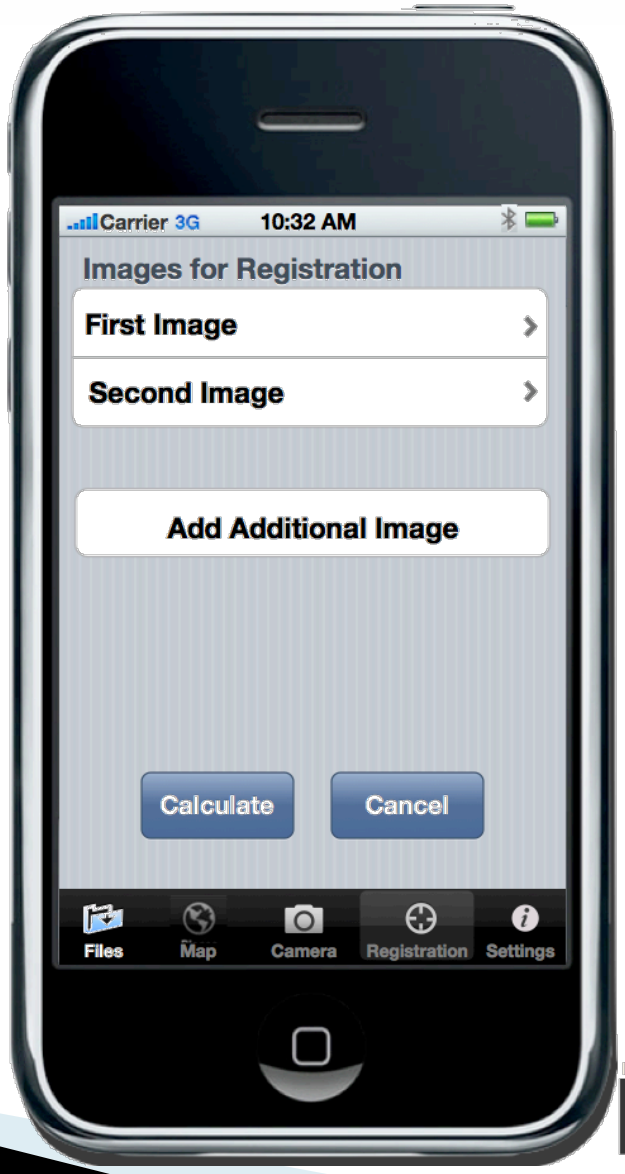

MAGIC Earned Value
800
700
600
500
400
300
200
100
0
Hours
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Week
Planned
Actual
EARNED VALUE

Graphical User Interface

Graphical User Interface

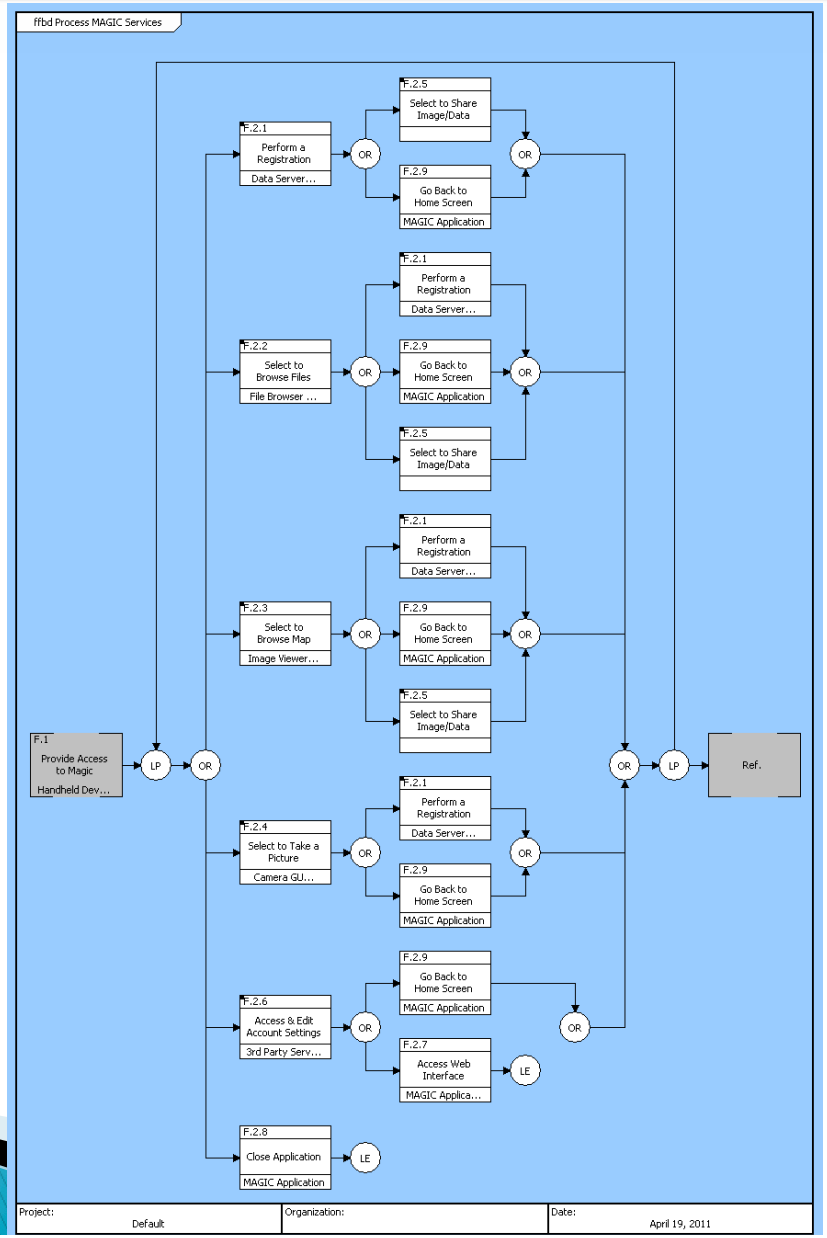
Graphical User Interface

Graphical User Interface

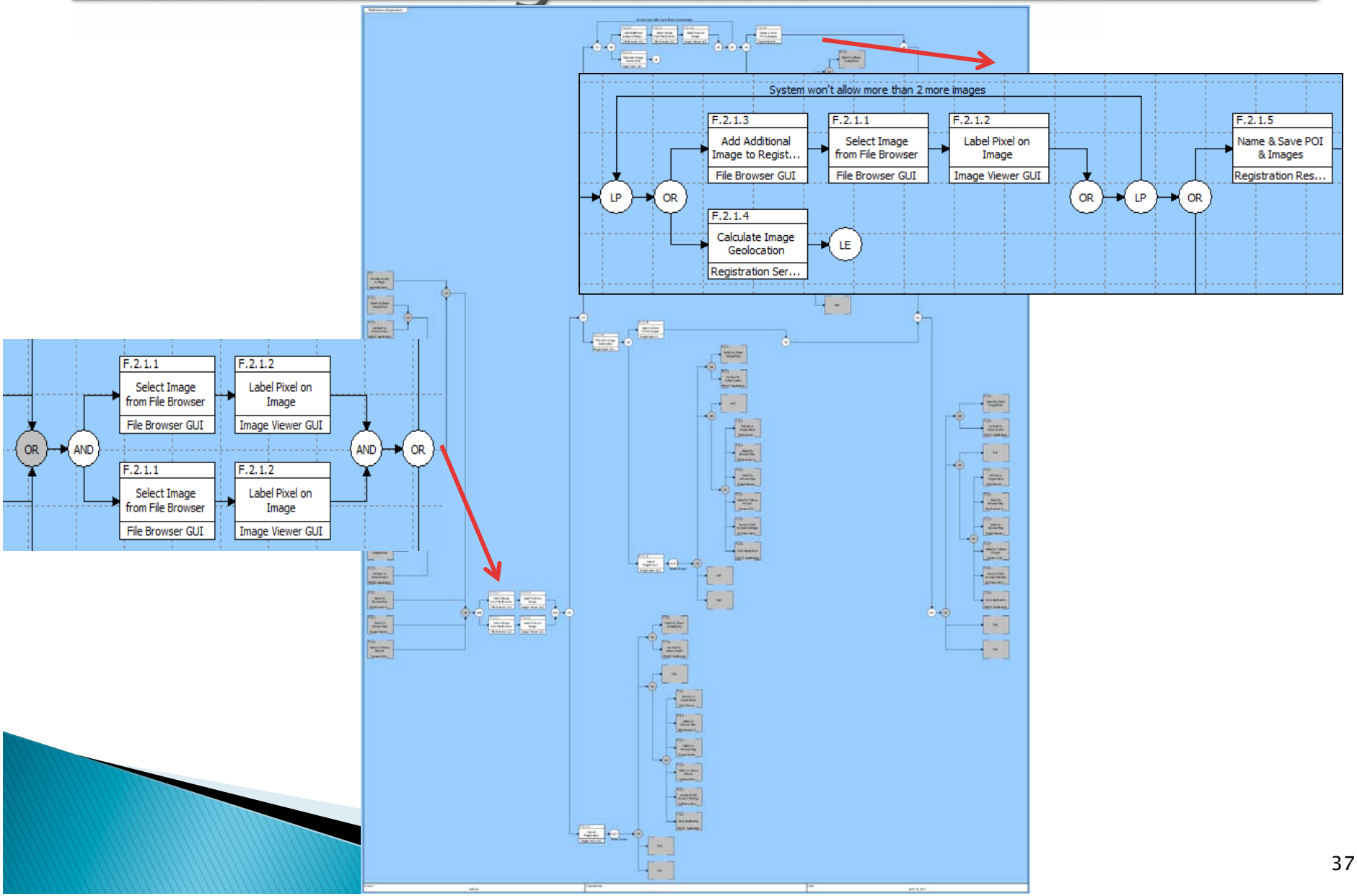


Graphical User Interface

Process Geolocation FFBD



Perform Registration FFBD



Provide Geolocation Services IDEF0