APPENDIX C:
USE CASE ANALYSIS

MOBILE APPLICATION FOR GEOLOCATION OF IMAGERY AND COLLABORATION

MAGIC

Prepared for:
OR680/SYST798 Capstone Project course at George Mason University

Prepared By:
MAGIC Team
Jeff Carpenter
Thomas Haas
Dawin Wright
Erika Rojas Mejia

SYST 798 / OR 680 Spring 2010
Course Professor: Dr. Kathryn Laskey
Project Sponsor: Kurt Rogers, Integrity Applications Inc.

Description

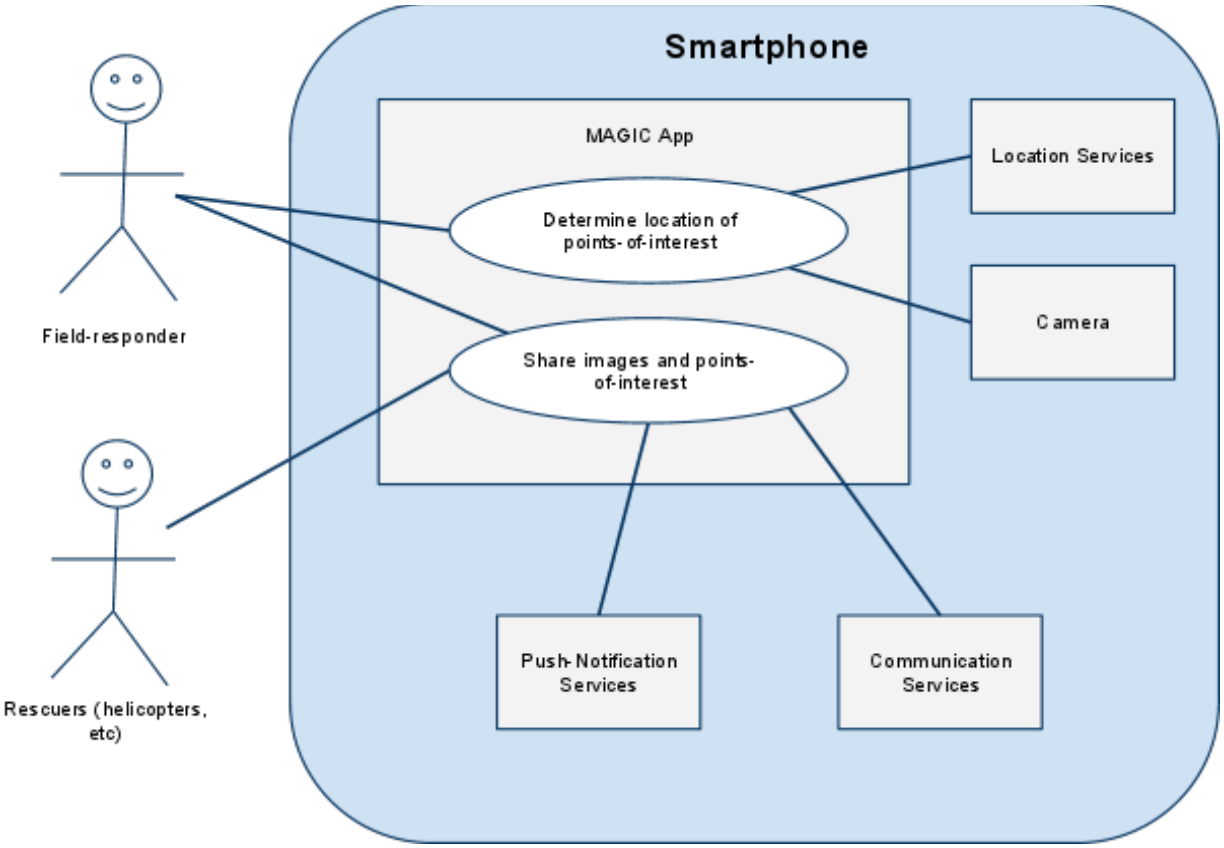
The Emergency Responder use cases address how MAGIC could be used to improve an organization's response to emergency situations. The number of lives lost and the amount of property destroyed during earthquakes, hurricanes, wildfires, floods, landslides, and other natural disasters can be affected by the timeliness and coordination of the emergency responders' actions. MAGIC could enable responders in the field to remotely identify points of interest, such as the position of a wildfire or stranded flood victims, geo-locate those points, and communicate the coordinates to personnel able to reach those points (a firefighting or search-and-rescue helicopter, for example).

Use cases in the Emergency Responder family will be associated with one of two system states: Distributed and Consolidated.

A. Distributed System-State

The Distributed system-state addresses those situations where the emergency responders do not have a unified command / base of operations coordinating their efforts (e.g. one hasn't been erected yet, or communication systems are down). Responders are acting and making decisions locally; the smartphone MAGIC app user must select points of interest and perform the geo-location computation locally on their phone. The users also may have little or no network connectivity via the phones. Use cases are:

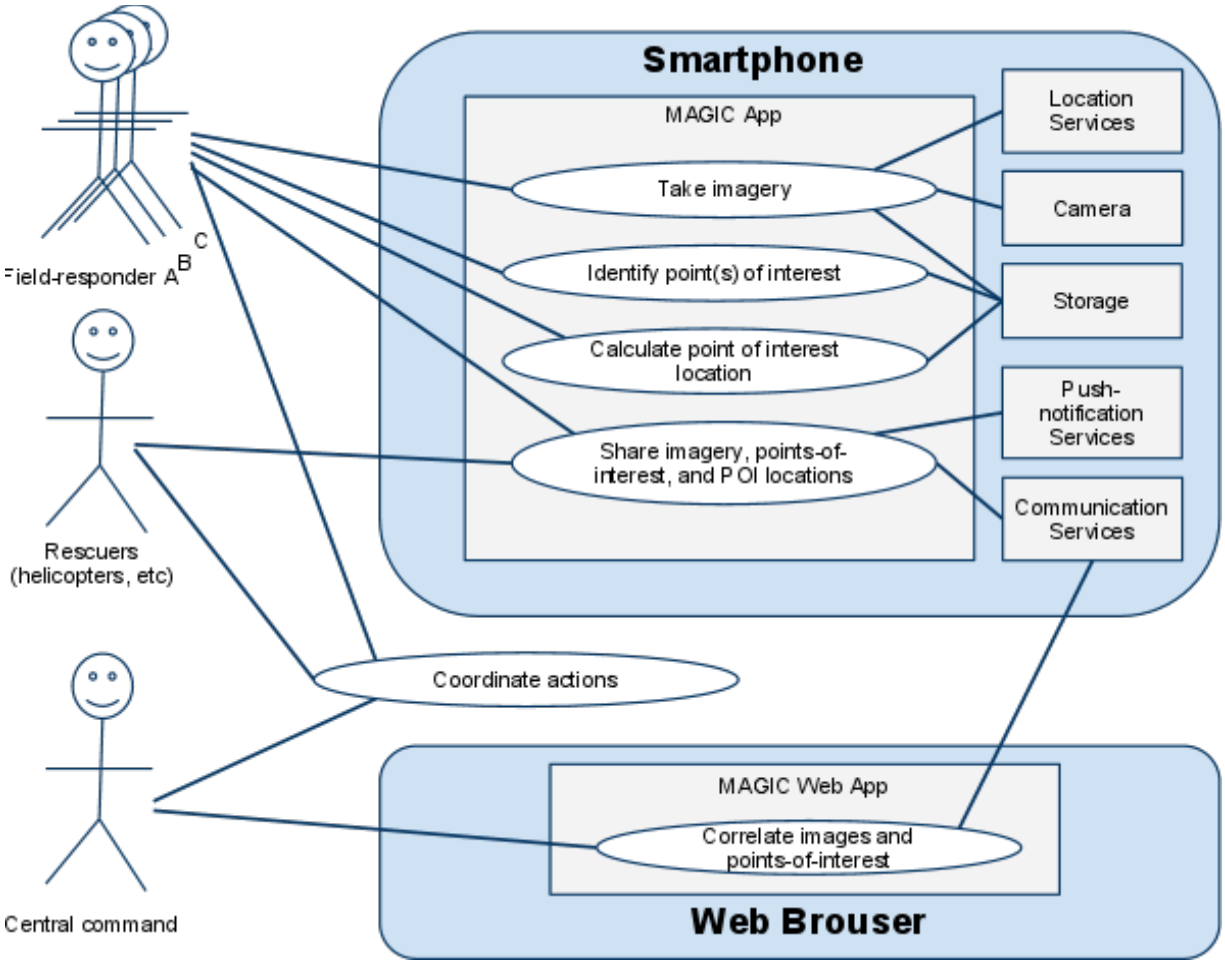
1. Determine location of points-of-interest
2. Share images and points-of-interest



B. Consolidated System-State

The Consolidated system-state addresses those situations where the emergency responders' actions are being coordinated centrally by a unified command / base of operations. Operators at central command, as well as the field-responders, are able to identify and calculate points-of-interest using images taken by multiple field responders, and can coordinate the actions of rescuers. Central command also has stronger tools for correlating images (e.g. plot all images and their fields-of-view on a single map, enabling the identification of additional points-of-interest in the images taken by disparate field-responders). Users also likely have access to network connectivity for their phones. Use cases are:

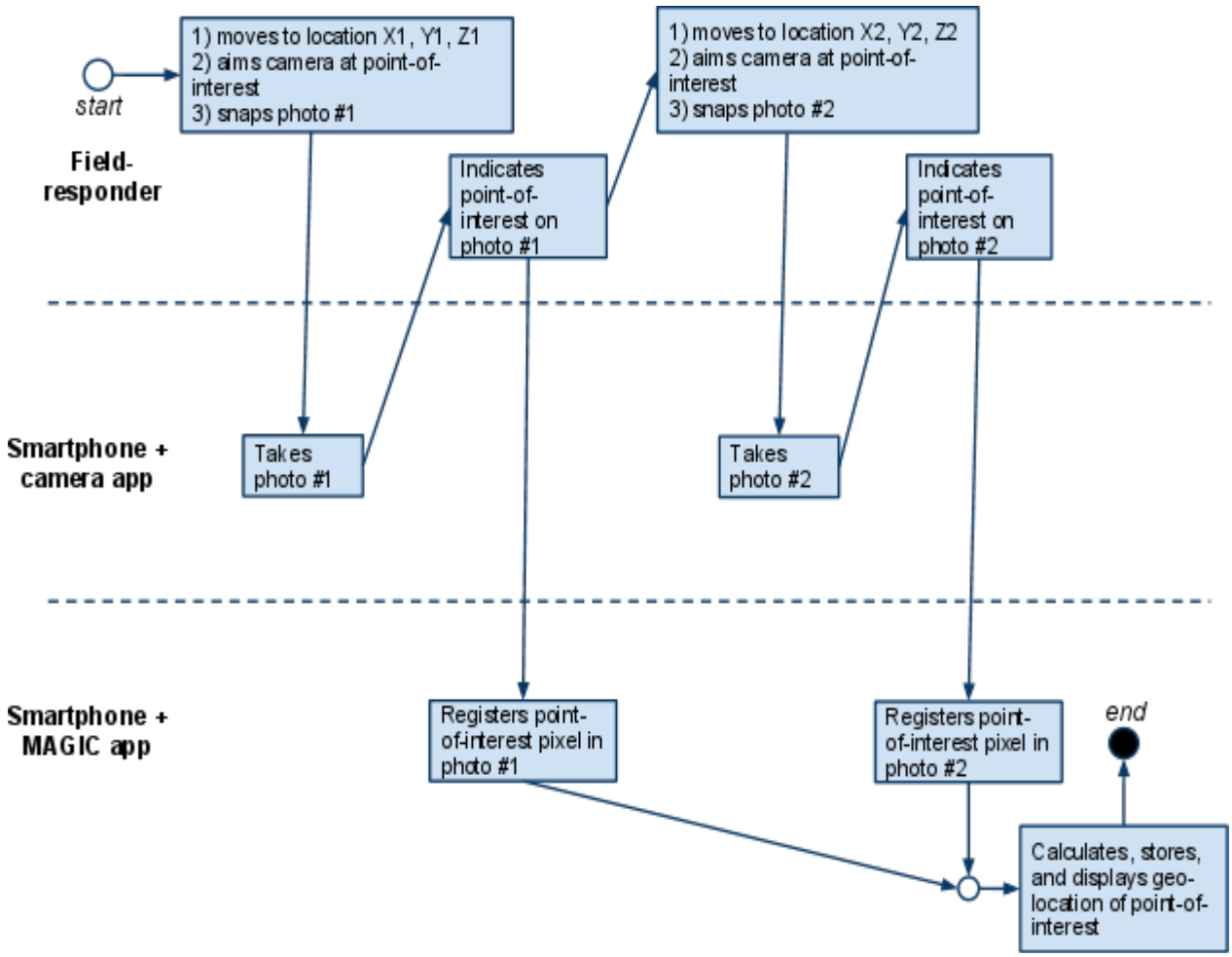
1. Take imagery
2. Identify point(s) of interest
3. Calculate point of interest location
4. Share imagery, points-of-interest, and POI locations
5. Correlate images and points-of-interest



Use Case A1: Determine location of points-of-interest

Description	The field-responder takes multiple images of a point-of-interest with his / her smartphone, and uses the MAGIC app to identify the point-of-interest in each image. The smartphone and MAGIC app compute, display, and store the geographic location of the specified point-of-interest.

Activity Diagram



Actors

Primary Actors

- **Field-responder**: an individual at or near the disaster scene, in possession of a smartphone with MAGIC.

Secondary Actors

- N/A

Trigger

Trigger

- The field-responder sees a specific situation that requires attention (the "point-of-interest").

Assumptions

- The field-responder is unable to attend to the situation directly (e.g. people stranded in a flood, whom the field-responder can see but cannot reach by foot)
- The field-responder wants to communicate the situation and its location to someone who is able to attend to the situation (e.g. someone with a helicopter or boat)

Pre-Conditions

- The field-responder is able to photograph the point-of-interest from at least two locations with a smartphone
- The smartphone and MAGIC app are in an operational state (i.e. not broken, out of power, etc)

Normal Flow (Happy Path)

Step #	Step Description
1	Field-responder takes a photograph of the point-of-interest with smartphone
2	Field-responder identifies the point-of-interest within the image
3	Field-responder takes a second photograph of the point-of-interest from a different location
4	Field-responder identifies the point-of-interest within the second image
5	MAGIC calculates the geo-location of the point-of-interest
6	MAGIC stores the images and geo-coordinates of the point-of-interest
7	MAGIC displays the geo-coordinates of the point-of-interest

Alternative Paths

Alternative Path A: Two field-responders - In this alternative path, one field-responder (B) sends his photo to another (A), who has taken a photo of her own. Field-responder A then indicates the point-of-interest in both photographs, and her smartphone computes the geo-coordinates.

Step #	Step Description
3A	Field-responder B takes a second photograph of the point-of-interest from a different location
4A	Field-responder B sends the second photograph to field-responder A
5A	Field-responder A identifies the point-of-interest within the second image
6A	MAGIC calculates the geo-location of the point-of-interest
7A	MAGIC stores the images and geo-coordinates of the point-of-interest
8A	MAGIC displays the geo-coordinates of the point-of-interest

Post Conditions

- The geo-location of the point-of-interest has been determined and stored in a format that will enable it to be communicated later.

Exception Paths

Exception Path 1: N/A

Step #	Step Description
1	
2	

3	

Alternative Path B: Central Command Personnel - In this alternative path, a central command personal selects two images within the same range and field of view from the shared images by field responders, he then identifies the point-of-interest on each image and his/her smartphone computes the geo-coordinates.

Step #	Step Description
4B	A Central Command Personnel identifies two photos, within the same range and the same field of view, shared by field responders
5B	CC personnel identifies point-of-interest on both photographs
6B	MAGIC calculates the geo-location of the point-of-interest
7B	MAGIC stores the images and geo-coordinates of the point-of-interest
8B	MAGIC displays the geo-coordinates of the point-of-interest

Post Conditions

- The geo-location of the point-of-interest has been determined and stored in a format that will enable it to be communicated later.

Exception Paths

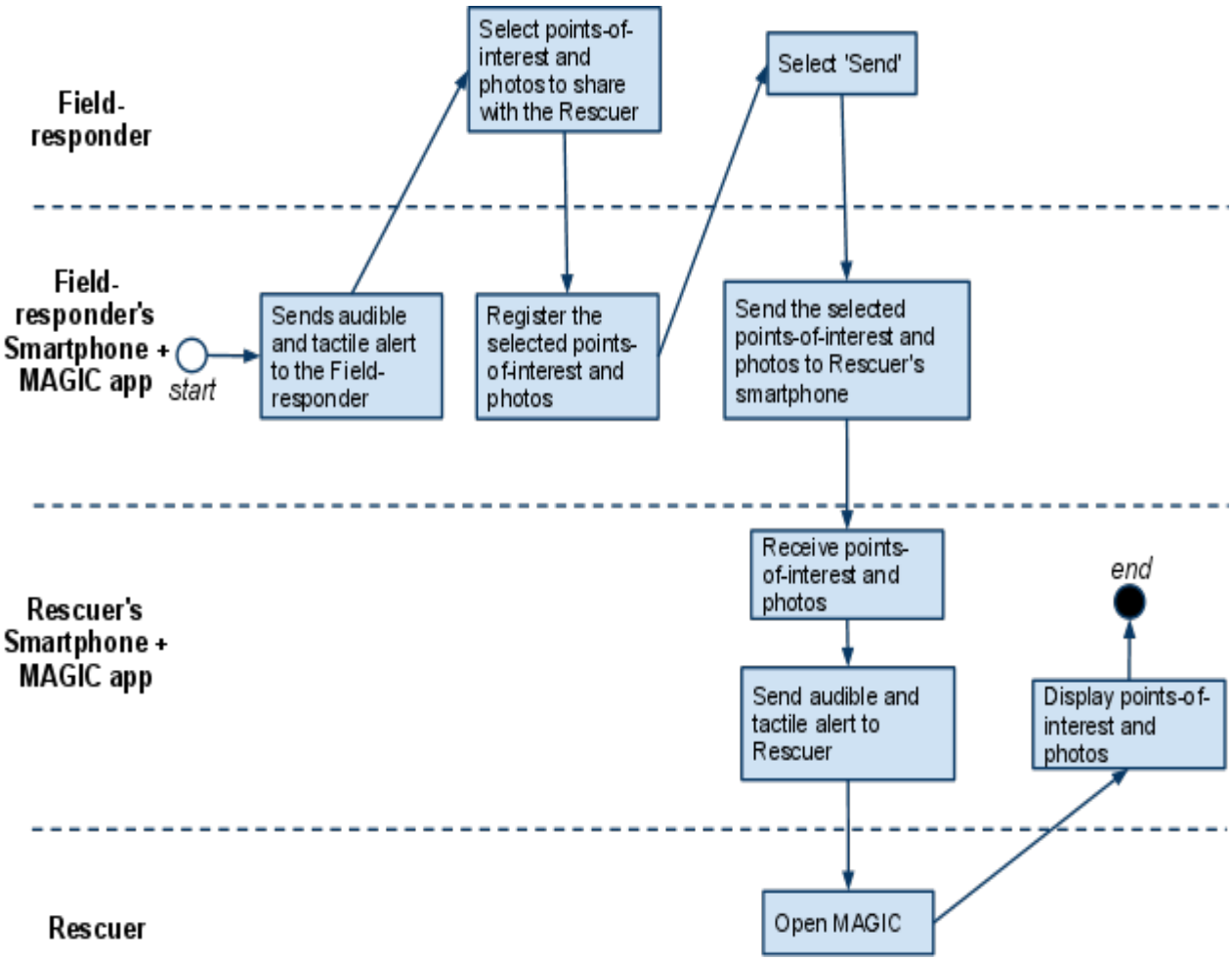
Exception Path 1: N/A

Step #	Step Description
1	
2	
3	

Use Case A2: Share images and points-of-interest

Description	The field-responder's MAGIC app and smartphone automatically detect when a Rescuer (equiped with a MAGIC app smartphone) is reachable, and notifies the Field Responder. The Field Responder selects points-of-interest and photos for forwarding to the Rescuer. The MAGIC app and smartphone send the selected points-of-interest and photos to the Rescuer.

Activity Diagram



Actors

Primary Actors

- **Field-responder**: an individual at or near the disaster scene, in possession of a smartphone with MAGIC.
- **Rescuer**: an individual in possession of a smartphone with MAGIC, and access to rescue-equipment (helicopter, first-aid kit, etc)

Secondary Actors

- N/A

Trigger

- The field-responder's MAGIC app smartphone detects another MAGIC app user in the area.

Assumptions

- The field-responder has identified and stored at least one point-of-interest with a MAGIC app
- The field-responder wants to communicate the point-of-interest to a rescuer (e.g. someone equipped to address the situation)

Pre-Conditions

- The smartphones and MAGIC apps of the field responder and the rescuer are both in an operational state (i.e. not broken, out of power, etc)
- The network connecting the field responder and rescuer's smartphones is in an operational state (i.e. able to carry data between smartphones)
- Both the field-responder and rescuer are identified & authenticated with MAGIC

Normal Flow (Happy Path)

Step #	Step Description
1	MAGIC alerts the field-responder that communication is possible with another MAGIC smartphone in possession of a rescuer
2	Field-responder selects points-of-interest and photos for sharing with rescuer
3	Field-responder sends points-of-interest and photos to rescuer
4	MAGIC alerts the rescuer that points-of-interest and photos are available for viewing
5	Rescuer opens MAGIC on his/her smartphone
6	MAGIC displays the shared geo-coordinates of the point-of-interest and photos

Alternative Paths

Alternative Path A: Automatic forwarding - In this alternative path, the field-responder has set MAGIC to automatically forward all stored points-of-interest and imagery to another MAGIC app when the communication channel is available. One might imagine this 'mode' being used when the field-responder is too distracted by a different situation to manually select and send points-of-interest.

Step #	Step Description
1A	MAGIC transmits all stored points-of-interest and photos to the rescuer's smartphone
2A	MAGIC alerts the rescuer that points-of-interest and photos are available for viewing
3A	Rescuer opens MAGIC on his/her smartphone
4A	MAGIC displays the shared geo-coordinates of the point-of-interest and photos

Post Conditions

- The geo-locations and photos of the points-of-interest have been provided to a rescuer, who is equipped to address the situation.

Exception Paths

Exception Path 1: Interrupted communication - During the transfer of points-of-interest and photos from the field-responder's smartphone to the rescuer's (Step 3), the link is broken (network goes down, one of the smartphones dies, etc)

Step #	Step Description
4.1	MAGIC alerts both the rescuer and field-responder that transfer of the points-of-interest and photos failed
5.1	Rescuer opens MAGIC on his/her smartphone

6.1	MAGIC displays what data did successfully transfer (if any)

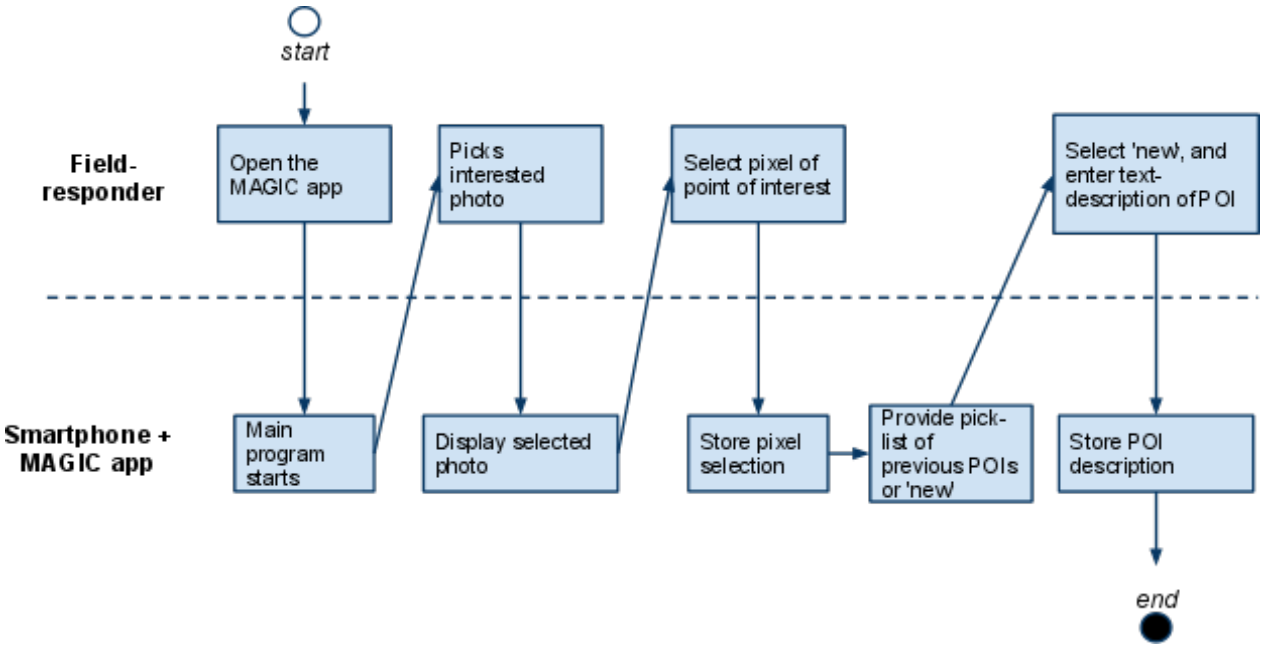
Use Case B1: Take imagery

Description	This use case is external to the MAGIC system. This description is provided only because of its importance to the MAGIC system's context. The field-responder uses the smartphone's camera to take a picture of a situation that needs attention (the 'point-of-interest'). The smartphone stores the image with associated metadata such as the image's global position and orientation. This use case is performed many times by many field-responders; sometimes but not always targeting the same point-of-interest.

Use Case B2: Identify point(s) of interest

Description	The field-responder uses the MAGIC app to find an image stored by the smartphone. Once viewing the desired image, the field-responder uses GUI-controls to precisely identify a pixel in the image that best represents the point of interest. Once identified, the MAGIC app uniquely identifies the point, and gives the field-responder the option of either 1) identifying the point as being one already identified in a previous photo, or 2) of adding a new text-description of it. Multiple points can be identified by this process within a given image.

Activity Diagram



Actors

Primary Actors

- **Field-responder**: an individual at or near the disaster scene, in possession of a smartphone with MAGIC.

Secondary Actors

- N/A

Trigger

- The field-responder is willing and able to identify a new point of interest in a photo stored on his / her smartphone.

Assumptions

- The field-responder's smartphone has stored images containing the point of interest (as a result of B1: Take imagery use case)
- The field-responder wants to identify a new point of interest (not identify an existing stored point of interest in a new photo)

Pre-Conditions

- The smartphone and MAGIC app are in an operational state (i.e. not broken, out of power, etc)

Normal Flow (Happy Path)

Step #	Step Description
1	Field-responder opens the MAGIC app on his / her smartphone
2	Field-responder scrolls through available images stored in the smartphone, and selects the one containing the point of interest
3	Field-responder uses MAGIC's GUI controls to precisely select the pixel of the point of interest within the image
4	The MAGIC app provides a pick-list that includes currently stored points of interest, and an option titled 'New'
5	Field-responder selects 'New'
6	Field-responder enters a text-description of the point of interest
7	MAGIC app stores the point of interest and its description

Alternative Paths

Alternative Path A: Field-responder selects and existing POI- In this alternative path, the field-responder selects an existing POI from the pick-list, rather than 'New'

Step #	Step Description
5A	Instead of selecting 'New', the field-responder picks an existing POI from the list. This is the entry point for use case B3: calculate point of interest location.

Post Conditions

- The point of interest and its description are stored.

Exception Paths

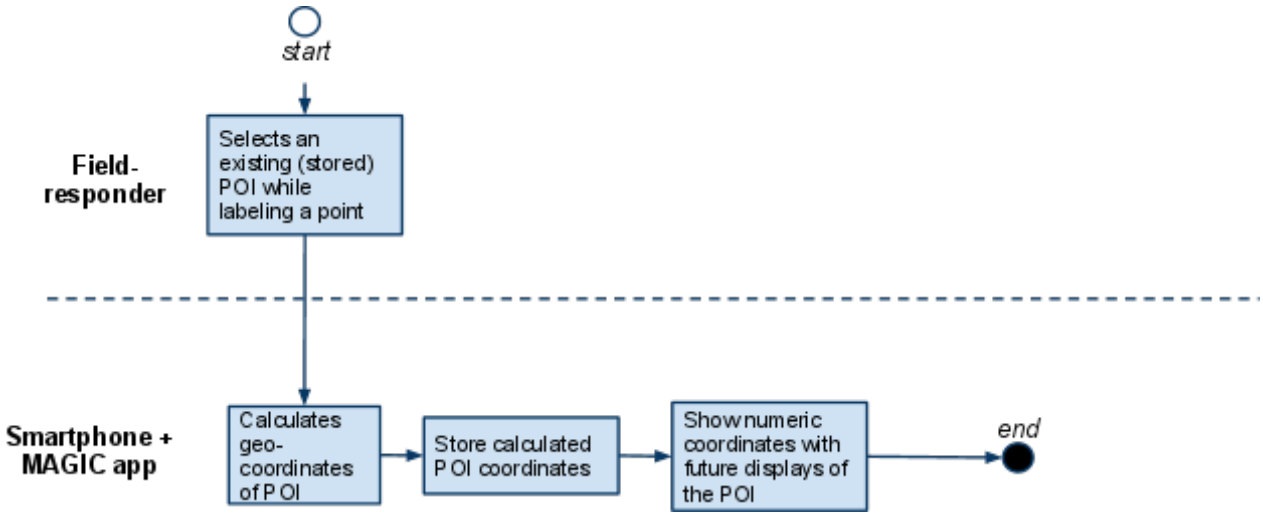
Exception Path 1: N/A

Step #	Step Description
1	
2	
3	

Use Case B3: Calculate point of interest location

Description	The field-responder identifies the current POI as being the same as an existing (stored) point of interest from a different image. The MAGIC app immediately begins computing the geo-location of the point of interest if this is the POI's 2nd image, or re-computing/updating the geo-location of the POI if it is its 3rd or later image. The geo-coordinates are displayed with the POI in all future pick-lists.

Activity Diagram



Actors

Primary Actors

- **Field-responder**: an individual at or near the disaster scene, in possession of a smartphone with MAGIC.

Secondary Actors

- N/A

Trigger

- The field-responder is labelling a POI, and wants to identify this new POI as one previously identified in a different image.

Assumptions

- The existing (stored) POI that is selected is feasible (e.g. the fields of view of the two images do overlap, etc)

Pre-Conditions

- The smartphone and MAGIC app are in an operational state (i.e. not broken, out of power, etc)
- The field-responder's smartphone has stored point(s) of interest to pick from (as a result of B2: Identify point(s) of interest)

Normal Flow (Happy Path)

Step #	Step Description
1	Field-responder selects one of the stored POIs from the pick-list while labelling a new point
2	MAGIC computes the coordinates of the POI based on the metadata of the two images and the pixels selected for the POI

3	MAGIC stores the computed coordinates of the POI
4	MAGIC displays the coordinates of the POI with the POI whenever the POI is displayed (in a future pick-list, for example)

Alternative Paths

Alternative Path A: POI coordinates already exist (3rd+ image)- In this alternative path, the field-responder selects an existing POI that already has coordinates calculated (and therefore this must be the 3rd or greater image that the POI has been identified in). This might be done to update or improve the accuracy of the calculated coordinates, for example.

Step #	Step Description
2A	MAGIC re-computes the coordinates of the POI based on the new image's metadata
3A	MAGIC stores the recomputed coordinates of the POI (along with a history of the POI's previous location estimates)

Post Conditions

- The point of interest and its description are stored.

Exception Paths

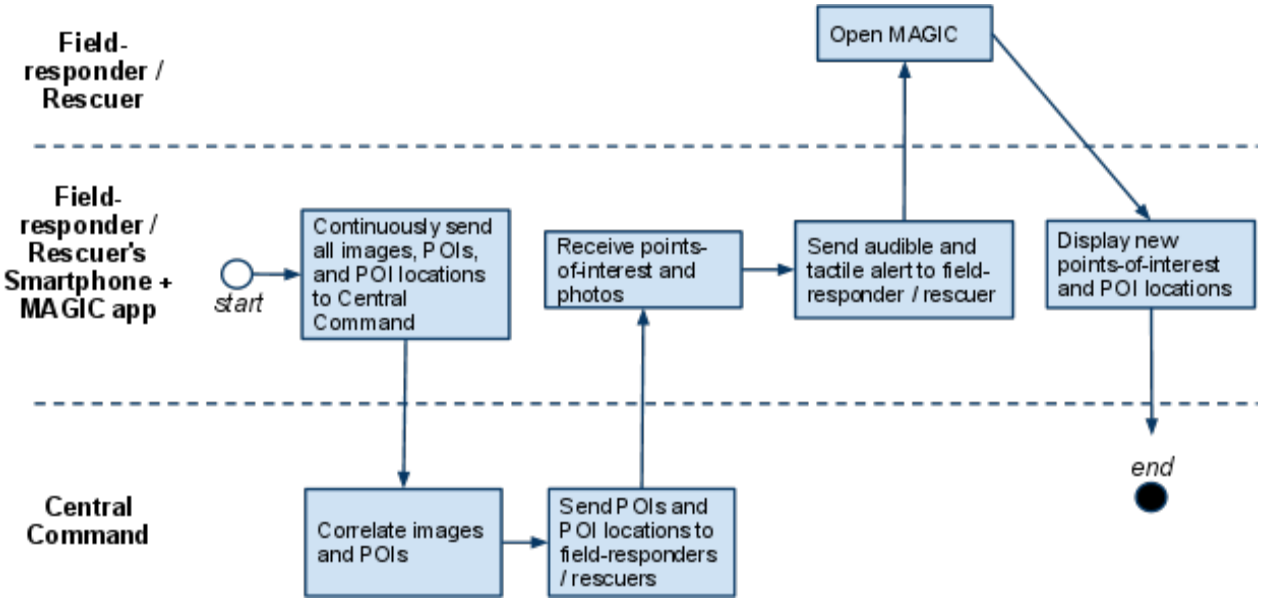
Exception Path 1: Unfeasible POI selected- In this exception path, the field-responder selects an existing POI from the list that cannot possibly be the same POI of the pixel in the current image (e.g. their fields-of-view don't overlap, etc)

Step #	Step Description
2.1	MAGIC calculates there is no feasible solution
3.1	MAGIC displays an error message to the field-responder

Use Case B4: Share imagery, points-of-interest, and POI locations

Description	The field-responder and rescuer's MAGIC app and smartphone automatically share all images, identified points-of-interest, and computed POI locations with Central Command. POIs and POI locations created by Central Command are sent to the relevant field-responders and rescuers. The field-responder and rescuer are notified when a new POI or POI location is available to them.

Activity Diagram



Actors

Primary Actors

- **Field-responder**: an individual at or near the disaster scene, in possession of a smartphone with MAGIC.
- **Rescuer**: an individual in possession of a smartphone with MAGIC, and access to rescue-equipment (helicopter, first-aid kit, etc)

Secondary Actors

- **Central Command**: in this use case, Central Command stands for both the actor called 'Central Command' and the MAGIC web app that actor uses. For the purposes of this use case, it is a "black box" representing the destination for shared images / POIs / POI locations and a source for new ones.

Trigger

- A new image, POI, or POI location is saved to the field-responder / rescuer's smartphone

Assumptions

- N/A

Pre-Conditions

- The smartphone and MAGIC app of the field responder / rescuer are both in an operational state (i.e. not broken, out of power, etc)

- The network connecting the field responder / rescuer's smartphone to Central Command is in an operational state (i.e. able to carry data between smartphones and Central Command)
- Central Command is in an operational state

Normal Flow (Happy Path)

Step #	Step Description
1	The field-responder / rescuer creates new data (either takes a new image, identifies a POI, or computes a POI location)
2	MAGIC and the smartphone automatically sends the data to Central Command
3	Central Command receives the data
4	See Use Case B5: Correlate images and points-of-interest
5	Central Command sends POIs and POI locations to the field-responder / rescuer's smartphone
6	MAGIC app notifies the field-reponder / rescuer that a new POI / POI location is available
7	Field-responder / rescuer opens the MAGIC app on their smartphone
8	MAGIC app displays the new POI / POI locations

Alternative Paths

Alternative Path A: N/A

Step #	Step Description

Post Conditions

- Central Command has all images, POIs, and POI locations
- Field-responders and rescuers have the POIs and POI locations appropriate to them

Exception Paths

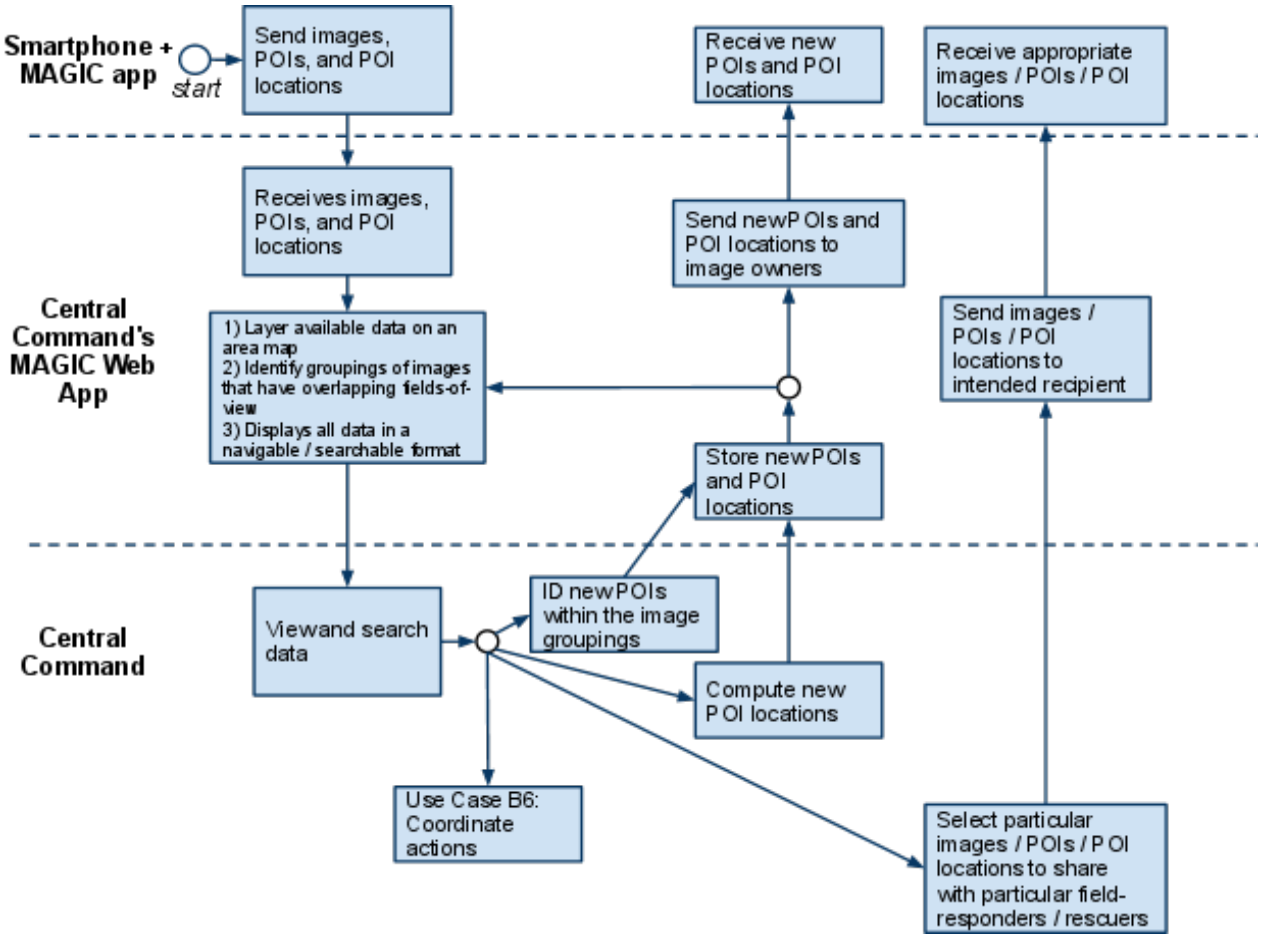
Exception Path 1: **Interrupted communication -** During the transfer of images / POIs / POI locations, the link is broken (network goes down, the smartphone dies, etc)

Step #	Step Description
2.1 / 5.1	MAGIC alerts both the rescuer / field-responder and Central Command that transfer of the points-of-interest and photos failed
3.1	Field-responder / rescuer opens MAGIC on his/her smartphone
4.1	MAGIC displays what data did successfully transfer (if any)

Use Case B5: Correlate images and points-of-interest

Description	The MAGIC Web App receives images, POIs, and POI locations from all available field-responders and rescuers in near-real time. Central Command uses the MAGIC Web App to identify sets of images with overlapping fields-of-view, view and navigate the images / POIs / POI locations, identify and label new POIs in the available imagery, and compute new POI locations. Central Command-created POIs and POI locations are automatically sent to the field-responders and rescuers that have the image(s) containing the POI. Central Command sends particular images, POIs, and POI locations to particular field-responders / rescuers via MAGIC. Central Command views a complete 'map' of the disaster area, layering all available MAGIC data on an area map.

Activity Diagram



Actors

Primary Actors

- **Central Command**: an authorized individual using a computer workstation with the MAGIC Web App. Part of the organization responsible for coordinating the disaster response.

Secondary Actors

- **N/A**

Trigger

- A new image, POI, or POI location is received by Central Command's MAGIC Web App from a field-responder or rescuer

Assumptions

- N/A

Pre-Conditions

- The smartphone and MAGIC app of the field responder / rescuer are both in an operational state (i.e. not broken, out of power, etc)
- The network connecting the field responder / rescuer's smartphone to Central Command is in an operational state (i.e. able to carry data between smartphones and Central Command)
- Central Command is in an operational state

Normal Flow (Happy Path)

Step #	Step Description
1	Central Command's MAGIC Web App receives the new image / POI / POI location
2	MAGIC Web App layers the data on an area map, identifies groups of images that share a field-of-view, and displays everything in a navigable format
3	Central Command views and navigates the data
4a	Central Command identifies new POIs in the image groups, and computes new POI locations
5a	MAGIC Web App stores new POIs and POI locations
6a	MAGIC Web App automatically forwards new POIs and POI locations to the field-responders / rescuers that have the image containing the POI
7a	Field-responder / rescuer's smartphone & MAGIC app receive the POIs and POI locations
4b	Central Command selects particular images / POIs / POI locations to be shared with specific field-responders and rescuers
5b	MAGIC Web App sends the images / POIs / POI locations to the intended recipents
6b	Intended field-repsonder / rescuer's smartphone & MAGIC app recieve the appropriate images / POIs / POI locations
4c	Central Command coordinates the actions of field-responders and rescuers (see Use Case B6: Coordinate actions - this use case is not within MAGIC's scope, but is important for explaining its context)

Alternative Paths

Alternative Path A: N/A

Step #	Step Description

Post Conditions

- Central Command has all images, POIs, and POI locations, giving them the information they need to coordinate the disaster response
- Field-responders and rescuers have the POIs and POI locations appropriate to them

Exception Paths

Exception Path 1: **Interrupted communication -** During the transfer of images / POIs / POI locations, the link is broken (network goes down, the smartphone dies, etc)

Step #	Step Description
1.1 6a.1 7a.1 5b.1 6b.1	MAGIC alerts both the rescuer / field-responder and Central Command that transfer of the image / POI / POI location has failed

Use Case B6: Coordinate actions

Description	This use case is external to the MAGIC system. This description is provided only because of its importance to the MAGIC system's context. Central Command uses voice communication (e.g. walkie-talkie, cellphone, landline) to issue commands to field-responders and rescuers based on the situational awareness the MAGIC system has provided them.