APPENDIX K:
ROUGH ORDER OF MAGNITUDE AND RETURN ON INVESTMENT ANALYSIS

MOBILE APPLICATION FOR GEOLOCATION OF IMAGERY AND COLLABORATION

MAGIC

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

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Course Professor: Dr. Kathryn Laskey
Project Sponsor: Kurt Rogers, Integrity Applications Inc.

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1.0 Introduction

The document provides a cost estimate and potential return on investment outlook for each possible option, of which there are six. The 1st two options identifies and explains the cost and ROI for a system designed for emergency responders with in-house back end processing and developed on the Apple or Android platform. The next two options assess cost and ROI for a system designed for casual users with in-house back end processing and developed on the Apple or Android platform. The last two options assess a system built for casual users on either the Apple or Android platform, but would contain no back end processing. This function is assumed to be handled by a 3rd party such as Facebook.

2.0 Rough Order of Magnitude (ROM)

This function point total is based on a document by William Roetzheim, "Estimating Software Costs," Cost Xpert Group, Inc. using a linear productivity factor and a penalty factor that corresponded to the type of development effort (Roetzheim). To obtain the total number of function points, an estimate of the number of external inputs, external interface files, external outputs, external queries, and logical internal tables was created. The raw values are converted in to actual function points using the conversion factors as noted in each table. From there, a software language equivalency factor was used to convert the number of function points into SLOC. The number of SLOC is used along with a "productivity" and "penalty" factor to come up with an estimate of man-months. This is the projected level of effort, which is converted to dollars by considering the number of hours in month to be 160 and the labor rate of developers to be $80.

COCOMO was used with modifications to the effort adjustment factor, which resulted in very similar schedule and cost estimates as above.

2.1 Emergency Responders + Apple OS w/BEP

The application/FEP, which would be used on only iPhone devices, would perform the point-of-interest calculation and many other essential functions. It would then be able to share this information with other users. The server/BEP would provide the data sharing function.

Note: It is assumed in this case that the contract is already awarded.

Note: It is assumed that a solution designed for emergency responders must have its own back end processing and cannot use a 3rd party for information sharing.

2.1.1 Software Development Costs

Software Development Estimate (Emergency Responders - Apple iOS - w/BEP)				
Function Point Estimate**	**Quantity**	**Conversion Factor**	**Function Points**	**Comments**
External Inputs	23	4	92	User provides 4 inputs for up to 4 photos. Also include settings inputs (7)
External Interface Files	3	7	21	Image, Metadata, and POIs are the 3 data object types
External Outputs	7	5	35	List of available images, map of images, search results, image with metatdata, ,image with POIs and several additional unique reports
External Queries	6	4	24	Sensors within the device itself (camera, gps, accel, gyro)
Logical Internal Tables	7	10	70	Table of images, POIs, pixels, setting options, smart phone db, and astronomical table. More on the server side
Total Function Points			**242**	Sum above point values
C++ language equivalency value			53	Assumed value from reference
KSLOC Estimate			12.8	Total Function Points x language equivalency value
Estimated Effort (person-months)			61.19	(Productivity) x (KSLOC^Penalty) (in months) see reference
Total Labor Hours			9,790.04	Effort x 160hours/month
Cost/Labor Hour ($80/hour)			$80	Assumed value from budget expert
Total Function Point Estimate			**$783,202.89**	Labor Hours x labor rate

Explanation:
C++ has a larger equivalency value, resulting in larger SLOC count
The productivity and penalty factors for government or military type projects are larger, which result in a larger estimated effort.
The use of a robust BEP requires more function points, which tie directly to the effort estimate.

2.1.2 Total Project Costs

System ROM (Emergency Responders - Apple iOS - w/BEP)					
	# Units/Hrs.	Cost/Unit/Hr.	Subtotal	Total	% of Total
Items					
1. Labor				**$200,000**	15%
Project Manager	800	$100	$80,000		
SE Team Members	1600	$75	$120,000		
2. Hardware				**$26,000**	2%
Handheld device	2	500	1000		
Servers	5	$5,000	$25,000		
3. Software				**$783,203**	60%
Software development*			$783,202.89		
4. Testing (10% of total hardware and software costs)				**$80,920**	6%
5. Reserves (20% of total estimate)			$218,024.64	**$218,025**	17%
Total project cost estimate				**$1,308,148**	
*See software development estimate					

A system designed with emergency responders in mind on either the Android OS or the Apple iOS platform using its own back end processing will require a more robust BEP than a system designed with the casual user in mind. The reason is that this option would require more complex data processing. It would also need to be more secure and more than likely require some level of redundancy. Also within this option, there will need to be human interaction that would have the capability of browsing and selecting specific images to be distributed to the field.

2.2 Emergency Responders + Android OS w/BEP

The application/FEP, which could be used on multiple Android OS compatible devices, would perform the point-of-interest calculation and many other essential functions. It would then be able to share this information with other users. The server/BEP would provide the data sharing function.

2.2.1 Software Development Costs

MAGIC System Software Development Estimate Emergency Responders - Android OS - w/BEP)				
Function Point Estimate**	**Quantity**	**Conversion Factor**	**Function Points**	**Comments**
External Inputs	23	4	92	User provides 4 inputs for up to 4 photos. Also include settings inputs (7) T=16+7=23
External Interface Files	3	7	21	Image, Metadata, and POIs are the 3 data object types
External Outputs	7	5	35	List of available images, map of images, search results, image with metatdata, ,image with POIs and several additional unique reports
External Queries	6	4	24	Sensors within the device itself (camera, gps, accel, gyro)
Logical Internal Tables	7	10	70	Table of images, POIs, pixels, setting options, smart phone db, and astronomical table. More on the server side
Total Function Points			**242**	Sum above point values
Java 2 language equivalency value			46	Assumed value from reference
KSLOC Estimate			11.1	Total Function Points x language equivalency value
Estimated Effort (person-months)			52.57	(Productivity) x (KSLOC^Penalty) (in months) see reference
Total Labor Hours			8,410.79	Effort x 160hours/month
Cost/Labor Hour ($80/hour)			$80	Assumed value from budget expert
Total Function Point Estimate			**$672,863.46**	Labor Hours x labor rate

Explanation:

- Java has a smaller language equivalency factor, which results in a lower SLOC count
- The productivity and penalty factors for government or military type projects are larger, which result in a larger estimated effort.
- The use of a robust BEP requires more function points, which tie directly to the effort estimate.

2.2.2 Total Project Costs

System ROM (Emergency Responders - Android OS - w/BEP)					
	# Units/Hrs.	Cost/Unit/Hr.	Subtotal	Total	% of Total
Items					
1. Labor				**$200,000**	17%
Project Manager	800	$100	$80,000		
SE Team Members	1600	$75	$120,000		
2. Hardware				**$26,000**	2%
Handheld device	2	500	1000		
Servers	5	$5,000	$25,000		
3. Software				**$672,863**	58%
Software development*			$672,863.46		
4. Testing (10% of total hardware and software costs)				**$69,886**	6%
5. Reserves (20% of total estimate)			$193,749.96	**$193,750**	17%
Total project cost estimate				**$1,162,500**	
*See software development estimate					

As stated before, the BEP would require more SLOC and therefore cost more due to the increase in capability and complexity.

2.3 Casual Users + Apple iOS w/BEP

The application/FEP, which would only be on iPhones, would perform the image and POI calculations on the phone itself and share this information using a server/BEP.

2.3.1 Software Development Costs

Software Development Estimate (Casual Users - Apple OS - w/BEP)				
Function Point Estimate**	**Quantity**	**Conversion Factor**	**Function Points**	**Comments**
External Inputs	23	4	92	User provides 4 inputs for up to 4 photos. Also include settings inputs (7)
External Interface Files	3	7	21	Image, Metadata, and POIs are the 3 data object types
External Outputs	5	5	25	List of available images, map of images, search results, image with metatdata, and image with POIs
External Queries	9	4	36	Google,Facebook, Twitter, Picassa, and the device itself (add camera, gps, accel, gyro)
Logical Internal Tables	6	10	60	Table of images, POIs, pixels, setting options, smart phone db, and astronomical table
Total Function Points			**234**	Sum above point values
C++ language equivalency value			53	Assumed value from reference
KSLOC Estimate			12.4	Total Function Points x language equivalency value
Estimated Effort (person-months)			33.57	(Productivity) x (KSLOC^Penalty) (in months) see reference
Total Labor Hours			5,371.43	Effort x 160hours/month
Cost/Labor Hour ($80/hour)			$80	Assumed value from budget expert
Total Function Point Estimate			**$429,714.66**	Labor Hours x labor rate

Explanation:

- There are more external queries since this type of system will interface with multiple 3rd parties such as Facebook and Twitter. The together with the larger language equivalency value constitutes the lager total estimate compared with the Android option.

2.3.2 Total Project Costs

System ROM (Casual Users - Apple OS - w/BEP)					
Items	# Units/Hrs.	Cost/Unit/Hr.	Subtotal	Total	% of Total
1. Labor				**$200,000**	24%
Project Manager	800	$100	$80,000		
SE Team Members	1600	$75	$120,000		
2. Hardware				**$26,000**	3%
Handheld device	2	500	1000		
Servers	5	$5,000	$25,000		
3. Software				**$429,715**	51%
Software development*			$429,714.66		
4. Testing (10% of total hardware and software costs)				**$45,571**	5%
5. Reserves (20% of total estimate)			$140,257.23	**$140,257**	17%
Total project cost estimate				**$841,543**	
*See software development estimate					

In this case, the BEP has less complexity than the emergency responder case in that it only requires network file sharing as opposed to full human interaction with special capabilities. However, having an in house BEP will also cost more to develop than a system that utilizes technology already present on the web for data sharing functions. If the goal is to keep costs as low as possible in the initial deployment phase, this becomes a significant factor.

2.4 Casual Users + Android OS w/BEP (recommended)

The application/FEP, which could be used on multiple Android OS compatible devices, would perform the point-of-interest calculation and many other essential functions. It would then be able to share this information with other users. The server/BEP would provide the data sharing function.

2.4.1 Software Development Costs

Software Development Estimate (Casual Users - Android OS - w/BEP)				
Function Point Estimate**	**Quantity**	**Conversion Factor**	**Function Points**	**Comments**
External Inputs	23	4	92	User provides 4 inputs for up to 4 photos. Also include settings inputs (7)
External Interface Files	3	7	21	Image, Metadata, and POIs are the 3 data object types
External Outputs	5	5	25	List of available images, map of images, search results, image with metatdata, and image with POIs
External Queries	9	4	36	Google,Facebook, Twitter, Picassa, and the device itself (camera, gps, accel, gyro)
Logical Internal Tables	6	10	60	Table of images, POIs, pixels, setting options, smart phone db, and astronomical table
Total Function Points			**234**	Sum above point values
Java 2 language equivalency value			46	Assumed value from reference
KSLOC Estimate			10.8	Total Function Points x language equivalency value
Estimated Effort (person-months)			29.01	(Productivity) x (KSLOC^Penalty) (in months) see reference
Total Labor Hours			4,642.23	Effort x 160hours/month
Cost/Labor Hour ($80/hour)			$80	Assumed value from budget expert
Total Function Point Estimate			**$371,378.36**	Labor Hours x labor rate

Explanation:

When compared with any option that uses a 3rd party for image and data sharing, the total SLOC is higher since the 3rd party option eliminates the need for any back end processing.

2.4.2 Total Project Costs

System ROM (Casual Users - Android OS - w/BEP)					
Items	# Units/Hrs.	Cost/Unit/Hr.	Subtotal	Total	% of Total
1. Labor				**$200,000**	26%
Project Manager	800	$100	$80,000		
SE Team Members	1600	$75	$120,000		
2. Hardware				**$26,000**	3%
Handheld device	2	500	1000		
Servers	5	$5,000	$25,000		
3. Software				**$371,378**	49%
Software development*			$371,378.36		
4. Testing (10% of total hardware and software costs)				**$39,738**	5%
5. Reserves (20% of total estimate)			$127,423.24	**$127,423**	17%
Total project cost estimate				**$764,539**	
*See software development estimate					

2.5 Casual Users + Apple iOS w/3rd Party Data Sharing

The application/FEP, which would only be on iPhones, would perform the image selection and POI calculations on the phone itself and share this information using a server/BEP.

2.5.1 Software Development Costs

Software Development Estimate (Casual Users - Apple OS - w/o BEP)				
Function Point Estimate**	**Quantity**	**Conversion Factor**	**Function Points**	**Comments**
External Inputs	23	4	92	User provides 4 inputs for up to 4 photos. Also include settings inputs (7) T=16+7=23
External Interface Files	3	7	21	Image, Metadata, and POIs are the 3 data object types
External Outputs	5	5	25	List of available images, map of images, search results, image with metatdata, and image with POIs
External Queries	6	4	24	Sensors within the device (camera, gps, accel, gyro)
Logical Internal Tables	6	10	60	Table of images, POIs, pixels, setting options, smart phone db, and astronomical table
Total Function Points			**222**	Sum above point values
C++ language equivalency value			53	Assumed value from reference
KSLOC Estimate			11.8	Total Function Points x language equivalency value
Estimated Effort (person-months)			31.80	(Productivity) x (KSLOC^Penalty) (in months) see reference
Total Labor Hours			5,087.93	Effort x 160hours/month
Cost/Labor Hour ($80/hour)			$80	Assumed value from budget expert
Total Function Point Estimate			**$407,034.67**	Labor Hours x labor rate

2.5.2 Total Project Costs

System ROM (Casual Users - Apple OS - w/o BEP)					
	# Units/Hrs.	Cost/Unit/Hr.	Subtotal	Total	% of Total
Items					
1. Labor				**$200,000**	26%
Project Manager	800	$100	$80,000		
SE Team Members	1600	$75	$120,000		
2. Hardware				**$1,000**	0%
Handheld device	2	500	1000		
Servers	0	$5,000	$0		
3. Software				**$407,035**	52%
Software development*			$407,034.67		
4. Testing (10% of total hardware and software costs)				**$40,803**	5%
5. Reserves (20% of total estimate)			$129,767.63	**$129,768**	17%
Total project cost estimate				**$778,606**	
*See software development estimate					

The big difference here is the cost savings in not having to develop the BEP for the application. The down side to this is that it may bog the system down as the number of interfaces increase.

Compared with a system designed for the emergency responder, the BEP for this configuration has less complexity since it will not have any special functions outside of data sharing and security.

2.6 Casual Users + Android OS w/3rd Party Data Sharing

The application/FEP, which could be used on multiple Android OS compatible devices, would perform the point-of-interest calculation and many other essential functions. It would then be able to share this information with other users. The server/BEP would provide the data sharing function.

2.6.1 Software Development Costs

Software Development Estimate (Casual Users - Android OS - w/o BEP)				
Function Point Estimate**	**Quantity**	**Conversion Factor**	**Function Points**	**Comments**
External Inputs	23	4	92	User provides 4 inputs for up to 4 photos. Also include settings inputs (7) T=16+7=23
External Interface Files	3	7	21	Image, Metadata, and POIs are the 3 data object types
External Outputs	5	5	25	List of available images, map of images, search results, image with metatdata, and image with POIs
External Queries	6	4	24	Google,Facebook, Twitter, Picassa, and the device itself (add camera, gps, accel, gyro)
Logical Internal Tables	6	10	60	Table of images, POIs, pixels, setting options, smart phone db, and astronomical table
Total Function Points			**222**	Sum above point values
Java 2 language equivalency value			46	Assumed value from reference
KSLOC Estimate			10,212	Total Function Points x language equivalency value
Estimated Effort (person-months)			26.34	(Productivity) x (KSLOC^Penalty) (in months) see reference
Total Labor Hours			4,214.60	Effort x 160hours/month
Cost/Labor Hour ($80/hour)			$80	Assumed value from budget expert
Total Function Point Estimate			**$337,168.15**	Labor Hours x labor rate

2.6.2 Total Project Costs

System ROM (Casual Users - Android OS - w/o BEP)					
	# Units/Hrs.	Cost/Unit/Hr.	Subtotal	Total	% of Total
Items					
1. Labor				**$200,000**	29%
Project Manager	800	$100	$80,000		
SE Team Members	1600	$75	$120,000		
2. Hardware				**$1,000**	0%
Handheld device	2	500	1000		
Servers	**0**	$5,000	$0		
3. Software				**$337,168**	49%
Software development*			$337,168.15		
4. Testing (10% of total hardware and software costs)				**$33,817**	5%
5. Reserves (20% of total estimate)			$114,396.99	**$114,397**	17%
Total project cost estimate				**$686,382**	
*See software development estimate					

This is the lowest cost solution because it eliminates the cost of servers due to the use of 3rd parties and it contains a lower language equivalency value.

3.0 Return on Investment (ROI)

3.1 ROI for Emergency Responder Based System

The ROI for an emergency responder based system looks a lot different from that of the casual user. This is primarily because of the difference in business practices. In this situation, a bid would be placed on contract. The potential profit or loss is contingent on the type of contract vehicle. Cost plus fee contract vehicles provide the lease amount of risk on the developer's part since it's understood that a profit would be made. That profit is determined early usually as a percentage. The firm fixed type of contract vehicle puts more risk on the contractor and should be avoided if at all possible. While the potential profit may be higher, the likelihood of a loss is ever present in any unprecedented development effort such as this one.

3.2 ROI for Casual User Based System

Assuming that the acceptable download price will continue to drop, then it can be stated with a high level of certainty that $1.50 is a reasonable price to charge for this application in 2012. With this assumption in mind, it would take approximately 480,000 downloads to recover the cost.

Going down the ad funded marketing path might mean offering two versions of the application: one that's free or "lite", to maximize the number of people who download it and thus draw in crowds to try out this service. This version could be used as an appetizer of sorts that would only offer a limited set of capabilities. The second prong of this strategy is to have a premium or priced version of the application, which would offer users the full suite of features and functionality.

A report from eMarketer states that ad-funded mobile applications typically serve 3-5 impressions each time a customer interacts with them, with even higher figures for some especially engaging applications (dotMobi, 2011). CPM is defined as revenue per 1000 impressions and the average CPM for ad based apps was around $8.75. With an application such as MAGIC, which has a legitimate chance to be a more frequently used application, one can see how lucrative it would be to go down this route. A report from AdWhirl says that "applications that crack the top 100 in the Free Apps list make $400-$5000 a day." This is a wide range, but even at the low end, it would amount to approximately $12,000 per month. With this in mind it would take approximately 65 months or 5.5 years to recover the $720K project cost. On the higher end at $5,000 per day or $150,000 per month, it would only take a little less than 5 months to break even.