



System Engineering Analysis for Improved Scout Business Information Systems

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1.0 Executive Summary

The project uses system engineering principles to address the need of Boy Scout leaders for an integrated system to facilitate advancement and awards records, leader training and planning for meetings and activities. Existing products to address needs of Scout leaders and relevant stakeholders function to support record keeping and some communication functions but opportunity exists for a better system to fully integrate these functions with training delivery and recording, activity planning along with feedback and information gathering from stakeholders. Key stakeholders for the system include Scouts and their families, leaders, training providers, sellers of supplies and awards, content generators and facilities that serve Scout activities. Key performance parameters for the system are protection of personal information, availability of current information, information accuracy and information content that has depth. Implementation concepts considered for the system include (1) owned and operated by Boy Scouts of America, (2) Contracted out to a vendor (3) distributed system that functions with BSA managed interfaces. The selected concept is to contract out to a vendor to maximize the likelihood of successful integration and take advantage of the best technology. Development of requirements considers three key use cases (1) System facilitates planning a hike with training needed satisfied in advance and advancement recording real time (2) Scheduling and documenting in-person training, (3) Family interested in Scouting receives information and can request follow-up. Non-functional requirements are analyzed with the Quality Function Deployment tool. Requirement addressing frequency of backup, compatibility with legacy and new technology, language support, software update are developed to address system reliability and intuitive interface. System functions analyzed include update of activity database, maintenance of advancement status, archive of documents, and monitoring of content that is accessible. The study examines risks associated with information security, technological change and continued popularity of Scouting. Mitigation is based on system functions that are defined. The approach to developing an improved system for facilitating Boy Scout leader functions was iterative with insights into capabilities coming in the course of working through the used cases and sequence diagrams.

2.0 Mission Description

The purpose of this project is to apply system engineering principles to address needs of Boy Scout or Cub Scout leaders to manage key aspects of their scouting units. For Cub Scout leaders this is a Pack or Den. For Boy Scout leaders, this is the Troop. Though there are detail needs that differ between the different age ranges served by Scouting units, this project will focus on needs that are common to all scouting units. Boys from Kindergarten through 5th grade participate in Cub Scouts while Boy Scout serves those between 5th grade and 18 years of age.

The following is the Mission Need Statement: "Boy Scout leaders need an integrated system to facilitate scout advancement and awards records, leader training, and planning for meetings and activities."

There are a range of products and services in existence that have been used address the needs for record keeping, training, and planning and some degree of integration exists. These have included

online tracking spreadsheets, Troop Master, and Scoutbook. In 2015, Boy Scouts of America® (BSA) acquired Scoutbook which a web application that incorporates a variety of useful functions. Also in 2015, requirements for ranks in Boy Scouts and Cub Scouts were updated.

Scoutbook does a good job of advancement recordkeeping and ordering awards. Unmet needs at present are strong integration for leader and adult helper training and "grass roots" knowledge about activities such as camping.

There are a number of operational constraints that are relevant for the development of the system. The system must preserve the privacy of the participants. It must make use of available technology platforms and software.

Figure 1. identifies key stakeholders important to the development of system requirements. Active stakeholders such as scout leaders, family members, and supplies retailers would interact with the system directly. Passive stakeholders involved with Scouting such as campsites, book sellers and meeting venues would have an interest in the system yet likely not interact with the system directly.

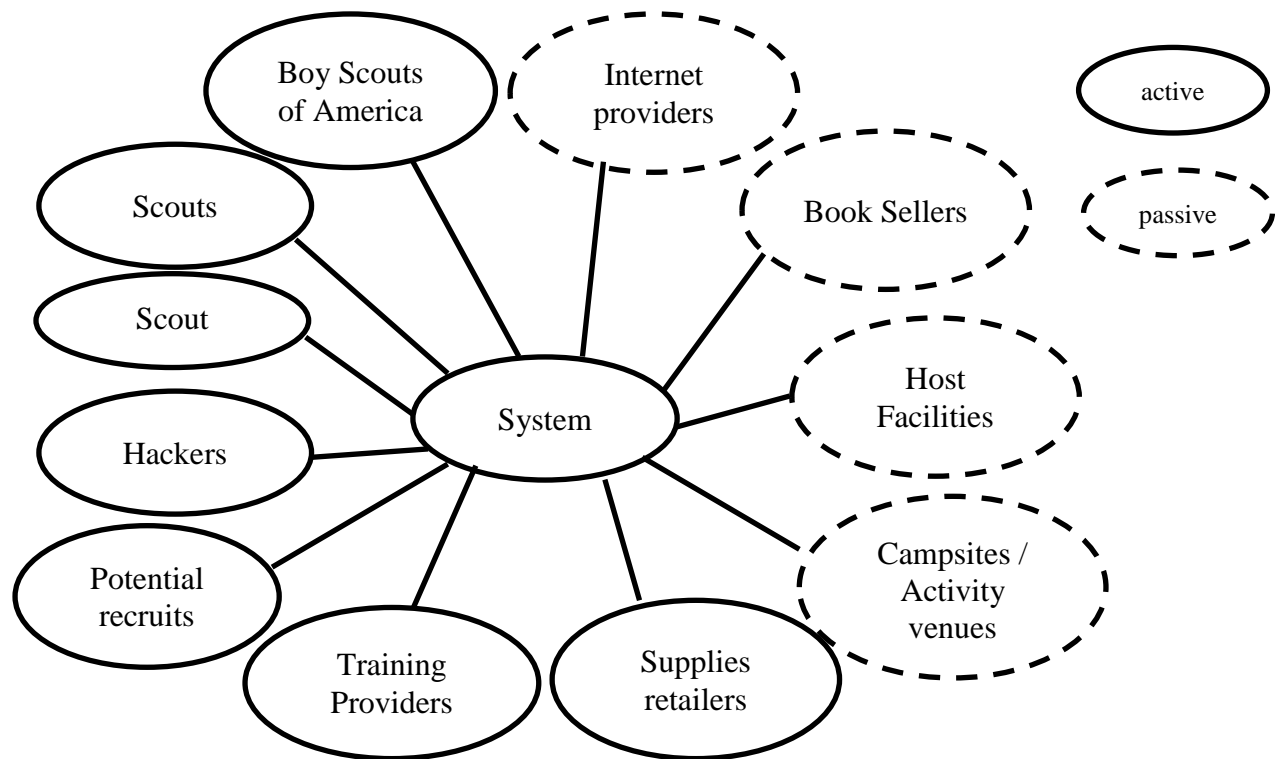


Figure 1. Identification of stakeholders

Table 1. Presents summarizes stakeholder expectations and classifies them as capabilities or characteristics of the system.

Table 1. Stakeholder Capability and Characteristic Expectations

Type of Expectation	Expectations of the system
Capability	Records completion of scout advancements
Capability	Records completion of scout awards
Capability	Links online training of leaders to recording training completion
Capability	Provides current forms in a fillable format for leaders and parents
Capability	Enables Parents to use the system to track progress and enter completion
Capability	Enables ordering of awards to be presented to scouts
Capability	Provides platform for units to share ideas on meeting plans and activities
Capability	Protects Personal information from public disclosure
Capability	Able to offer Tiered cost structure
Capability	Includes General Website informing the community about the pack/troop
Capability	Compatible with personal computers, portable devices, smart phones
Capability	Links to sites where Families buy general Scouting supplies, uniforms etc.
Capability	Includes social network function: information sharing, uniform sharing, supplies sharing
Capability	Current information is available
Characteristic	Error rate less than 1% (or at least 99% reliability)
Capability	Includes searchable Deep information content for planning activities
Characteristic	System downtime (i.e. maintenance impact) is less than 1% and scheduled at times of least customer usage
Characteristic	Accommodates updates to requirements and publications at least annually
Capability	Information content has a depth that makes it function as a go-to resource for planning

The following are subset of stakeholder expectations that are considered Key Performance Parameters (KPPs). These are the sacred expectations for the system and must be true for the successful system

1. Personal information is protected from public disclosure
2. Current information is available
3. Information is accurate: Error rate less than 1%
4. Deep information content

KPP 1 covers the needed capability that the system protects private information from broad dissemination. This is especially important since the system involves minors.

KPP 2 covers the needed capability of the system to include current information. This includes current revisions of BSA publications, current requirements for awards and badges, and current information that would be used for planning activities.

KPP3 is the characteristic of the system to ensure errors are minimized. Examples of unwanted errors could include incorrect information on award completion, registration or training status.

KPP4 is the capability of the system information to have a depth that would be seen as very informative. For example, the system is successful if the information available on the trails in a state park available in the system be as informative as what could be gathered from thorough searching of the broader World Wide Web. It is successful if it is seen as the go-to or exhaustive resource for such information.

Figure 2 illustrates the current reference architecture. It shows the integration that is present in the current environment and shows connections elements that are present that could benefit from integration. For example, current advancement requirements are captured within the existing system and there is a linkage between the leaders, the families and the award supplier. Information available on Unit web pages is available but not integrated with the existing system. The BSA website (scouting.org) has a variety of publications that leaders can use; however certain key planning publications (Pack Leader guide, Den Leader guide) that have specific meeting plans are only available as printed publications available for purchase and not available in the electronic system. Online training is currently available on my.scouting.org. Entry and recording of the completed training is not as automatic as an integrated system could provide.

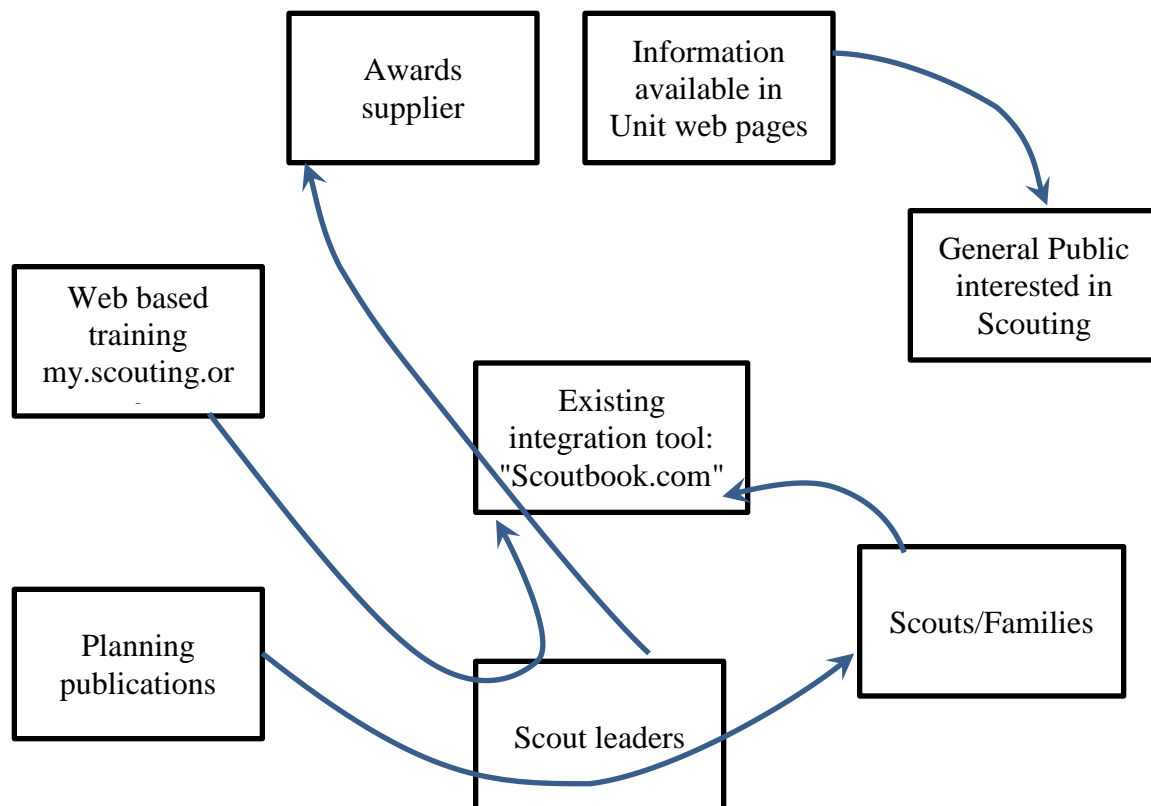


Figure 2. Reference Architecture: The As-is Environment

At present, if a leader wants to get the best information about what a particular hiking trail or campground might have to offer, one would use an internet search engine and hope that results include candid detailed trip reports with photos and narrative that would provide some helpful additional context beyond what is available in on an official park district brochure or website.

3.0 Solution Environment

Figure 3 illustrates the Operational context of the proposed system. From the user's perspective, the system will provide information on a variety of platforms to serve the desired purposes. It is computer-based and available via the World Wide Web. For Scouts/Families and Unit leaders the interface may be accessible via a computer login or downloadable app to interact with system features. For Families and product or service vendors, interface may be via email or text communication or ecommerce api. The system can be vehicle a to inform potential Scout families about Scouting in general and their local units in particular providing information that would be appropriate to share with the broad audience of the World Wide Web. The users of this functionality could, if they wish, provide contact information or questions that a representative can follow up. (Maybe the system could create a pack/troop email box that leaders could have access to and respond to questions.)

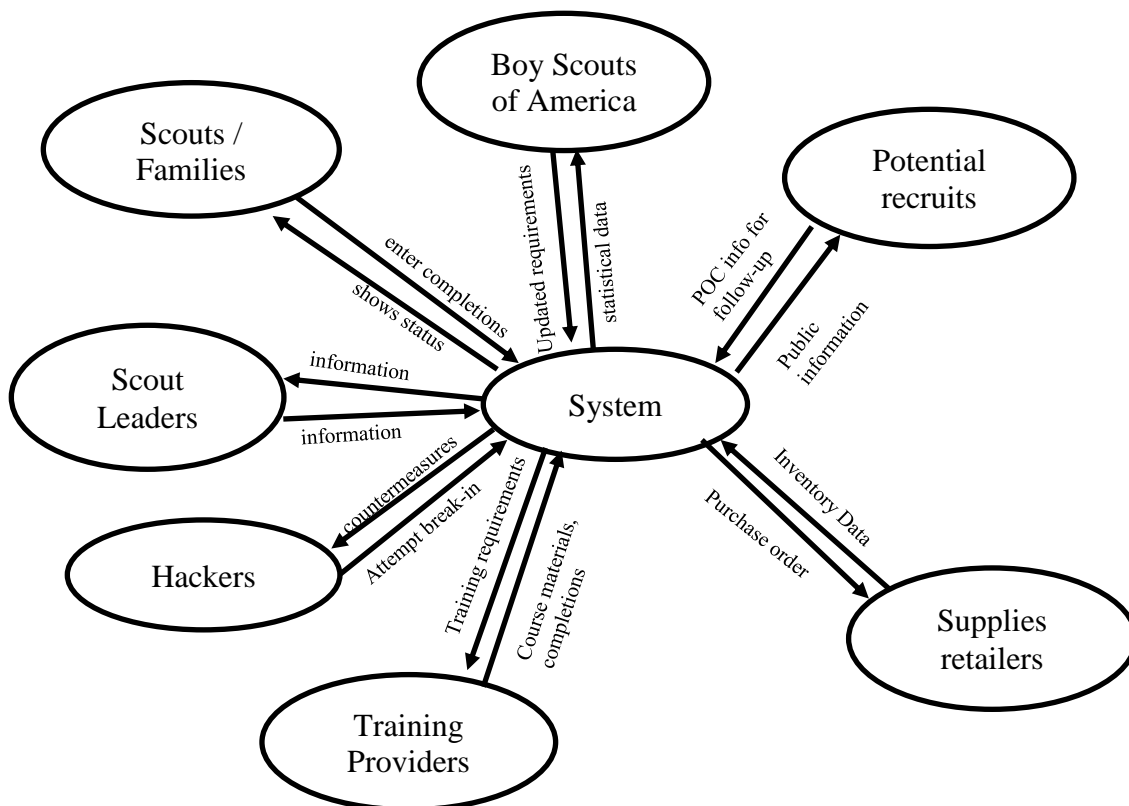


Figure 3. Operational context

4.0 Operational Scenarios

This study covers three general scenario areas: scout advancement and awards records, leader training, and planning for meetings and activities.

Scout advancement and awards are a key element in the Scouting program. Activities to fulfill requirements for advancement ranks and awards can take place at meetings and at special activities such as hikes or camping trips. Some activities are done at home with the Scout's family and can be signed off by the Scout's parent.

Leader training includes general training that is required of all leaders and adults supporting a Scout activity such as Youth Protection training or training to support overnight camping or swimming activities. Training can also take the form of specific training to support unique high adventure activities. Technology has enabled a significant portion of training to be accessible via online content. Certain subject areas that involve hands on skills or interpersonal or group dynamics will likely remain delivered as in-person training

Planning for meetings and activities is supported by a variety of resources. The BSA produces publications that cover meeting plans, activity plans for camping trips. Local roundtable meetings are held that provide a forum to support information sharing and planning. Existing online tools support accessible calendars and tools for generating activity invitation communication.

5.0 System Concepts

Three main alternative implementation concepts are considered in this study.

- 1) The first is a system that is owned, developed and maintained by the Boy Scouts of America®. This concept is essentially the all-in-house concept
- 2) The second concept is an all-in-one system solution that would meet the needs of the full set of system requirements. To realize this concept, the BSA would contract out the development and maintenance of the system to a vendor who can meet the requirements.
- 3) The third concept is a more distributed system that is managed by the BSA consisting of a portfolio of products and interfaces that taken together would serve the various functions and interfaces that meet the system requirements.

Table 2 shows the comparison between the alternatives studied using a Pugh Matrix that scores the alternatives relative to the Key Performance Parameters (KPPs).

Concept 1 (BSA owns the solution) should be the least likely to compromise privacy since the solution owner is already responsible for the protected information. Since information such as requirements texts originates with BSA, keeping information current should be a strength. This concept is likely to have the disadvantage of less information depth compared with solutions that are more oriented to take advantage of what other entities and the broader Internet can offer.

Concept 2 (BSA contracts out the solution) represents a middle ground between Concepts 1 and 3. This solution is envisioned as an all-inclusive package provided by a vendor that bids for the job and provides the system to the BSA. This approach would potentially better utilize the range of technologies available in the market place.

Concept 3 (BSA manages the interfaces) envisions that the fully realized system would consist of modules from potentially multiple vendors or information sources. BSA would manage the interfaces so that from the user perspective, the experience is seamless. Because this concept is the most complicated, there is a greater potential for reliability problems associated with the various interfaces that tie the system modules together.

Table 2. Pugh Matrix comparison of solution alternatives

KPPs	1: BSA owns the solution	2: BSA contracts out the solution	3: BSA manages interfaces
1 Protect privacy	+	S	+
2 Current information	+	S	-
3 Deep info content	-	S	+
4 Accuracy	+	S	-
Σ +	3	0	2
Σ -	1	0	2
Satisfactory	0	4	1

Based on the tradeoffs, reviewed in the Pugh Matrix, the preferred alternative is Option 2. With this approach, the BSA would retain an appropriate degree of control/influence over the overall system and have the best chances of a reliable, stable system with an appropriate degree of innovation.

6.0 Use Cases and System Level Scenarios

Figure 4 illustrates with a sequence diagram a use case involving planning an event that combines the aspects discussed in this study: activity planning, scout advancement and leader training. The system provides, planning information, event communication, required forms, advancement update, and supplying helpful information to the system for other leaders to use for their planning. The scenario also involves leader training. The scenario begins with the leader querying the system for information about the details that would be helpful to plan a hike. The system returns information that covers trail description and photos, current conditions, permits and fees that might be required and unique features that might relate to specific scout advancement activities. For example, if a trail had unique plants or animals that would be helpful for a set of badge requirements this would be highlighted. The leader then specifies the families to receive information that will help them plan to attend the hike. The system then sends a communication to each family. This might be an email or text as appropriate for preferences that the family has established. The system provides a vehicle to RSVP. The system provides to the participating families forms that might be required (i.e. medical release). The system also facilitates the leader completing trip planning forms that the local scout district may require. The system receives these completed forms as input and serves as an archive.

In advance of the hike if participating adult needs training (such as youth protection training), the system sends a notice of this need to the leader and sends a request to the family. The family is provided with a training link allowing them to log into the system. The training is delivered to the adult and the adult demonstrates proficiency.

During the hike, as activities satisfy advancement requirements, the leader can capture the participating scouts who have completed the requirements. After the hike, the leader can provide trip information to the system that can be of benefit to Scout families and leaders who want to go there in the future.

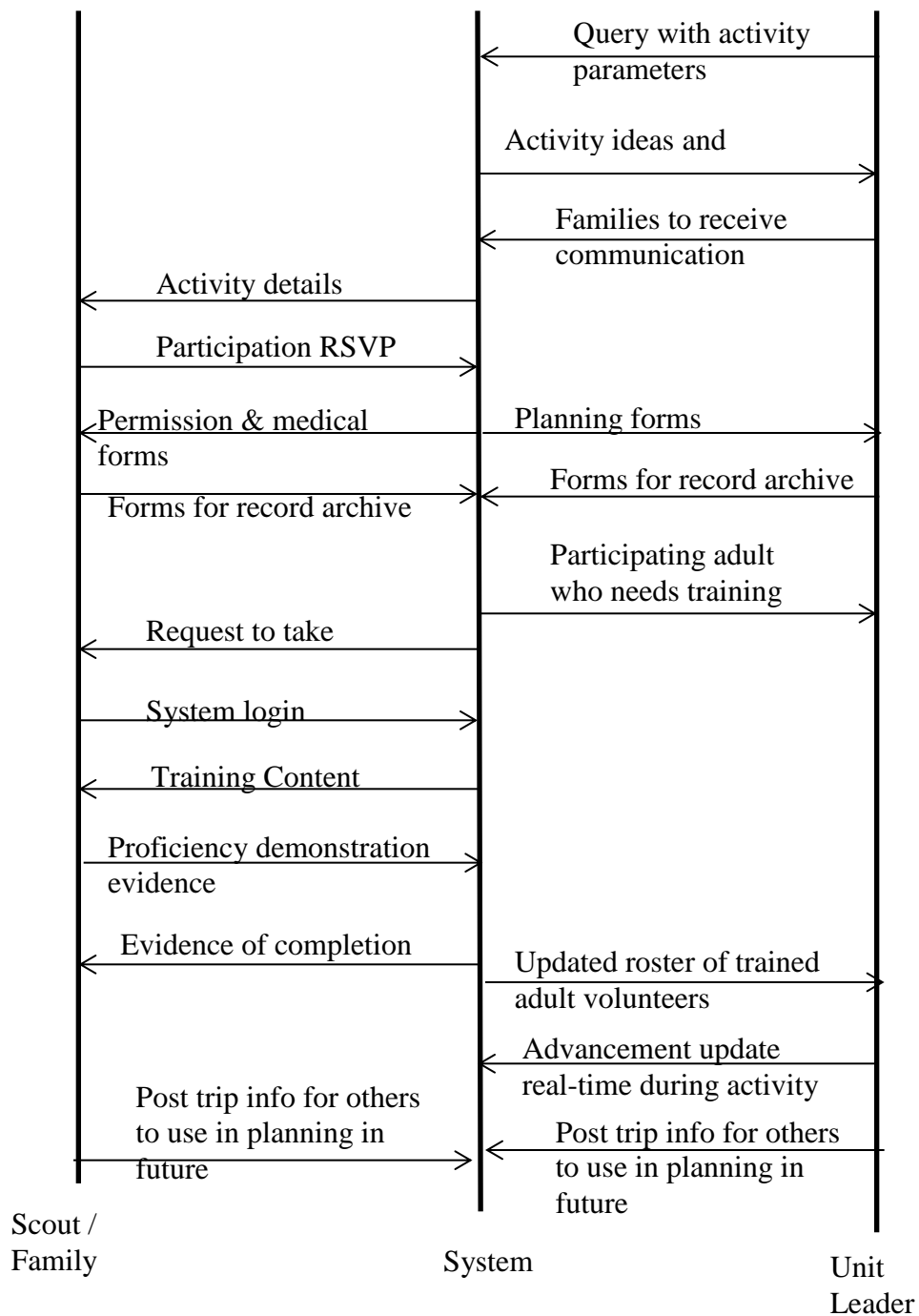


Figure 4. Sequence Diagram shows in-person training integrated using the system

Figure 5 shows a use case which handles in-person classroom or seminar style training which is sometimes used for leaders or adults. In this scenario, the participants interacting with the system are the unit leader, the training provider and the adults receiving the training.

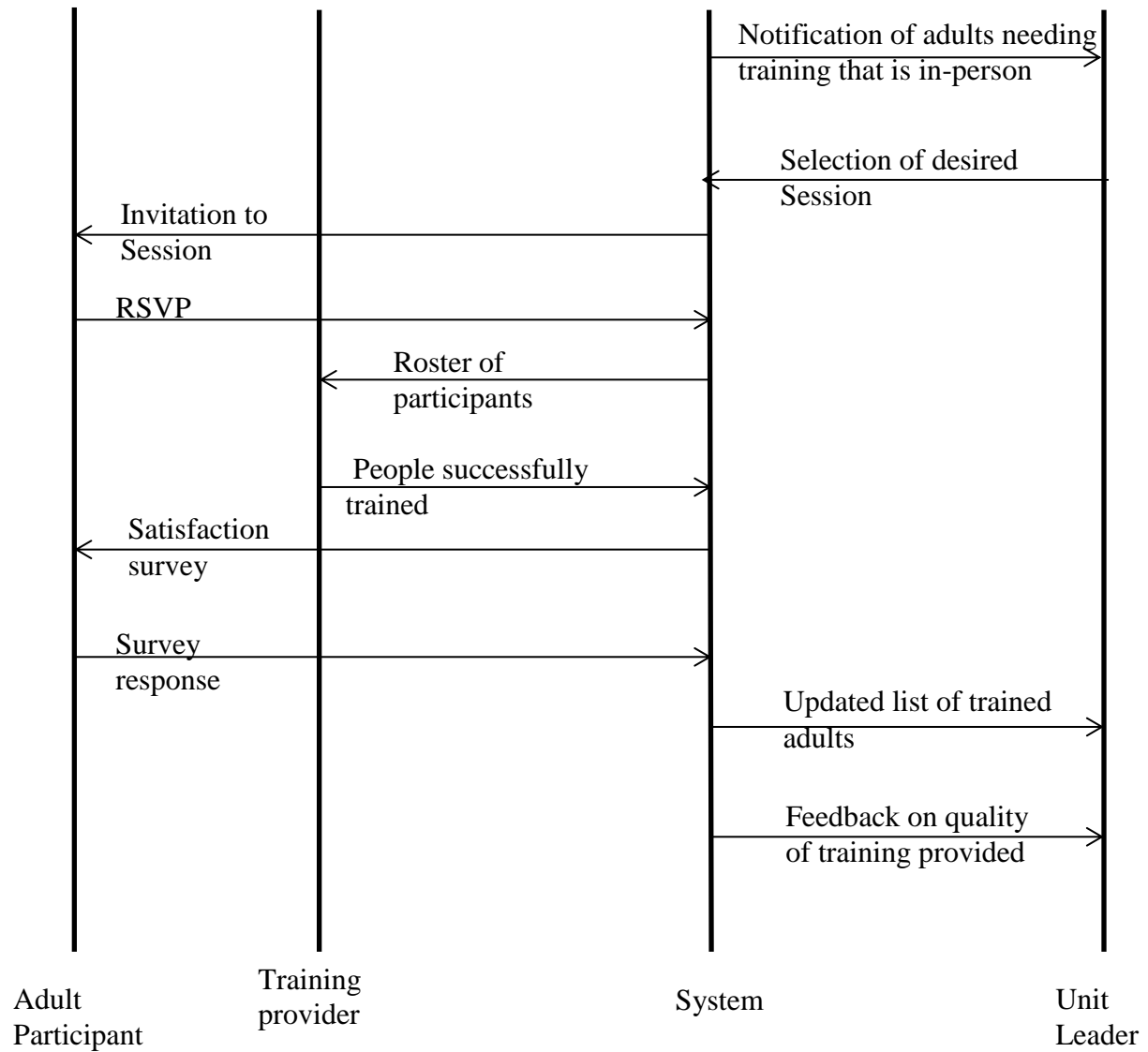


Figure 5. System facilitates delivery and recording in-person training

Figure 6 shows a use case in which the general public interacts with the system and Scout recruitment is facilitated. In this scenario, a person interested in Scouting arrives at a unit webpage hosted by the system. The page is populated with information to provide general Scouting information as well as specific local information that would be of interest to someone considering joining a local unit. The interface would provide a mechanism for the person to request followup information. The system would prompt the appropriate unit leader of the request for followup. The system would provide a means to generate a message tailored to the request of the interested family.

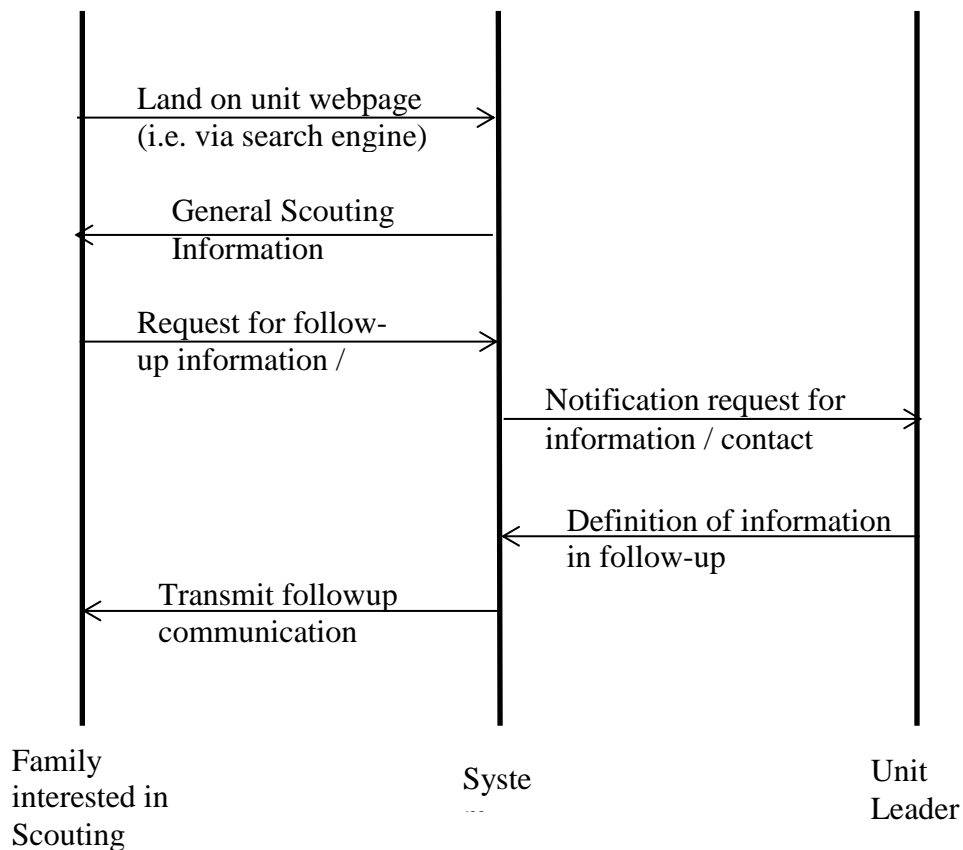


Figure 6. Family interested in Scouting receives information and can request follow-up

Figure 7 illustrates the use of a Quality Function Deployment (QFD) matrix to develop system level non-functional requirements from system characteristics desired by the stakeholders. The matrix shows that low error rate is supported by requirements specifying frequent backup, supporting common languages used and frequent software update. Low system downtime is supported by frequent data backup. Intuitive user interface is supported by backward compatibility, compatibility with new devices and frequent software update. Cost and schedule are tradeoffs for these non-functional requirements. The matrix also shows that enhancing backward compatibility is at odds with robust support for multiple languages but is helped by frequent software updates.

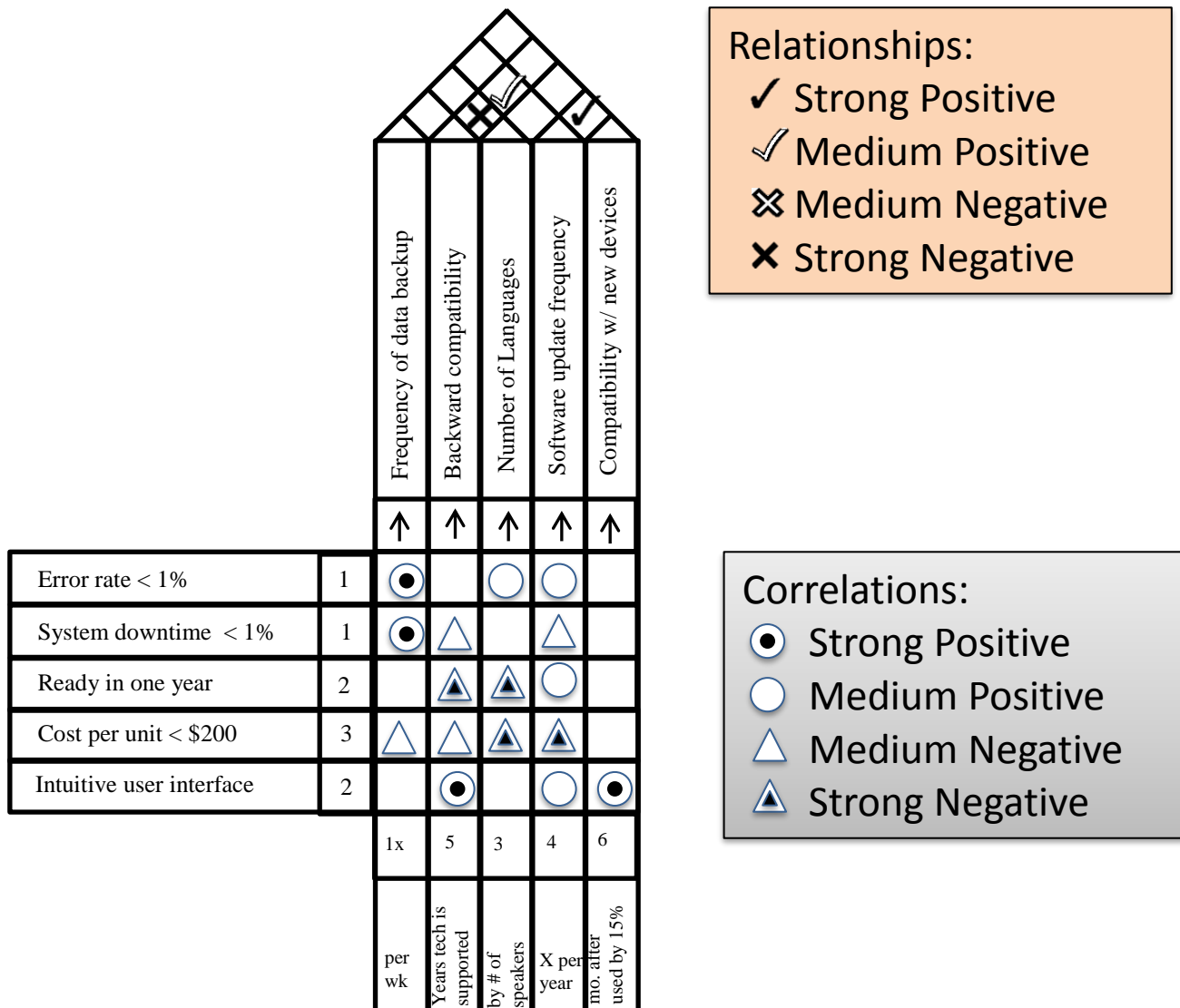


Figure 7 System Quality Function Deployment (QFD) matrix

7.0 Proposed system operational Architecture

The envisioned working of the system is depicted in figure 8 which shows diagram of the Architectural Concept. The focus of the diagram is to depict the flows of information and functionality between the system and the stakeholders.

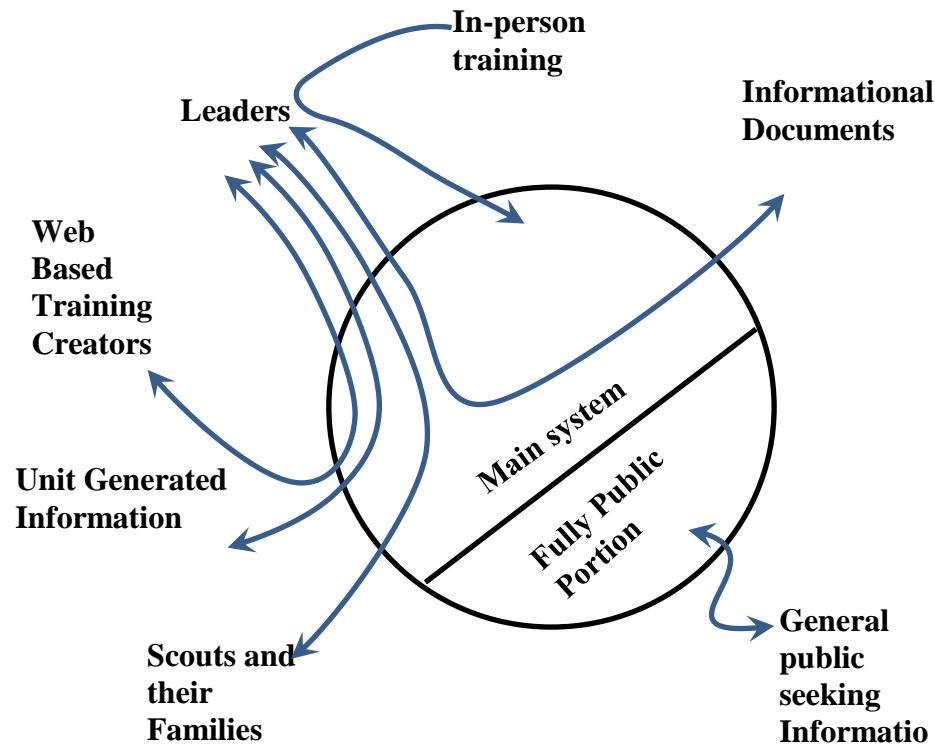


Figure 8. System Architectural Concept diagram

The architectural concept illustrated adds includes functionality that is not present in the as-is reference architecture. For example, in-person training is directly linked to the system, informational documents are integrated and the functionality that the general public would encounter to become informed about Scouting is integrated.

8.0 System requirements

The following sections list system requirements grouped by Input, output, functional and non-functional requirements. Input, output and functional requirements are derived from the use cases discussed. Non-functional requirements listed are those developed using the QFD.

Input Requirements

- The system shall receive a query with activity parameters.
- The system shall receive a list of families to notify of an upcoming activity.
- The system shall receive RSVP communication from invited families.
- The system shall receive completed forms from families.
- The system shall receive completed forms from leader.
- The system shall accept a login to grant entry to the system.
- The system shall accept updates to scout advancement completions.
- The system shall receive the training completion evidence from the trained adult.
- The system shall receive trip information from the leader.
- The system shall receive in-person training RSVP from the invited adult.
- The system shall receive the selection of desired session from the leader.
- The system shall receive trip information from Scout / family participants.
- The system shall receive the list of adults who completed the training session.
- The system shall receive satisfaction survey responses.
- The system receive a request for follow up information from interested non-member.
- The system shall receive definition of information of information to be included in follow-up communication with an interested family.

Output Requirements

- The system shall generate activities that fit the criteria defined by parameters.
- The system shall transmit a communication to identified families of activity details.
- The system shall transmit required forms to leader.
- The system shall transmit required forms to participating families.
- The system shall provide leader notification of participating adults who need activity specific training.
- The system shall provide family communication to take activity specific training.
- The system shall deliver the training content to the adult needing training.
- The system shall send the trained adult evidence of completion.
- The system shall send the leader an updated roster of trained adult volunteers.
- The system shall notify the unit leader of adults needing training that is delivered in person.
- The system shall provide invitation to the adult participant of the session.

- The system shall provide the training provider a roster of participants.
- The system shall provide the adult participants with a satisfaction survey.
- The system shall provide the unit leader an updated list of trained adults.
- The system shall provide the unit leader an report of feedback to evaluate participant satisfaction with training.
- The system shall notify the unit leader of request for information from interested family in his area.
- The system shall transmit follow-up information to the interested family.

Functional requirements

- The system shall generate activity details with input provided by unit leader.
- The system shall determine the needed forms in accordance with current policies based on type of activity.
- The system shall archive completed leader and Scout forms for future access.
- The system shall identify leader training needed based on planned activity .
- The system shall compare needed training against planned participant status.
- The system shall report upcoming training needs to the unit leader.
- The system shall link advancement activities that are associated with activity locations.

Non-functional requirements

- The system data shall be fully backed up once per week.
- At a minimum the system shall support hardware and software technology that is within 5 years of initial release.
- The system shall provide translation of content to the top three languages spoken in the United States by number of speakers.
- Software updates shall be implemented at least 4 times per year.
- System shall be compatible with new user devices six months after used by 15% of the households

9.0 Functional Architecture

System Functional architecture is illustrated in Figure 9. The functions illustrated capture inputs from Scout leaders and families as well as the BSA to update system information and plan events. System outputs to Scout families and leaders covers event communication and advancement status.

At present, if a leader wants to get the best information about what a particular hiking trail or campground might have to offer, one would use an internet search engine and hope that results include candid detailed trip reports with photos and narrative that would provide some helpful additional context beyond what is available in on an official park district brochure or website.

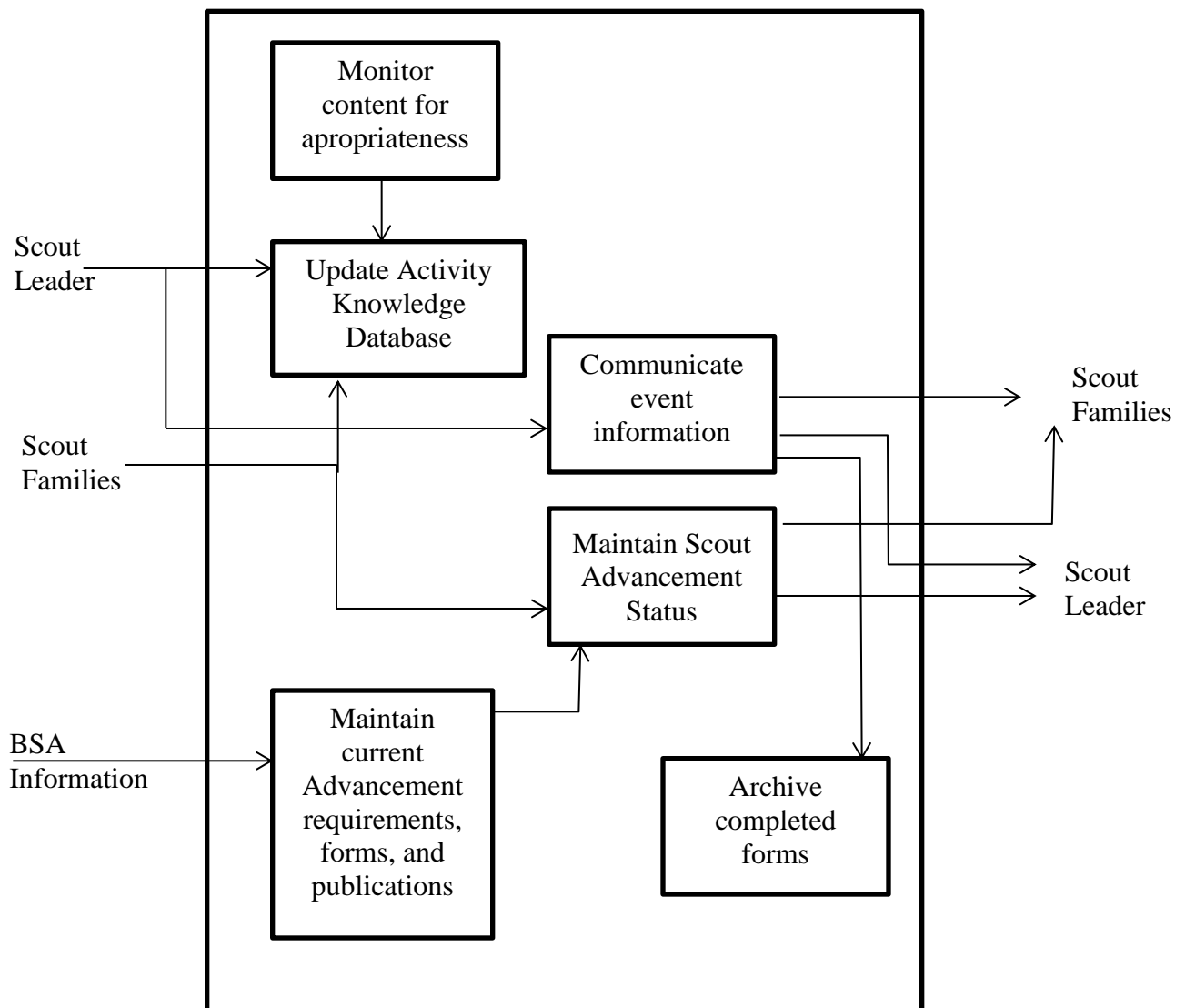


Figure 9. System Functional architecture

10.0 Organizational and Business Impact

Operational support for the system described in this study will involve an interplay between the content generated by the BSA, supporting the variety of hardware and software elements used to make the system operate and that users employ to use the system. Periodically requirements for Scout badges and awards are updated. The system function that maintains this information will need to ensure the system reflects these changes when they are implemented. The function that handles the information that supports activity planning is envisioned as having a depth of detail and local tailoring. To support this function, staff with local knowledge to ensure the quality and appropriateness of the information and that the quality is excellent will be needed. A support organization to address the risks of personal information breach and system compromise will be needed.

11.0 Risks and technology readiness

Table 3 summarized risks to the system considered. Technical risks associated with information security are of the greatest significance and are addressed with appropriate investment in information technology. Lower risks are associated with changing technology preferences and the popularity of the Scouting program.

Table 3. Risk Matrix

Risk	Title	Likelihood Lo 1 - 5 High	Consequence Lo 1 - 5 High	Risk Level	Mitigation Approach
1	System hack releases personal information	3	4	Medium	Invest in IT capability to continuously defend system or contract with top security company.
2	System hack disables system	3	4	Medium	Invest in IT capability to continuously defend system or contract with top security company. Frequently back-up system
3	Fundamental shift from web/app based communication	2	4	Medium	Annual strategic planning to update system to incorporate technological trends
4	Scouting experiences reduced participation	1	3	Low	System functionality includes outreach to families to build interest in joining Scouting

12.0 Personal Reflection

The iterative nature of system engineering was evident in the course of investigating the subject of this report. The work began with the author's personal experience of shortcomings of the existing systems

and the potential for improvement. It was possible to generate initial expectations of an improved system. In thinking through details of the sequence diagrams for use cases for example, important capabilities became apparent that were added to the list of system capabilities that would be important to stakeholders. For this topic desirable capabilities were more readily generated than characteristics. Developing a QFD matrix helped lead to additional desired characteristics for the system that weren't initially apparent.