Sharik 1.0: User Needs and System Requirements for a Web-Based Tool to Support Collaborative Sensemaking

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Abstract

All-source analysts collaborate with each other on various information requirements. They receive different types of information from various collators, integrate and relate those information items to produce intelligence, and then share the new intelligence items with their peers. In this report, the authors describe Sharik (SHAring Resources, Information, and Knowledge), a web-based tool aimed at supporting collaborative sensemaking among all-source intelligence analysts in distributed command and control centers. The primary goal of this tool is to support analysts in producing, and more importantly sharing, new intelligence pieces with their teammates while retaining a high situational awareness of the intelligence production's status.

Significance to Defence and Security

Analysts are continuously dealing with larger amounts of information to review, analyse, and extract intelligence from. A wide range of solutions is proposed for tackling this information overload issue, including various analytic tools supporting analysts' analyses. On a different spectrum, another solution would be facilitating collaboration and sensemaking among teams of analysts working together on a common mission with the ultimate goal of improving efficiency and reducing redundancy in intelligence analysis activities. Hence, the tool described in this report was designed to support collaborative sensemaking among intelligence analysts.

This work is being carried out at Defence Research and Development Canada (DRDC) under project 05da: JICAC (Joint Intelligence Collection and Analysis Capability) within the Joint Force Development (JFD) S&T portfolio. The JICAC project is being run as a collaboration between DRDC's Valcartier and Toronto Research Centres, and aims at providing the Canadian Armed Forces (CAF) with tools, techniques, and advice for procurement to reduce the amount of time all-source intelligence analysts must search for information, and maximise the amount of time they can spend doing analysis.

Résumé

Les analystes toutes sources collaborent entre eux afin de répondre à divers besoins en matière d'information. Ils reçoivent et intègrent divers types d'information de différents compilateurs et établissent des liens entre les éléments d'information pour en obtenir du renseignement dont ils partageront ensuite les éléments avec leurs pairs. Dans ce rapport, les auteurs décrivent Sharik (SHAring Resources, Information and Knowledge, soit le partage des ressources, de l'information et des connaissances), un outil Web qui facilite le raisonnement collaboratif chez les analystes du renseignement toutes sources disséminés dans les centres de commandement et contrôle. L'objectif principal de cet outil est d'aider les analystes à produire, certes, mais surtout à partager de nouveaux éléments de renseignement avec leurs coéquipiers, tout en conservant une connaissance élevée de la situation quant à l'état de la production de renseignement.

Importance pour la défense et la sécurité

Le volume d'information que les analystes doivent examiner et analyser afin d'en extraire du renseignement augmente sans cesse. Par conséquent, il existe un vaste éventail de moyens de s'attaquer à ce problème de surabondance d'information, dont divers outils d'analyse. Or, il existe également un autre moyen qui permettrait de faciliter la collaboration et le raisonnement au sein d'équipes d'analystes travaillant ensemble dans le cadre d'une mission commune dont l'objectif ultime est d'améliorer l'efficacité et de réduire la redondance des activités d'analyse du renseignement. L'outil décrit dans ce rapport a été conçu afin d'appuyer le raisonnement collaboratif chez les analystes du renseignement.

Ce travail se déroule à Recherche et développement pour la défense Canada (RDDC) dans le cadre du projet 05da: JICAC (Collecte de renseignements interarmées et de capacité d'analyse) du portefeuille de S & T du Développement de la force interarmées (DFI). Les centres de recherches de Valcartier et de Toronto collaborent à ce projet qui vise à fournir aux Forces armées canadiennes (FAC) des outils, des techniques et des conseils en matière d'approvisionnement afin de réduire le temps que les analystes du renseignement toutes sources doivent passer à rechercher de l'information et de maximiser celui qu'ils peuvent consacrer à l'analyse.

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1 Introduction

In this report, we describe the user needs and system requirements for a software tool that is being developed as part of a larger project designed to develop new tools and techniques to support all-source intelligence analysts. The project, called the Joint Intelligence Collection and Analysis Capability (JICAC), is being run as a collaboration between DRDC's Valcartier and Toronto Research Centres, and aims to provide the Canadian Armed Forces (CAF) with tools, techniques, and advice for procurement to reduce the amount of time analysts must search for information, and maximise the amount of time they can spend doing analysis.

All-source analysts produce intelligence products by integrating information from multiple sources. During the scoping exercise for JICAC, subject-matter experts (SMEs) identified collaboration as an important aspect of the analysts' job that could be enhanced through the use of tools to support it. All-source analysts receive different types of information from collators or collection assets, and then integrate the information items to produce intelligence products.

Sharik is designed to support analysts working together on different aspects of an intelligence problem by providing them with a means by which intelligence production can happen effectively in a collaborative fashion. Specifically, the Sharik is designed to help analysts:

- effectively manage and integrate the information they receive from various sources;
- effectively manage and integrate the knowledge they share and collaboratively produce intelligence products;
- collaborate with their peers in an unobtrusive way; and,
- form and maintain a high level of situational awareness (Endsley, 1988) with respect to the current status of the intelligence mission to which they are contributing.

To develop Sharik, we conducted an initial requirements analysis. The results of this analysis are reported here. Fourteen major use cases were identified as a result of this analysis. These use cases formed the basis of the design and development of a mock-up prototype (See Annex A for samples of screenshots). This prototype helped the JICAC team build a shared understanding of what such a collaborative sensemaking tool was supposed to do and how much of a good fit it was to the complementary tools being developed at DRDC under JICAC.

The development of Sharik is still in progress. Additional requirements and use cases will be added and documented over the next design and development iterations. The purpose of this report is to describe the use cases built into the Sharik system to date.

2 Background

2.1 Requirements Gathering Method

To establish the requirements of the system, two categories of resources were reviewed:

- Reports of interviews with subject matter experts at Canadian Forces (Bandali et al., 2007; Derbentseva, McLellan, & Mandel, 2010).
- Past research and guidelines on individual and collaborative sensemaking in the context of Intelligence Analysis (Bier, Card, & Bodnar, 2008; Kang, Gorg, & Stasko, 2011; Kang & Stasko, 2012; Keel, 2007; Mahyar & Tory, 2014; Paul & Morris, 2009; Umapathy, 2010).

The review of these resources made the basis of the user goals and use cases defined for Sharik.

2.2 Intelligence Cycle (IC)

Intelligence is typically produced through a four stage process called the Intelligence Cycle (IC) (Bandali et al., 2007). The four stages are presented in Figure 1 and resonate with the sensemaking loop model proposed by Pirolli and Card (2005) (see Figure 2).

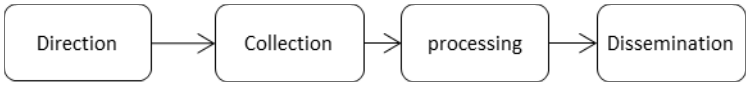

Figure 1: *The Intelligence Cycle (IC).*

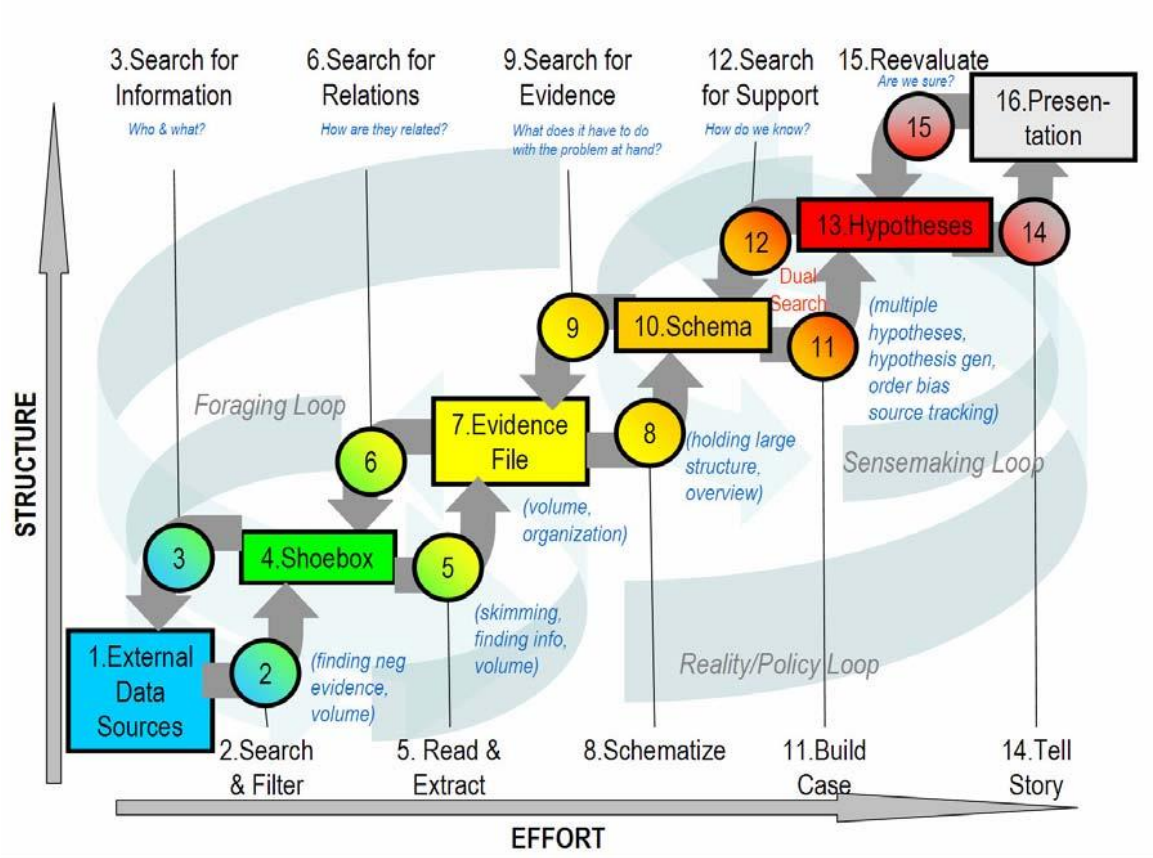

Figure 2: *Sensemaking loop for intelligence analysis [picture is extracted from (Pirolli & Card, 2005)].*

Direction: When an operation starts, the Commander communicates his or her information needs or requirements to staff. Within the CAF's intelligence community, the needs are referred to as the Commander's Critical Information Requirements (or **CCIR**s) which are decomposed to create a so-called, Intelligence Collection Plan (**ICP**). A group of analysts along with information officers will break down the CCIRs into Priority Intelligence Requirements (PIR)s. CCIRs and PIRs are standing requirements representing information that needs to be known for the entirety of the mission.

Many of the PIRs can be answered simply. For example, daily temperatures, towns in a region, or the coordinates of landmarks are types if information that can be easily found from various sources. Other PIRs however will require information to be searched, collected and processed into reports that provide answers and satisfy them. The Collection Coordination and Intelligence Requirements Management (CCIRM) section has the responsibility to manage and prioritise PIRs.

Collection: Once PIRs are identified, they will be broken down into individual items called Information Requirements (IRs).The IRs are assigned to analysts who address them by:
1) assigning the IRs to collators who will be able to look into existing databases or open-source data publicly available via the Internet, or 2) sending a Request for Information (RFI) to the CCIRM if collators were not able to find a satisfactory response.

Processing: The processing stage involves a high-level integration where IRs are processed and fused together to answer a PIR. The collected information might come from various intelligence disciplines (e.g., OSINT, HUMINT, SIGINT, etc.) and in different formats. The six sub-functions under processing include collation, evaluation, analysis, integration, interpretation, and confirmation (cf. Bandali et al., 2007). In general, the processing stages involve analysts identifying key entities, relationships, and patterns, eventually forming an overall picture. In the confirmation stage, analysts refute or confirm the conclusions or conjectures made in the previous steps.

Dissemination: Information or intelligence is disseminated in various formats such as verbally, in writing, graphically, or electronically. Regardless, it is recommended that it should be clearly stated whether the new intelligence being disseminated is fact or interpretation of the analyst.

2.3 Scope Definition

The online collaborative sensemaking tool described here is to support collaboration among all-source analysts. A number of analytic tools are likely to be integrated into this system in the future. However, the discussion of those tools is out of the scope of this document. The focus of this version of Sharik discussed here is to support the collection and processing stage of the intelligence cycle. Other stages of the cycle will eventually be supported in the future versions of Sharik.

2.4 Intended Users

All-source analysts are the intended primary users of this system. However, given their relationship with collators and the CCIRM, the latter two are likely to be users as well in the next versions of Sharik.

2.5 User Goals

A high-level breakdown of users' tasks was created based on the combination of Figures 1 and 2 and by incorporating the guidelines and findings reported in past literature on both individual and collaborative sensemaking. Figures 1 and 2 are merged in Figure 3 which shows the high level user goals for a collaborative sensemaking system. In Figures 5 and 6, these goals have been broken down into more fine-grained user goals. The user goals make the basis of the use cases which will be described in the following sections. The stages "Direction" and "Dissemination" are out of the scope of this version of Sharik.

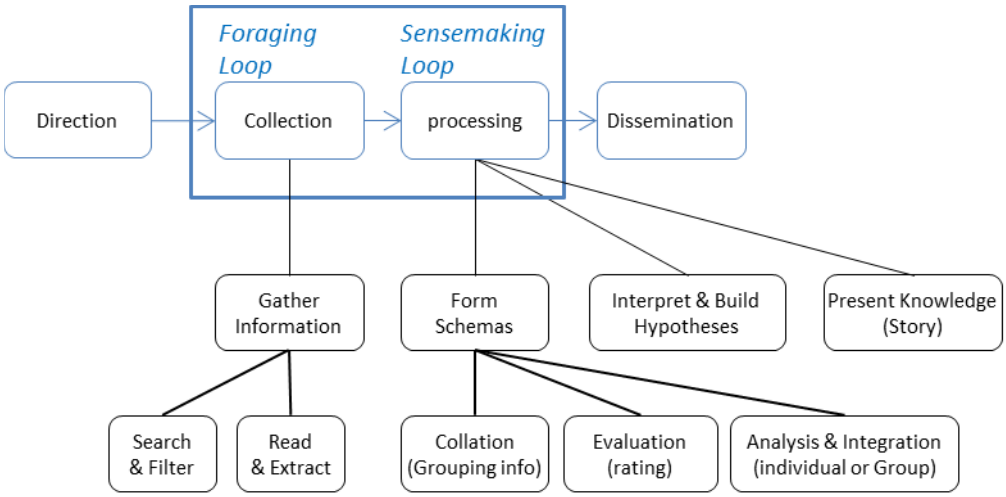

Figure 3: *Intelligence Cycle (IC)—CF procedures and Sensemaking loop combined.*

Online Collaborative Sensemaking: Task Analysis

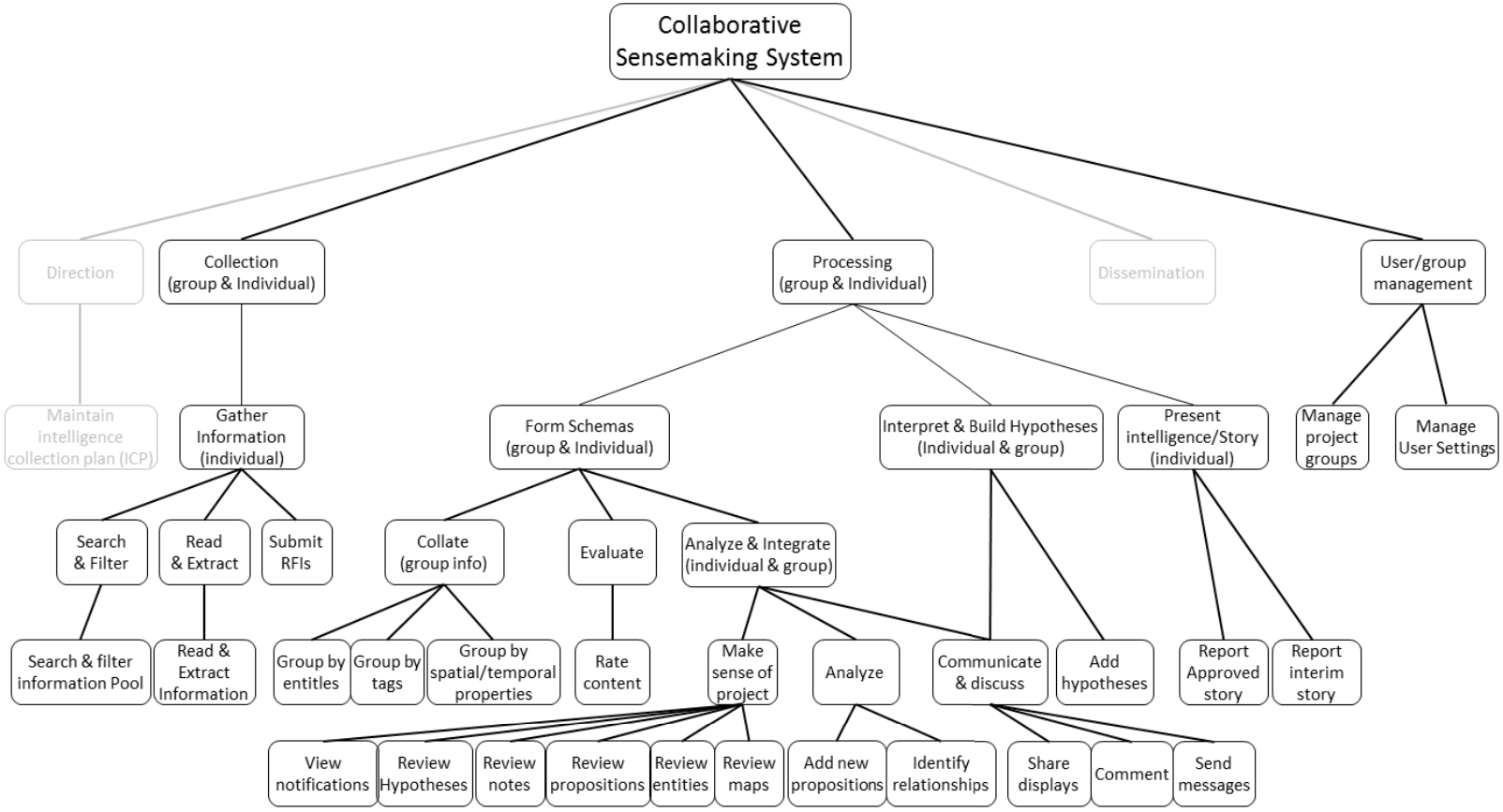

Figure 4: *Online Collaborative Sensemaking user goals breakdown for "Gathering Information", "Forming Schema", "Interpreting and Building Hypotheses", and "Presenting Intelligence".*

Online Collaborative Sensemaking: Task Analysis

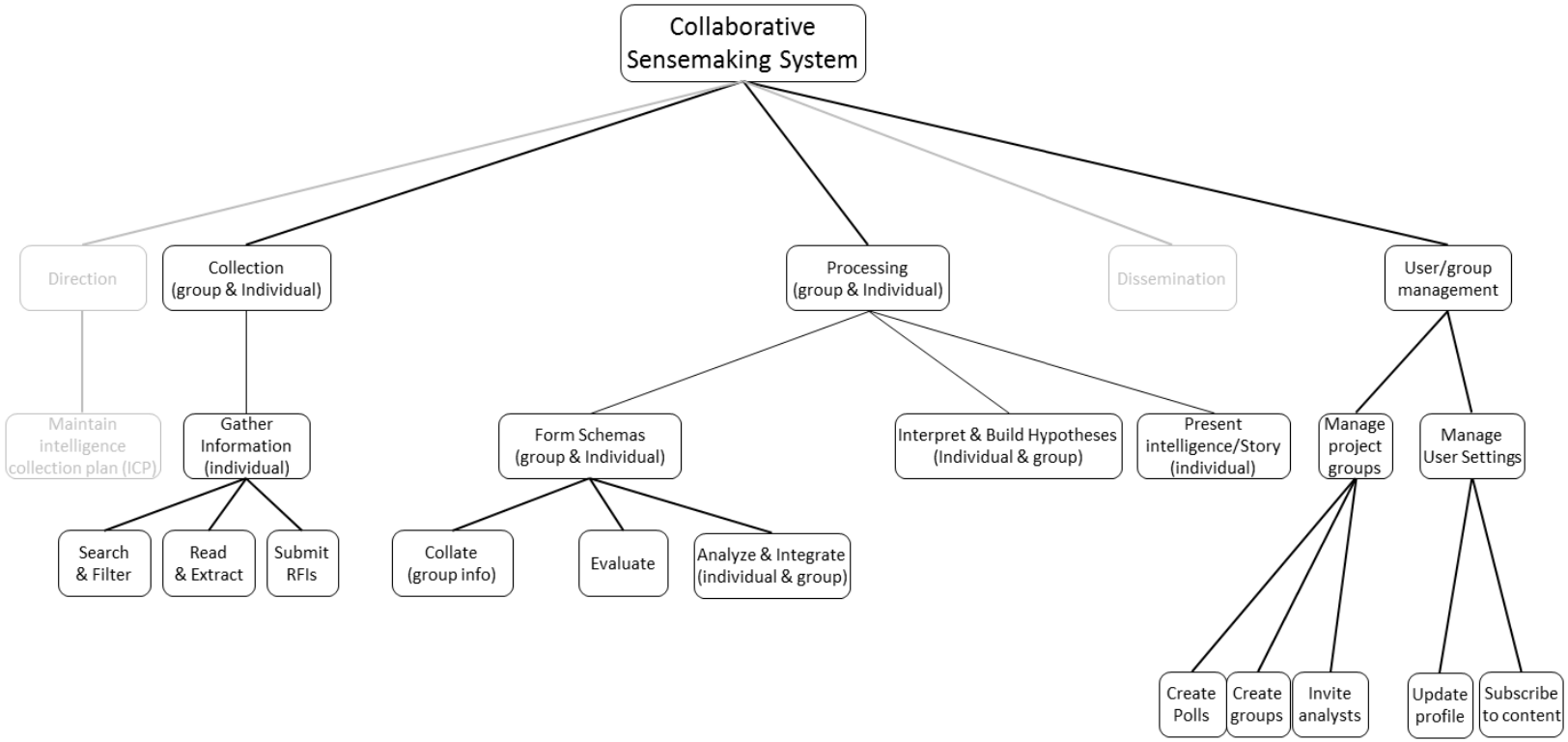

Figure 5: *Online Collaborative Sensemaking user goals breakdown for "User/Group Management".*

2.6 Definitions

2.6.1 Information Pool

We assume that there is a central repository where all the external content ever collected for an investigation are stored and could potentially be accessible by all analysts.

2.6.2 Project Space

Any intelligence analysis project has an "individual online" space where analysts would be able to store, review, and update the content that is related to that project. Any content submitted to the system should be associated with, or belong to, a specific project. In Sharik, each PIR is given a dedicated project space.

2.6.3 Stored Content Types

There are four different ways that content is stored and represented in Sharik: Notes, wikis, Propositions and Concept Maps. Some formats are created with content from other formats. Consider the chart in Figure 6. In this figure, the arrows indicate what kinds of content provide information to feed into other formats. For example, wikis are formed from information taken from notes and files provided to the analyst. As another example, Propositions form the basis of Concept Maps (Cmaps).

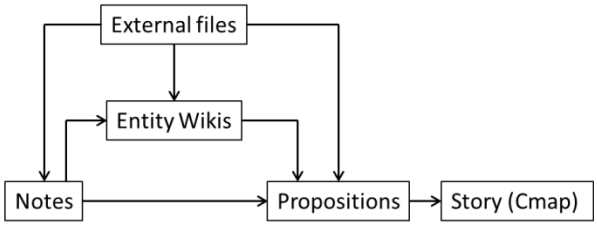

Figure 6: *Content types designed for intelligence analysis procedures and practices (arrows represent the flow of information).*

Notes: Notes are written/generated by analysts while searching the information pool or the inter/intranet. Analysts create notes to log details of people, locations, organizations, or anything considered relevant to a project or argument. Notes are generally expected to have supplementary files (e.g., documents, movies, pictures, etc.). In our view, notes should have evaluation ratings attached to them to describe aspects such as the reliability and credibility of the information contained within them. Ratings could be submitted following the criteria provided in the table below (Bandali et al., 2007):

Table 1: *Reliability and credibility ratings guideline.*

Reliability of the Source		**Credibility of the Information**	
A	Completely reliable	1	Confirmed by other sources
B	Usually reliable	2	Probably true
C	Fairly reliable	3	Possibly true
D	Not usually reliable	4	Doubtful
E	Unreliable	5	Improbable
F	Reliability cannot be judged	6	Not Credible

Entity wikis: Entities are the named concepts of interest in a project that are relevant to an investigation. For example, places, people, cities, groups, organizations, movements, and events are among the types of entities that could be central to an investigation.

Once data is collected about an entity, analysts may feel the need to *integrate* this data into an individual page or report. Sharik uses wikis for this purpose. Analysts have the option to create a wiki page for any concept/entity of the project. Whether or not the wiki feature is used depends on whether analysts have the luxury of time to record and elaborate on entities. The wiki feature may be most applicable to strategic analyses wherein there is not an immediate requirement for an answer to an RFI. In operational contexts, analysts may not have the time to create a wiki page for any of their entities.

Propositions (intelligence): While investigating entities and concepts of interest, a key task for analysts includes finding and describing the *relationships* between them. These relationships would be uncovered from information contained in notes, entity wikis, or new files received from collators. In Sharik, the analyst expresses and stores facts or hypotheses pertaining to an investigation in the form of a proposition. A proposition is a statement linking two concepts or entities and is expressed as a judgment that is either true or false (Kwantes, Derbentseva, 2015). For example, the statement *Jason Bourne met David Webb* is a proposition because it is either true or false. In our scheme, a proposition is expressed as a triple containing two concepts connected by a linking phrase.

We differentiate among three types of propositions: *facts*, *extracts*, and *conjectures*. *Extracts* represent factual statements that are supported by supplementary files or notes. *Facts* are statements that are considered to be true *without* supporting documentation. Finally, *conjectures* are propositions that could be true or false but are as yet, unknown. We presume that conjectures form the basis of the analysts' new RFIs. Once the requisite evidence supporting a conjecture is found, they may be able to change a conjecture to an extract.

Properties: Analysts may need to input additional details about a proposition such as a time or the place associated with an event (e.g., *Jason Bourne met David Webb in Toronto in Fall 2012*). Once a proposition is created, Sharik allows the user to add any number of arbitrarily created properties.

Conclusion: Conclusion is a special property associated with propositions. Conclusion propositions are facts or conjectures that represent the final findings of an investigation, or the conjectures that precipitated the investigation. For example, validating the proposition "*Jason Bourne works for David Webb*" might be the purpose for conducting an investigation. We identify

certain propositions as conclusions because, when they are rendered in visualization, we think that it is important that the user's attention be easily directed to propositions (i.e., facts or conjectures) that are central to the goals of the investigation.

Externalizing Propositions as Concept Maps: Propositions are the "intelligence pieces" that are put together to form a story. A concept map (Cmap, Novak, 1998) is a visual technique for laying out all the relationships among propositions as a graph visualization of interconnected nodes linked by linking phrases. Sharik uses a Cmap visualization technique to provide analysts with an overview of a project's knowns and unknowns (Derbentseva & Kwantes, 2015).

Spatial and Temporal maps: In addition to the graph-representation of propositions, where each proposition is represented as connected nodes, analysts may also choose to view propositions on geospatial or temporal maps. Although not implemented yet, this feature will be applied to those propositions containing location and date/time details.

3 Use Cases

Fourteen major use cases have been identified for the system (See Table 2). Priorities are assigned based on the order in which they will be implemented in this project. The descriptions of the use cases are provided in the following sections.

Table 2: *List of 14 use cases defined for Sharik.*

Use case name	Actor(s)	Priority
1. Search and filter information pool	"All-Source" analysts	Low
2. Read and extract information	"All-Source" analysts	High
3. Submit RFIs	"All-Source" analysts	High
4. Collate by entities	"All-Source" analysts	High
5. Collate by tags	"All-Source" analysts	Medium
6. Collate by maps	"All-Source" analysts	Low
7. Evaluate content	"All-Source" analysts	Medium
8. Make sense of project	"All-Source" analysts	High
9. Add propositions	"All-Source" analysts	High
10. Add hypotheses	"All-Source" analysts	Medium
11. Communicate and discuss	"All-Source" analysts	High
12. Present intelligence	"All-Source" analysts	Low
13. Manage group projects	"All-Source" analysts	Medium
14. Manage user settings	"All-Source" analysts	High

3.1 Search and Filter Information Pool

Use case Name: Search and filter information pool

Description: Users can search information pool by keywords or tags. The search task on external online resources is out of the scope of this project.

Actors: All-source intelligence analysts

Priority: Low

Pre-conditions: The Information Pool contains information pieces collected from all the projects at Canadian Forces.

Flow of Events:

Basic path:

1. The user chooses the option for searching the information pool.

2. The system displays the search criteria.

3. The user sets one or more of the search criteria to search the “Information Pool”.

4. The system returns the search results ordered by relevance.

5. The user browses through the list.

Alternative path:

5. If user prefers to order the list by date or a different criteria:

   5.1. The user chooses to order the list by criteria other than relevance.

   5.2. The system re-orders and returns the search results.

   5.3. The user browses through the list

Post-conditions: NA

Requirements:

- The system should provide users with various search criteria.
- The system should provide users with various sort criteria.
- The system should store all the information pieces in a central repository accessible through Information Pool.
- The system should provide users with access to the information pieces collected by the analysts of all CF projects including active and closed projects.

3.2 Read and Extract Information

Use case Name: Read and extract information

Description: This use case is related to the review of content available in:

1. Information Pool: Users can review information pieces available in *Information Pool* and add or update the relevant ones to the project’s space.

2. Open Source content: In additional to the information pool, users would also search the Internet for any relevant publicly available data.

3. Project’s space: Users also frequently review the currently existing content in the project’s space.

Often, when users review the project’s space, information pool, or the Internet they **create a note** (from scratch) on what they learn and add the note to the project’s space.

Actors: All-source intelligence analysts

Priority: High

Pre-conditions: The user has already searched and reviewed the central information pool (see use case "Search and Filter") or the project's space (see use case "make sense of project").

Flow of Events:

Basic path:

1. The user chooses to read a content piece existing in the Information pool, the Internet, or the project's space.

2. The system displays the content.

3. The user reviews the content.

4. The user closes the content.

Alternative path:

4. If the user wants to **create a note** on the project's space:

   4.1. The user reviews the content.

   4.2. The user creates a note to record what she/he learnt from the just reviewed content.

   4.3. The user adds a link to the file/source from which the note is extracted.

   4.4. The user sets the access level of the note (public or private).

   4.5. The system displays the note on the project's space.

Post-conditions: The projects' space contains the newly added evidence and/or note.

Requirements:

- The system should allow users to **create notes** on the projects' space.
- The system should allow users to add sources to their notes.
- The system should allow users to set access levels for their notes.
- The system should display all content items of a project under the project's space.

3.3 Submit RFI

Use case Name: Submit RFI

Description: Users submit request for information (RFI) forms to Collection Coordination & Intelligence Requirements Management (CCIRM) section to ask for information in cases

where what they are looking for are not located in the information pool nor the open-source content publicly available on the internet.

Actors: All-source intelligence analysts

Priority: High

Pre-conditions: The user was not able to satisfy her/his information need by reviewing the central information pool (see use case "Search and Filter"), the project's space (see use case "make sense of project"), or the internet.

Flow of Events:

Basic path:

1. The user chooses to send an RFI to CCIRM.
2. The system displays the RFI form.
3. The user fills in the form.
4. The user chooses to submit the form.
5. The system sends the RFI to CCIRM.

Post-conditions: The RFI is sent to CCIRM.

Requirements:

- The system should allow users to **submit RFIs** to CCIRM.
- The system should be able to connect to CCIRM.
- The system should allow users to link propositions to their RFIs.
- The system should keep an archive of pending and closed RFIs.

3.4 Collate by Entities

Use case Name: Collate by entities

Description: Users can group related items together by creating entities based on different content pieces. They create entities based on a group of content pieces that are all related to a same *entity* such as person, location, organization, etc. If the entity already exists in the system, users will supplement the existing entity with new information.

Actors: All-source intelligence analysts

Priority: High

Pre-conditions: The project's space contains at least one content piece.

Flow of Events:

Basic path:

1. The user chooses the option to create a new entity.
2. The user specifies entity properties.
3. The user chooses to add sources to the content of entity.
4. The system displays the project's content items.
5. The user selects the relevant content items.
6. The system displays links added to the entity.
7. The user chooses to add the entity to the project's entities list.
8. The system displays the new entity in project's entities list.

Alternative path:

1. If the entity already exists in the system:
    1.1. The user chooses to edit an entity.
    1.2. The system goes to Step 2.

Post-conditions: The new or updated entity is available in the project's entities list.

Requirements:

- The system should allow users to create entities.
- The system should allow users to edit entities.
- The system should provide users with a list of entity types.
- The system should have pre-defined entity properties.
- The system should allow users to define new properties for the entities.
- The system should allow users to add sources to entities.

3.5 Collate by Tags

Use case Name: Collate by tags

Description: Users can group related items by adding tags to them.

Actors: All-source intelligence analysts

Priority: Medium

Pre-conditions: The project's space contains at least one content piece and the user has already found the content to be tagged.

Flow of Events:

Basic path:

1. The user chooses to add tags to a content item.
2. The system displays a list of currently existing tags.
3. The user chooses tags from the tags list.
4. The system displays the new tags along with the previous tags assigned to the evidence.

Alternative path:

3. If the user does not find a proper tag in the tags list:

    3.1. The user adds new tags to the evidence.

    3.2. The system returns to Step 4.

Post-conditions: The content piece has new tags.

Requirements:

- The system should allow users to assign tags (new or existing) to evidence items.
- The system should provide users with a list of tags already existing in the system.

3.6 Collate by Maps

Use case Name: Collate by maps

Description: Users can view content items on spatial and/or temporal maps.

Actors: All-source intelligence analysts

Priority: Low

Pre-conditions: There is at least one content piece that has a valid spatial or temporal property.

Flow of Events:

Basic path:

1. The user chooses to view the temporal or geospatial maps of the content.

2. The system displays the temporal/geospatial map of the project's content.

3. The user reviews the map.

Post-conditions: NA

Requirements:

- The system should allow users to assign temporal and geospatial properties to content items.
- The system should display a temporal/geospatial map view of all the items.

3.7 Evaluate Content

Use case Name: Evaluate content

Description: When the user adds a new content item to the project's space, he/she will have to rate that item based on the credibility of its content and the reliability of its source.

Actors: All-source intelligence analysts

Priority: Medium

Pre-conditions: The user has already added a content item to the project and found the item in the project's space.

Flow of Events:

Basic path:

1. The user chooses to rate the item.

2. The system will display the rating options.

3. The user will assign a rating to the item.

Post-conditions: The item has a rating for the reliability of its source and the credibility of its information.

Requirements:

- The system should allow users to submit ratings to content based on CF standards.

3.8 Make Sense of Project

Use case Name: Make sense of project

Description: To produce new intelligence, users would have to first gain a clear understanding of what has been recorded in the project. This will be an iterative process and includes the review of project's space, recent activities, entities, propositions, maps, and notifications. For this use case, it is assumed that users review all these items at once. However, this might not be the case in the real setting.

All users of the collaborative system have an account containing their profile information. Users can view the notifications of the system via their account. Notifications could include group invitations; screen sharing invitation; new emails and messages; new comments or updates on content created, commented, or subscribed to. Users are able to subscribe to the content created by other users in order to receive notifications on any further updates on that content.

Actors: All-source intelligence analysts

Priority: High

Pre-conditions: The project already has the items to be reviewed.

Flow of Events:

Basic Path 1:

1. The user logs in to the system.
2. The system displays the new notifications.
3. The user reviews the notifications.
4. The user selects to view a notification item.
5. The system directs the user to where the notification points to (i.e., the corresponding comment, group invitation, shared display, email, or message).
6. The user reviews the new comment, accepts/denies the group/display invitation, or reads the new email/message.

Basic Path 2:

1. The user browses through project's space.
2. The user chooses to **search for content** in the project's evidence.
3. The system displays the search criteria.
4. The user sets one or more of the search fields to search the project's space.

5. The system returns the search results.

6. The user sets the sort criteria.

7. The user browses through the list.

Basic Path 3:

1. The user chooses to view **Propositions**.

2. The user specifies whether she/he wants to see propositions created by all project members or certain members.

3. The system displays the propositions list.

4. The user browses through propositions list.

Basic Path 4:

1. The user chooses to view **entities**.

2. The system displays the list of entities.

3. The user browses through entities list.

Basic Path 5:

1. The user chooses to view the **propositions' concept map**.

2. The user specifies whether she/he wants to see the content created by all project members or certain members.

3. The system displays the project's concept map.

4. The user reviews the map.

Basic Path 6:

1. The user chooses to view the project's **hypotheses**.

2. The user specifies whether she/he wants to see hypotheses created by all project members or certain members.

3. The system displays the project's hypotheses.

4. The user reviews the hypotheses list.

Post-conditions: NA

Requirements:

- The system should allow users to view notifications.
- The notifications should provide a link to the corresponding invitation, comment, email, or message.
- The system should provide users with various search criteria.
- The system should provide users with various sort criteria.
- The system should store all the content pieces in a central repository.
- The system should provide users (i.e., project members) with access to the content of the project.
- The system should provide users with a chronological log (timeline) of **recent activities**.
- The system should present **propositions** list.
- The system should provide users with a **concept map** created from propositions.
- The system should display a list of **entities**.
- The system should display a list of **hypotheses**.
- The system should allow users to filter propositions based on their initiators.
- The system should provide users with a log of notifications.
- The system should highlight the new notifications since user's last log-in time.

3.9 Add Propositions

Use case Name: Add propositions

Description: To produce new intelligence, users may feel the need to link different pieces of evidence or intelligence together.

Actors: All-source intelligence analysts

Priority: High

Pre-conditions: The user has identified a new relationship between entities/concepts.

Flow of Events:

Basic path:

1. The user chooses to add new propositions.
2. The user specifies the two concepts or entities to be linked.
3. The user specifies the type of the relationship linking the two items (i.e., the linking words).

4. The user specifies the properties of the new proposition.

5. The system confirms the addition of the new proposition.

6. The system shows the updated propositions list with propositions from all project members.

Alternative path:

4. If the user wants to add a source to the proposition link or entities:

   4.1. The user adds sources to the propositions.

   4.2. The system confirms the addition of the new proposition.

   4.3. The system returns to Step 5.

Post-conditions: The new proposition is added to the list of propositions.

Requirements:

- The system should allow users to add new propositions.
- The system should allow users to add properties to the propositions.
- The system should allow users to add sources to the propositions.

3.10 Add Hypotheses

Use case Name: Add hypotheses

Description: Users can add hypotheses to the project's space.

Actors: All-course intelligence analysts

Priority: Medium

Pre-conditions: NA

Flow of Events:

Basic path:

1. The user chooses to add a hypothesis to the project.

2. The user specifies the two concepts or entities to be linked.

3. The user specifies the type of the relationship linking the two items (i.e., the linking words).

4. The user specifies the properties of the new hypothesis.

5. The system displays the updated list of hypotheses.

6. The user reviews the hypotheses list.

Alternative path:

4. If the user wants to add a source to the hypothesis:

    4.1. The user adds sources to the hypothesis.

    4.2. The system confirms the addition of the new hypothesis.

    4.3. The system displays the updated list of hypotheses.

    4.4. The system returns to Step 5.

Post-conditions: The new hypothesis is added to the list of hypotheses.

Requirements:

- The system should allow users to add hypotheses to the project's space.
- The system should allow users to add sources to their hypotheses.

3.11 Communicate and Discuss

Use case Name: Communicate and discuss

Description: Group members need to be constantly in contact with each other to discuss the content of the project. To achieve this goal, users can comment on the project's content (i.e., notes, entities, propositions, Cmaps, maps, and hypotheses), send messages to each other, share their displays, or participate in votes.

Actors: All-source intelligence analysts

Priority: High

Pre-conditions: The list of the project members is available to the user.

Flow of Events:

Basic Path 1:

1. The user chooses to post a **comment** under a content piece.

2. The user enters the comment.

3. The system notifies teammates who have had an interaction with the content piece in the past (i.e., created or commented on the piece).

4. The system displays the comment underneath the content.

Basic Path 2:

1. The user chooses to send a **message** to a teammate.
2. The user chooses the teammate(s).
3. The user enters the message.
4. The system notifies the teammate and sends the message to the teammate.
5. The system displays the reply.

Basic Path 3:

1. The user chooses to share her/his **display** with one or more teammates.
2. The user chooses the teammate(s).
3. The system notifies the designated teammates to view the user's displays.
4. The teammates accept or deny the view access.

Basic Path 4:

1. The user chooses to participate in a **poll**.
2. The user submits her/his vote.
3. The system displays the updated poll results.

Post-conditions: The comment is available to view for all project members. The teammate is notified of the new message. The teammates can view the screen of the user. The poll result is updated.

Requirements:

- The system should allow users to comment on notes, entities, propositions, and hypotheses.
- The system should allow users to send messages to one another.
- The system should allow users to share their displays.
- The system should allow users to participate in polls.
- When a new comments is added to a content piece, the system should notify the teammates who had created, commented, or subscribed to that content piece.
- The system should notify users of the new messages sent to them.
- The system should notify users of the shared display requests.

3.12 Present Intelligence

Use case Name: Present intelligence

Description: Analysts need to brief their commander on a regular basis during and at the end of an investigation. Within this use case users will be able to create automatic reports or presentations on the status of the project. The reports and presentations will be built based on the existing project notes, propositions, and maps.

Actors: All-source intelligence analysts

Priority: Low

Pre-conditions: The project's space contains content.

Flow of Events:

Basic path:

1. The user chooses to create a report/presentation from the project's content space.
2. The user specifies the settings.
3. The system will automatically generate the report/presentation and make it available to the user.

Post-conditions: The user will receive an automatically generated report/presentation.

Requirements:

- The system should create automatic reports/presentations using the project's content.
- The system should allow users to change the settings of the report/presentation.

3.13 Manage Project Groups

Use case Name: Manage project groups

Description: One of the group members are designated as the leader of the project with additional duties that are listed under this use case: 1) creating a group, 2) adding the CCIRs to the project space, 3) inviting analysts to the group, 4) creating polls.

Actors: Project leader who is an all-source agent her/himself

Priority: Medium

Pre-conditions: The Commander's Critical Information Requirements (CCIRs) has been produced by the Commander and released to the group leader. A list of currently available

analysts is available to be viewed by the group leader. All analysts have a profile listing their skills and capabilities.

Flow of Events:

Basic Path 1:

1. The user chooses to create a **new project** group.
2. The user specifies the name of the group.
3. The user adds the CCIRs to the project's space.
4. The user chooses to add/invite members to the group.
5. The system provides the user with a list of analysts.
6. The user browses through the profiles of the analysts.
7. The user selects the analysts.
8. The system notifies the selected analysts of the invitation.

Basic Path 2:

1. The user chooses to **create a poll** for the group.
2. The user specifies the poll questions.
3. The user specifies the voting options.
4. The user chooses to publish the poll.
5. The system displays the poll on the project's space.

Post-conditions: All the invited analysts receive the invitation notification. The project's space contains the CCIRs. The poll is posted on the project's space.

Requirements:

- The system should allow users to create groups.
- The system should allow users to invite analysts to groups.
- The system should allow users to add CCIRs to the project's space.
- The system should provide the group's leader with a list of analysts.
- The system should send a notification to users who are invited to a group.
- The system should display the polls on the project's space.

3.14 Manage User Settings

Use case Name: Manage user settings

Description: All users of the collaborative system have an account containing their profile information. Users can view the notifications of the system via their account. Notifications include group invitations; screen sharing invitation; new emails and messages; new comments or updates on content created, commented, or subscribed to. Users are able to subscribe to the content created by other users in order to receive notifications on any further updates on that content.

Actors: All-source analysts

Priority: Low

Pre-conditions: The user has already created an account. The new notifications are highlighted.

Flow of Events:

Basic Path 1:

1. The user chooses to update his profile.
2. The user edits the profile properties.
3. The system displays the updated profile.

Basic Path 2:

1. The user subscribes to a proposition of interest.
2. The system notifies user of any further updates to that proposition.
3. The system displays the updated profile.

Post-conditions: Once user reviews the new notifications, the notifications will no longer be highlighted.

Requirements:

- The system should allow users to subscribe to content created by other users.
- The system should allow users to update their profiles.

4 System Requirements

The system requirements are divided into three categories: functional requirements, data requirements, and non-functional requirements (Environmental, user characteristics, usability goals, and user experience goals) (Rogers, Sharp, & Preece, 2011).

4.1 Functional Requirements

The functional requirements of the system are prioritized based on the urgency of implementing them into the system.

High Priority

- The system should allow users to **create notes** on the projects' space.
- The system should allow users to add sources to their notes.
- The system should allow users to set access levels for their notes.
- The system should display all content items of a project under the project's space.
- The system should allow users to **submit RFIs** to CCIRM.
- The system should be able to connect to CCIRM.
- The system should allow users to link propositions to their RFIs.
- The system should keep an archive of pending and closed RFIs.
- The system should allow users to create entities.
- The system should allow users to edit entities.
- The system should provide users with a list of entity types.
- The system should have pre-defined entity properties.
- The system should allow users to define new properties for the entities.
- The system should allow users to add sources to entities.
- The system should allow users to view notifications.
- The notifications should provide a link to the corresponding invitation, comment, email, or message.
- The system should provide users with various search criteria.
- The system should provide users with various sort criteria.
- The system should provide users (i.e., project members) with access to the content of the project.
- The system should provide users with a chronological log (timeline) of **recent activities**.
- The system should present **propositions** list.
- The system should provide users with a **concept map** created from propositions.

- The system should display a list of **entities**.
- The system should display a list of **hypotheses**.
- The system should allow users to filter propositions based on their initiators.
- The system should provide users with a log of notifications.
- The system should highlight the new notifications since user's last log-in time.
- The system should allow users to add new propositions.
- The system should allow users to add properties to the propositions.
- The system should allow users to add sources to the propositions.
- The system should allow users to comment on notes, entities, propositions, and hypotheses.
- The system should allow users to send messages to one another.
- The system should allow users to share their displays.
- The system should allow users to participate in polls generated by the project leader.
- When a new comments is added to a content piece, the system should notify the teammates who had created, commented, or subscribed to that content piece.
- The system should notify users of the new messages sent to them.
- The system should notify users of the share display requests.

Medium Priority

- The system should allow users to assign tags (new or existing) to evidence items.
- The system should provide users with a list of tags already existing in the system.
- The system should allow users to submit ratings to all types of evidence based on CF standards.
- The system should allow users to add hypotheses to the project's space.
- The system should allow users to add sources to their hypotheses.
- The system should allow users to create groups.
- The system should allow users to invite analysts to groups.
- The system should allow users to add CCIRs to the project's space.
- The system should provide the group's leader with a list of analysts.
- The system should send a notification to users who are invited to a group.
- The system should display the polls on the project's space.

Low Priority

- The system should provide users with various search.
- The system should provide users with various sort.

- The system should provide users with access to the information pieces collected by the analysts of all CF projects including active and closed projects.
- The system should allow users to assign temporal and geospatial properties to content items.
- The system should display a temporal/geospatial map view of all the items.
- The system should create automatic reports/presentations using the project's content.
- The system should allow users to change the settings of the report/presentation.
- The system should allow users to subscribe to content created by other users.
- The system should allow users to update their profiles.

4.2 Data Requirements

- The system should store all the information pieces in a central repository accessible through Information Pool.
- The evidence pieces related to different projects are accessible from any other CF intelligence projects through the Information Pool.
- The system should support a wide range of file types.
- The system should always present the date, author (where applicable), and rating of each content item.

4.3 Non-Functional Requirements

- The users of the system are expected to be trained for using CMaps and other analytical tools.
- The users of the system are expert users.
- Each user might be involved in multiple projects at the same time.
- It is expected that users would use this system constantly when working on intelligence analysis projects.
- The system should be easy to use and learn.
- The user interface design should be user-friendly and easy to use.
- The user interface should help the user to focus on the key tasks, free of any unnecessary disruptions.
- The notifications should not disrupt the user's primary tasks.
- The UI should look serious.

5 Conclusion

A web-based collaborative sensemaking system is proposed to support the user tasks involved in the Intelligence Cycle of Canadian Forces. Past interview reports with all-source intelligence analysts were consulted to establish the design requirements. Besides, past research on collaborative sensemaking and intelligence analysis tools were reviewed. Fourteen major use cases were identified and the design requirements were reported in 3 categories of functional, data, and non-functional requirements.

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Annex A Screenshots from the Mock-up Prototype

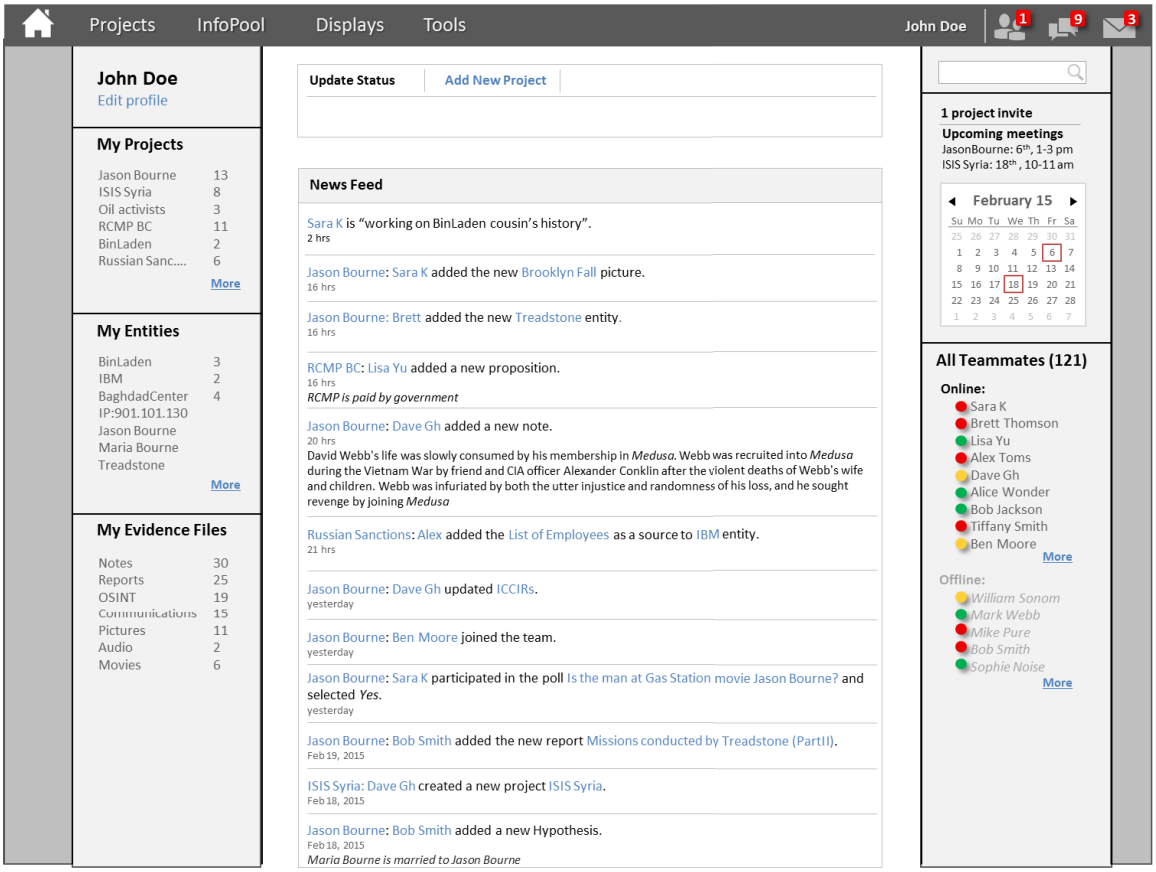

Figure A.1: *Home page.*

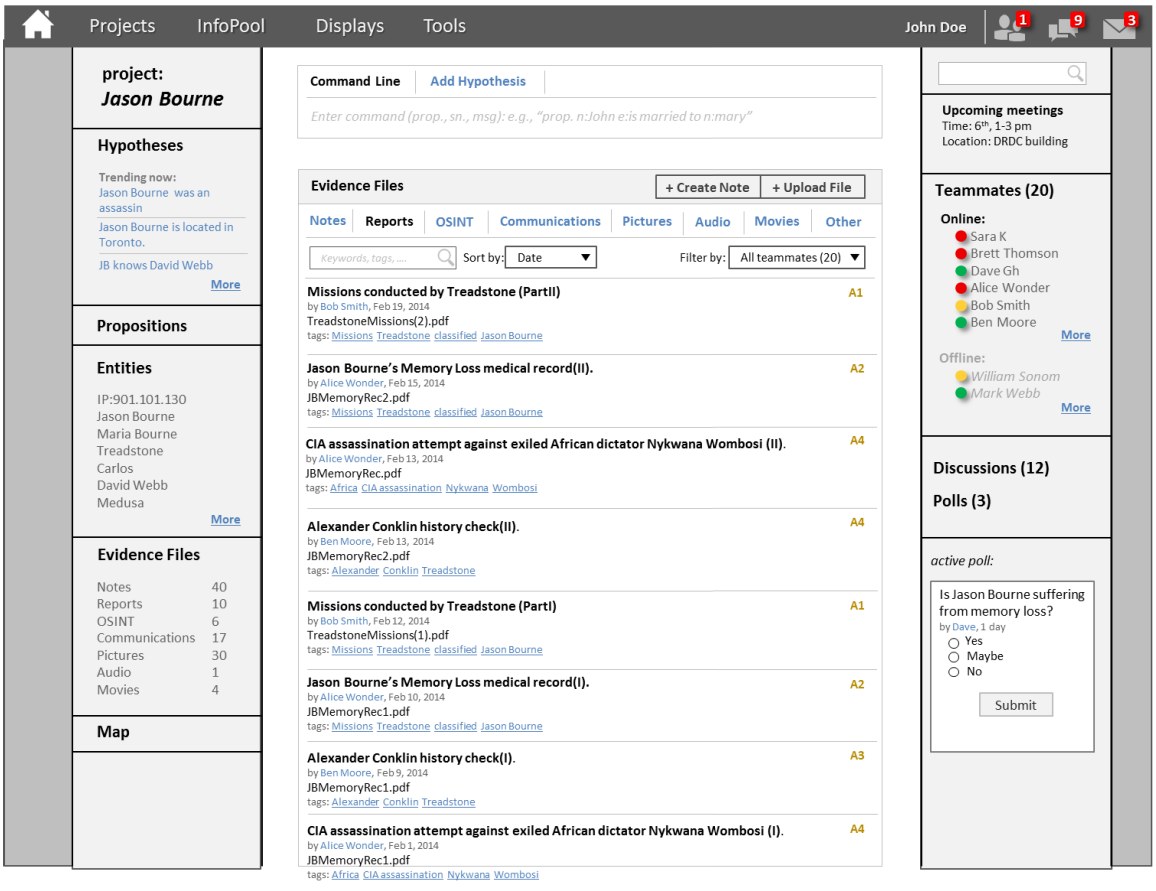

Figure A.2: *"Jason Bourne" project space.*

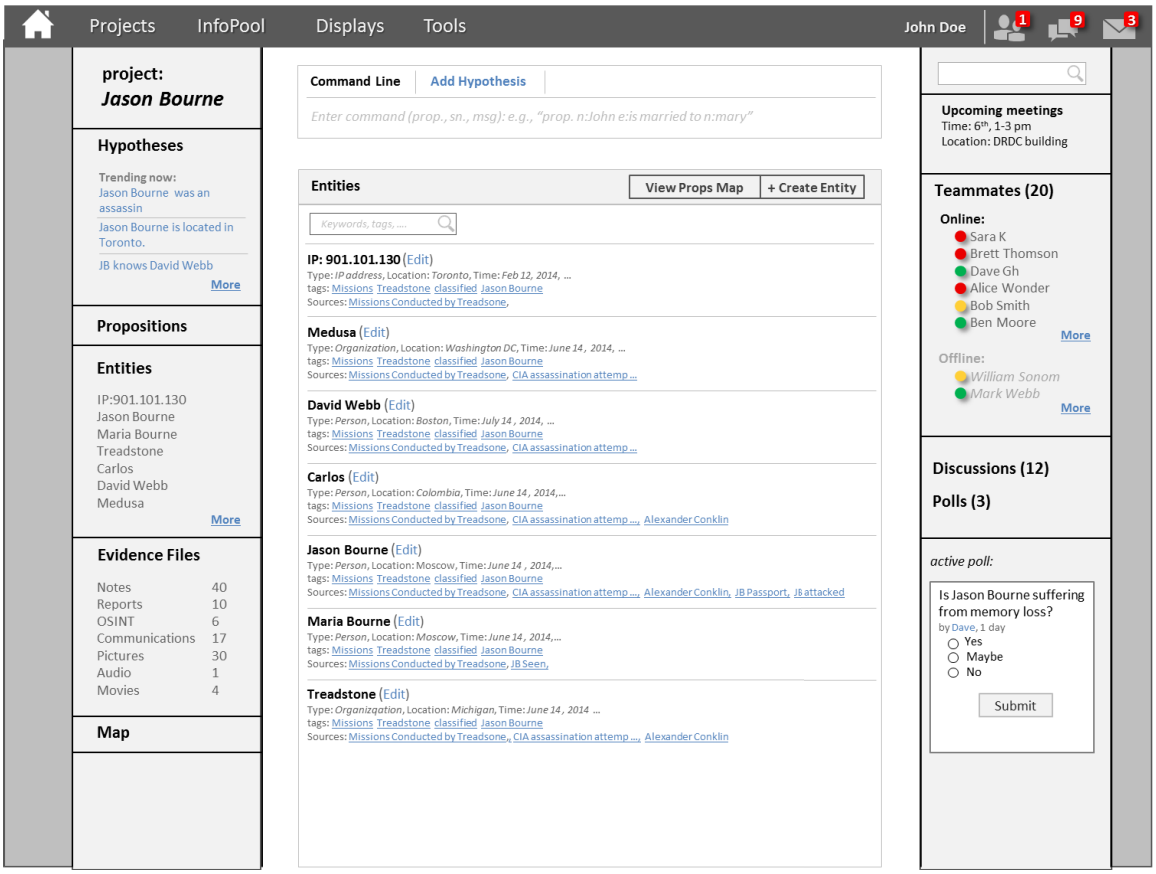

Figure A.3: *Entities under "Jason Bourne" project space.*

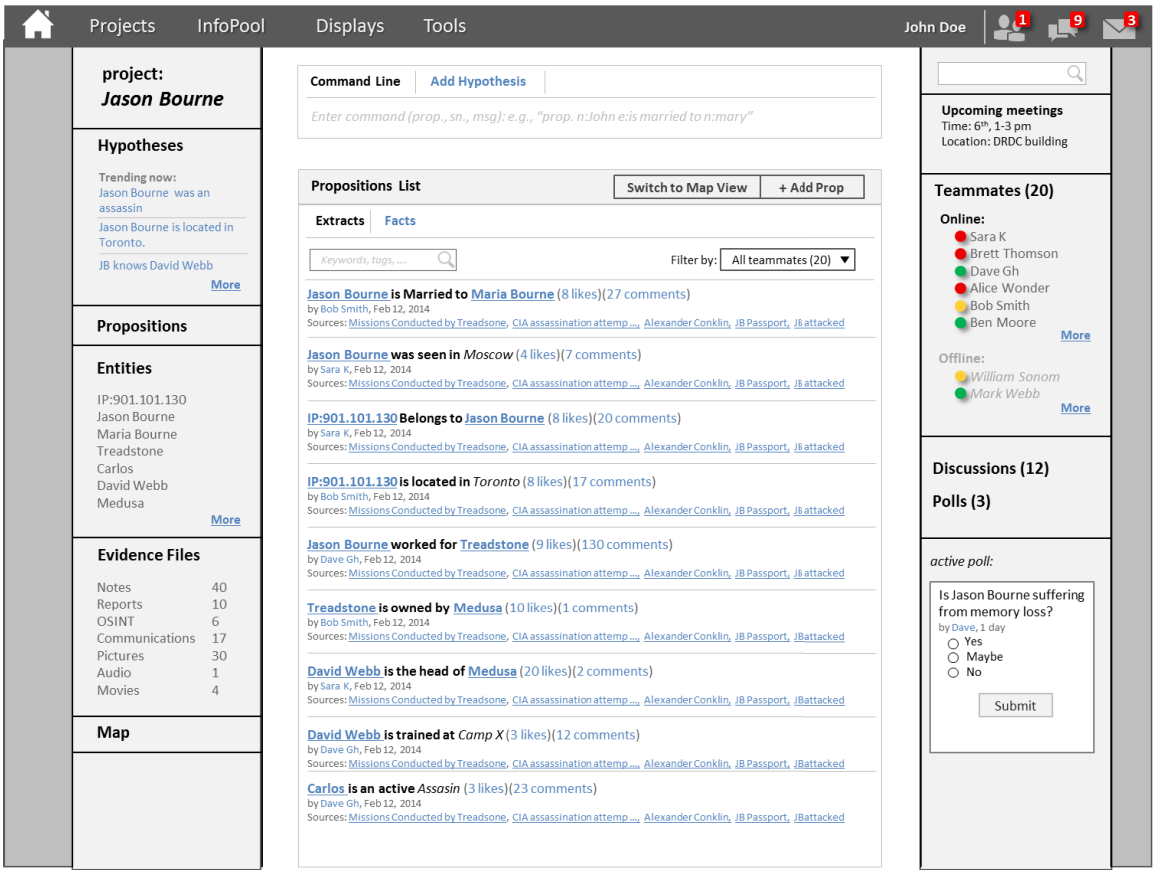

Figure A.4: *Propositions under "Jason Bourne" project space.*

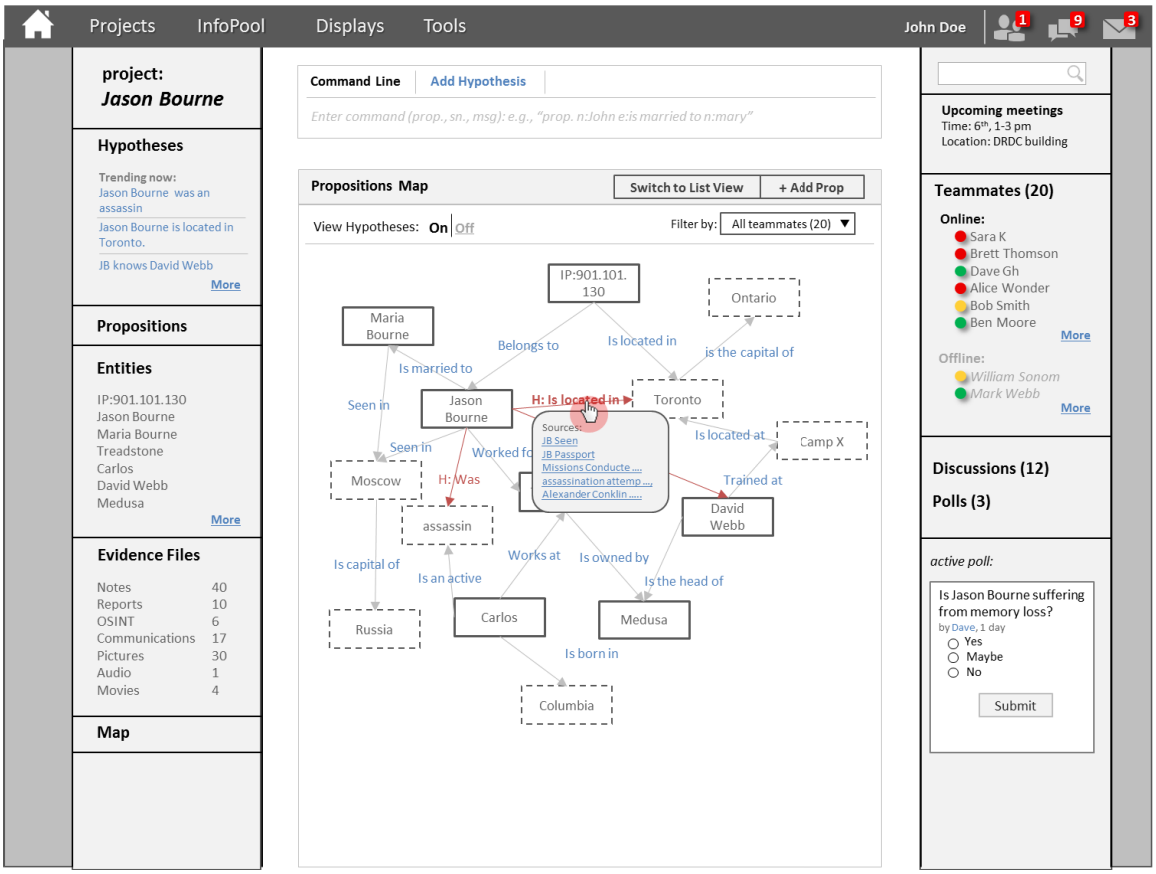

Figure A.5: *Cmap of propositions under "Jason Bourne" project space.*

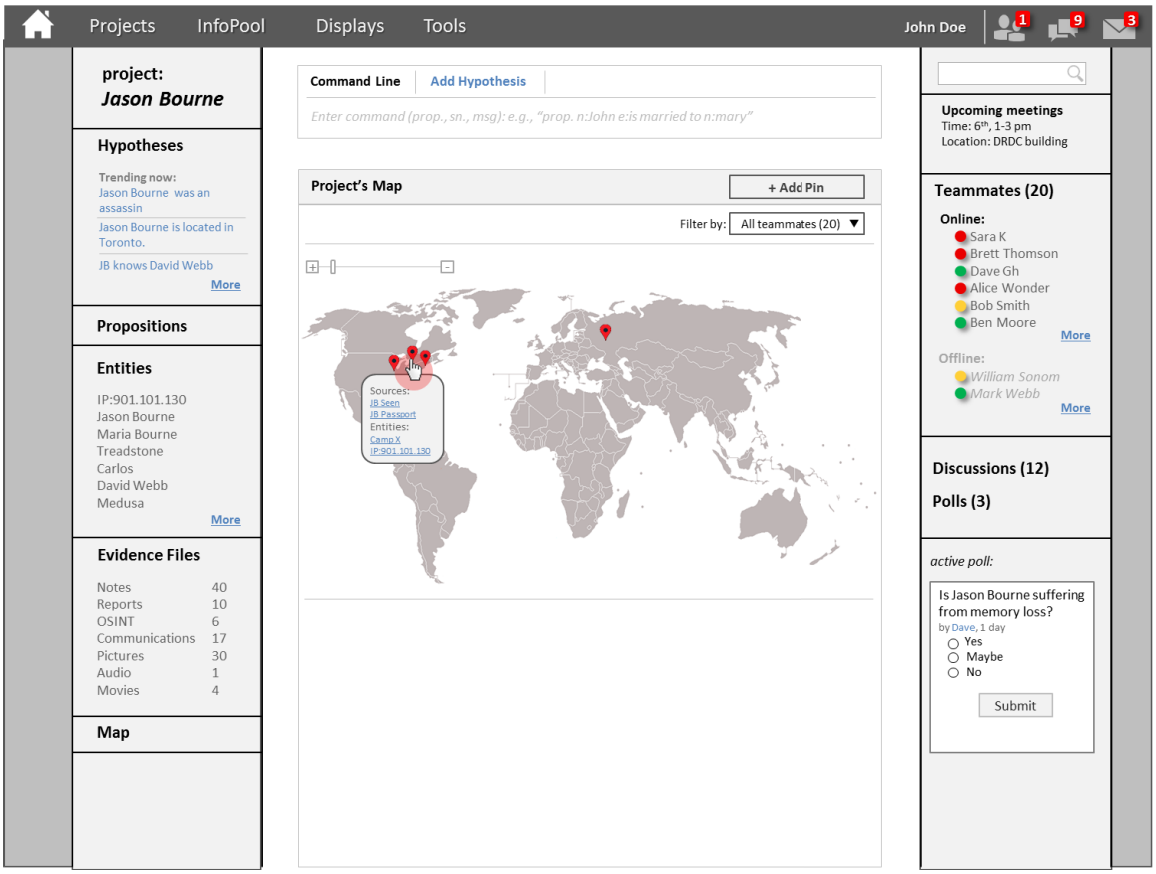

Figure A.6: *Geospatial map of entities under "Jason Bourne" project space.*

List of Symbols/Abbreviations/Acronyms/Initialisms

CAF	Canadian Armed Forces
CCIR	Commander's Critical Information Requirements
CCIRM	Collection Coordination and Intelligence Requirements Management
CF	Canadian Forces
Cmap	Concept Map
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DSTKIM	Director Science and Technology Knowledge and Information Management
HUMINT	Human Intelligence
IC	Intelligence Cycle
ICP	Intelligence Collection Plan
IR	Information Requirement
JICAC	Joint Intelligence Collection and Analysis Capability
OSINT	Open Source Intelligence
PIR	Priority Intelligence Requirement
RFI	Request for Information
Sharik	SHAring Resources, Information, and Knowledge
SIGINT	Signal Intelligence
SME	Subject Matter Expert

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All-source analysts collaborate with each other on various information requirements. They receive different types of information from various collators, integrate and relate those information items to produce intelligence, and then share the new intelligence items with their peers. In this report, the authors describe Sharik (SHAring Resources, Information, and Knowledge), a web-based tool aimed at supporting collaborative sensemaking among all-source intelligence analysts in distributed command and control centers. The primary goal of this tool is to support analysts in producing, and more importantly sharing, new intelligence pieces with their teammates while retaining a high situational awareness of the intelligence production's status.

Les analystes toutes sources collaborent entre eux afin de répondre à divers besoins en matière d'information. Ils reçoivent et intègrent divers types d'information de différents compilateurs et établissent des liens entre les éléments d'information pour en obtenir du renseignement dont ils partageront ensuite les éléments avec leurs pairs. Dans ce rapport, les auteurs décrivent Sharik (SHAring Resources, Information and Knowledge, soit le partage des ressources, de l'information et des connaissances), un outil Web qui facilite le raisonnement collaboratif chez les analystes du renseignement toutes sources disséminés dans les centres de commandement et contrôle. L'objectif principal de cet outil est d'aider les analystes à produire, certes, mais surtout à partager de nouveaux éléments de renseignement avec leurs coéquipiers, tout en conservant une connaissance élevée de la situation quant à l'état de la production de renseignement.

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Collaborative Sensemaking tool; user needs; system requirements