Functional Requirements and Technology Blueprint

Community Based Surveillance

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Introduction

This document defines the high-level requirements for Community Based Surveillance (CBS). The document describes requirements gathered through workshops and meetings with the following stakeholders:

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The document can be used as the basis for the following activities:

- Onboarding of new developers
- Creating solution designs
- Developing test plans, test scripts, and test cases
- Determining project completion
- Assessing project success

CBS project introduction

[Project introduction - To come]

High-level requirements

High-level functional requirements

The CBS system should be an integrated and active part of CBS projects through interaction with stakeholders and a robust data collection strategy that lays the foundation for analysis, usage and reporting of the ingested data. More specifically, the CBS system shall support the following requirements:

- Enable better decision making by providing situational intelligence of all ongoing activities, trends and events in areas of interest.
- Quality assure CBS projects through standardisation and integrated quality assurance of content
- Engage and keep stakeholders informed through a number of event-triggered, scheduled and manually triggered feedback loops by SMS.
- Streamline response and data collection with system supported workflows in the event of alerts.
- Report historic and ongoing events and trends shareable with health authorities and other relevant third parties.
- Provide modernized and user-friendly interfaces for data collection and configuration.
- Develop an extensible and future-proof platform.

User role descriptions

Any user of the CBS system must be assigned a user role. The user role determines what permissions the user has, and what user information is required. The following user roles are defined in the system:

- **Data collector**
    - Technically not a user of the system (but may become redefined a user when application-based data collection is enabled)
    - The data collector cannot log into the platform and does not require such credentials
    - The data collectors have received training and are supported by their supervisors to undertake their tasks as data collector for CBS.
    - Their function in the CBS system is to to send SMS reports
    - Profile: The data collector is a local Red Cross/Red Crescent Volunteer. He/she lives in a community in a rural area, is trusted in their community and is trained to detect health risks and provide first. They might seek out the people themselves or the community might contact them for support. The community has provided consent for the data collector to report health risks they may observe. The data collector could be educated or uneducated and may be illiterate.

- **Data verifier**
    - The data verifier is responsible for reviewing and verifying aggregated data from data collectors in their area.

    - Data verifiers are responsible to train, support and supervise a subset of data collectors, typically within a geographical area.
    - If SMS reports from a data collector(s) exceed the set threshold for a health risk, the data verifier will receive an alert, and must assess the situation; support the data collector; and decide whether the alert should be escalated.
    - Profile: the data verifier lives in a city or small town and has some education, and a background in health. The data verifier is a a volunteer or a Red Cross/Red Crescent staff member, or for another agency affiliated with the Red Cross (e.g. ministry of health or another NGO). They might have the responsibility of about 10-50 data collectors, and will not know all of them personally. The Data Verifier may be multilingual and therefore might translate between the data collector and data owner, where local language is different from that spoken in the NS head office.
    - There can be up to three levels of data verifiers in a national society data repository. A level 1 data verifier can escalate an alert to a level 2 data verifier and so on. All levels of data verifiers will be assigned the same role (data verifier) in the system, but the hierarchy (who reports to who) is defined in the system.

- **Data owner**
    - The data owner holds the overall responsibility for the data: in that, which data is collected by whom and for what purpose, and how the data is stored, managed, analysed and shared.
    - The data owner will define CBS reporting and sharing with data consumers, through defining and saving filters etc.
    - The data owner can request the Content Administrator to add the NS language to the system.
    - Profile: The Data Owner is employed at the National Society Head Office, is educated with some health background. The Data owner is a national citizen of the project country. The data owner is responsible for the project implementation, coordination with other stakeholders. Multilingual.

- **Data consumer**
    - The data consumer receives the CBS reports defined by the data owner for purposes of coordination and decision making (response).
    - The data consumer has read but not write access, and has limited access to non-sensitive data.
    - Examples of data consumers are; Agencies that get reports, National Ministry of Health, World Health Organisation, Centers for Disease Control and Prevention and Red Cross Staff (without a role in the project).

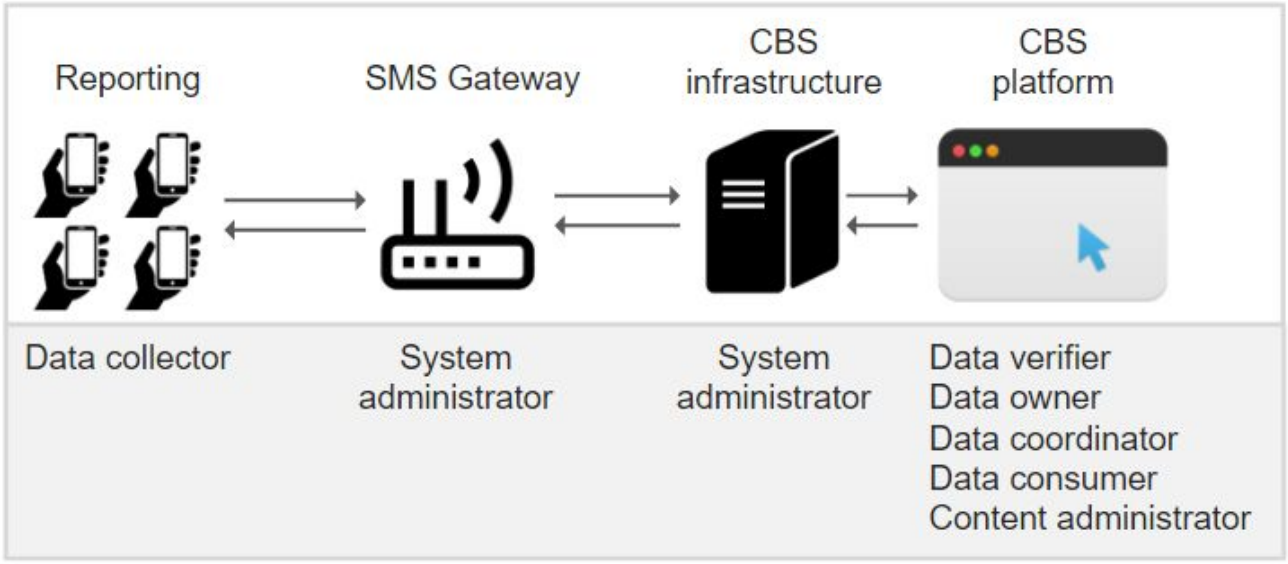
- **Data coordinator**
    - The data coordinator holds the same access/edit rights as a data owner, but for multiple countries/data repositories (as defined by Which CBS National societies are you following? in user registration)
    - Their role is offer technical/programmatic support to the data owner.

- They cannot be a data owner of a national society data repository.

- **Content administrator**
  - Content administrators are responsible for verifying the data owners and granting the data owners access to their first national society data repository.
  - Content administrators can add new languages, health risk, and case definitions
  - Content administrators users are hard coded into the system.

- **System administrator**
  - System administrators are responsible for the technical backbone of the application. This includes making sure the systems operates normally, configuring SMS gateway, administer backup routines, diagnostics and technical support.
  - System administrators can be Red Cross staff or someone from a third party actor (support provider).

High level data flow and roles



Workflow support for alerts
The system will autonomously trigger alerts that initiates a pre-defined feedback-response loop to alert the responsible stakeholders and collect the outcome of their investigation. The workflow will support an escalation path from the data verifiers (levels 1-3) to the data owner.

Feedback loops
The system will autonomously trigger tailored feedback on numerous events so to better engage and inform the stakeholders. Additionally, the system will contain a user-friendly interface for directly interacting with data collectors through SMS, both with groups and with individuals.

Data model and integrity

Implementation of system supported alert workflows will increase the value of collected data by linking case reports from data collectors with investigation reports sent from the various data verifiers.

Reporting
Reports transform data into situational intelligence with historic analytical capabilities, grouping related case reports together with added context from data collected by data verifiers.

User friendliness
User interfaces on web and app that reflect modern standards.

Functional requirements

This section outlines the functional requirements of the CBS system. The requirements are primarily based on user stories, of which the primary purpose is to capture the required system behavior from the perspective of the end-user in achieving one or more desired goals.

P01 - Create a CBS account

A new user will enter the National Society CBS user registration website and select sign up with either CBS or Humanitarian Identification (HID). If HID is selected, the user is rerouted to HID website, where the user creates an identity and verifies their email (external website).

After a new HID account is created, the user must go back to CBS platform and login in with HID username and password which redirects the user to CBS profile update page. The user must fill in the following required fields (see data owner in matrix below):

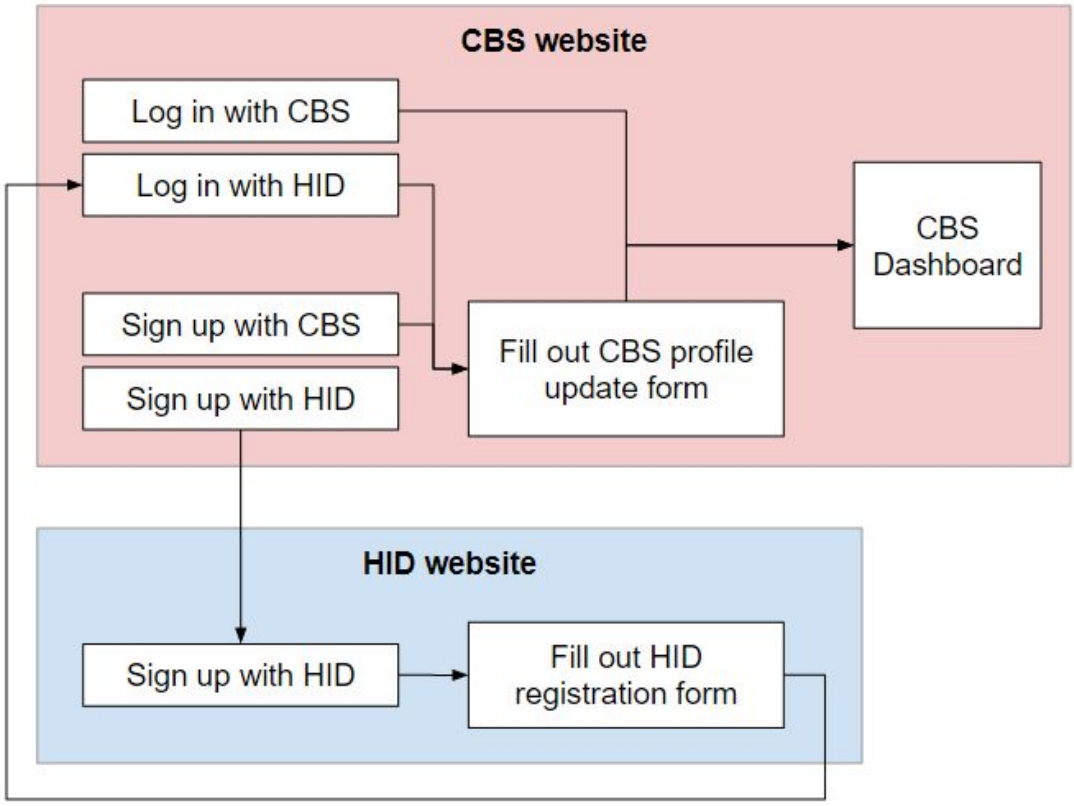


Diagram showing the process of registering as a new CBS user

M	Mandatory
O	Optional
A	Automatic
AM	Automatic, with manual ovveride

	System administrator	Content administrator	Data coordinator	Data owner	Data verifier	Data consumer	Data collector	Input type
Full name	M	M	M	M	M	M	M	Free text
Display name	M	M	M	M	M	M	M	Free text
Email address	M	M	M	M	M	M		Text with email format validation
Year of birth		M	M	M	M		M	Year (YYYY)
Sex (Male, female, other)		O	O	O	O		M	Radio button
National society/IFRC/ICRC		M	M	M	M			Drop down
Which CBS National societies are you following?		M	M	O	O	M		Drop down, multiple choice
Preferred language		M	M	M	M			Drop down - only languages confirmed by system configurator available
Mobile phone number(s)		M	M	M	M		M	Text with phone number format validation
Duty station (Head office, branch)				M	M			Radio button
- if branch: Please specify				O	O			Drop down
Location (GPS or area)					M	M	M	Radio button
- if GPS: Coordinates (Long-/latitude)					O	O	M	Number with coordinate validation
- if area: Please specify					O	O		Free text or drop down
Role (RC volunteer, RC staff, other)				M	M	M		Radio button
- if RC staff: Please specify job title					O	O		Free text
- if other: Please specify					O	O		Free text
Organisation/Affiliation (Nat. Soc. or other)					M	M		Radio button
- if other: Please specify					O	O		Free text
Mobile phone number confirmed		A	A	A	A		A	System generated
Registration date	A	A	A	A	A	A	A	System generated
Data verifier 1							AM	Automatically set to the user who registers the new user. Can be manually overwritten.
Data verifier 2					O			
Data verifier 3					O			
Data owner					AM			Automatically set to the user who registers the new user. Can be manually overwritten.

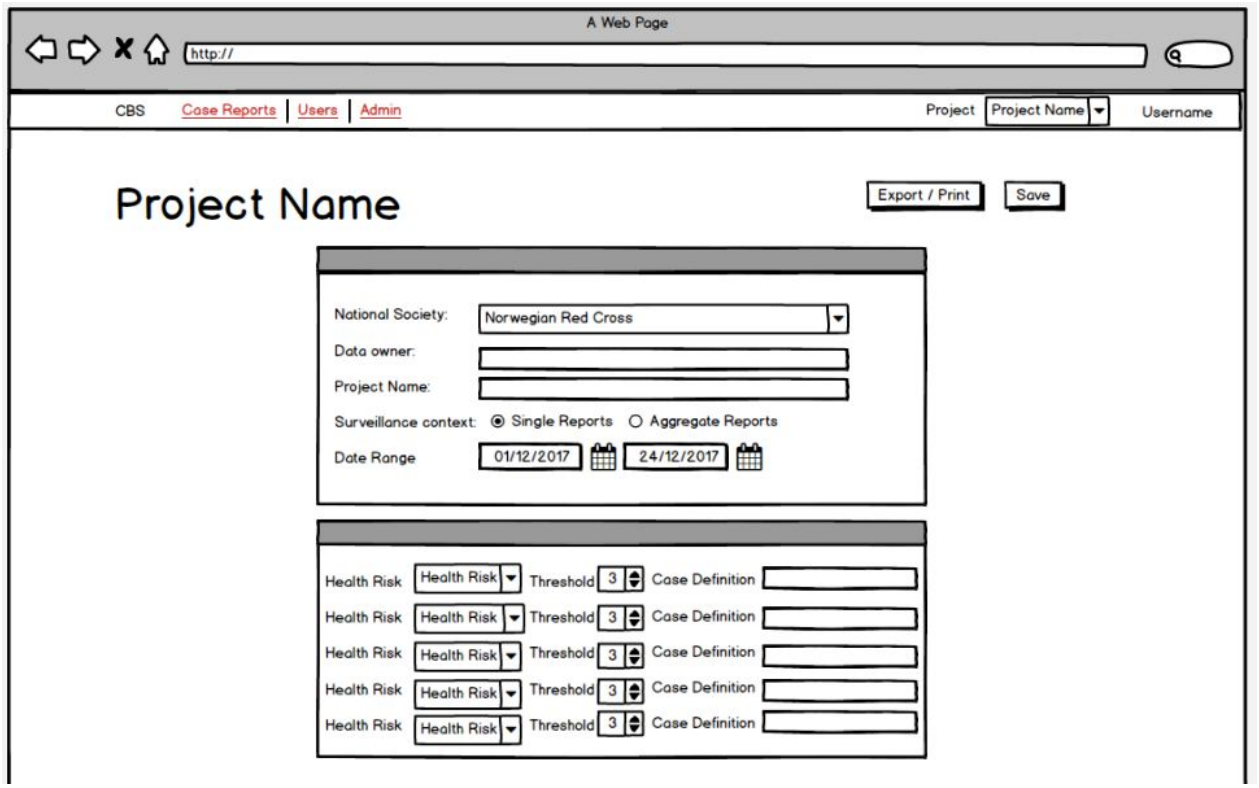
Role-information requirement matrix

P02 - Setting up a new national society data repository

Setting up a new national society data repository is the process for defining the terms of a new CBS implementation in a Red Cross Red Crescent (RCRC) National Society (NS).

Once a user is verified (manual procedure), the system configurator will assign a role to the user (data owner). System configurator will create a data repository and assign the user to the data

repository. The data owner can now edit the data repository information. The data owner can assign a new data owner to the data repository. If data owner transfers data ownership to a new user (data owner), the system triggers email notifications to both the former data owner, the new data owner and the content admin. The new data owner needs to confirm data ownership which will generate a second email to original data owner, new data owner and the content admin. Responsibility and ownership of data will remain with original data owner until new data owner has confirmed ownership of the data. Data ownership can only be transferred to a user within the same NS.



Conceptual sketch for adding new national society data repository

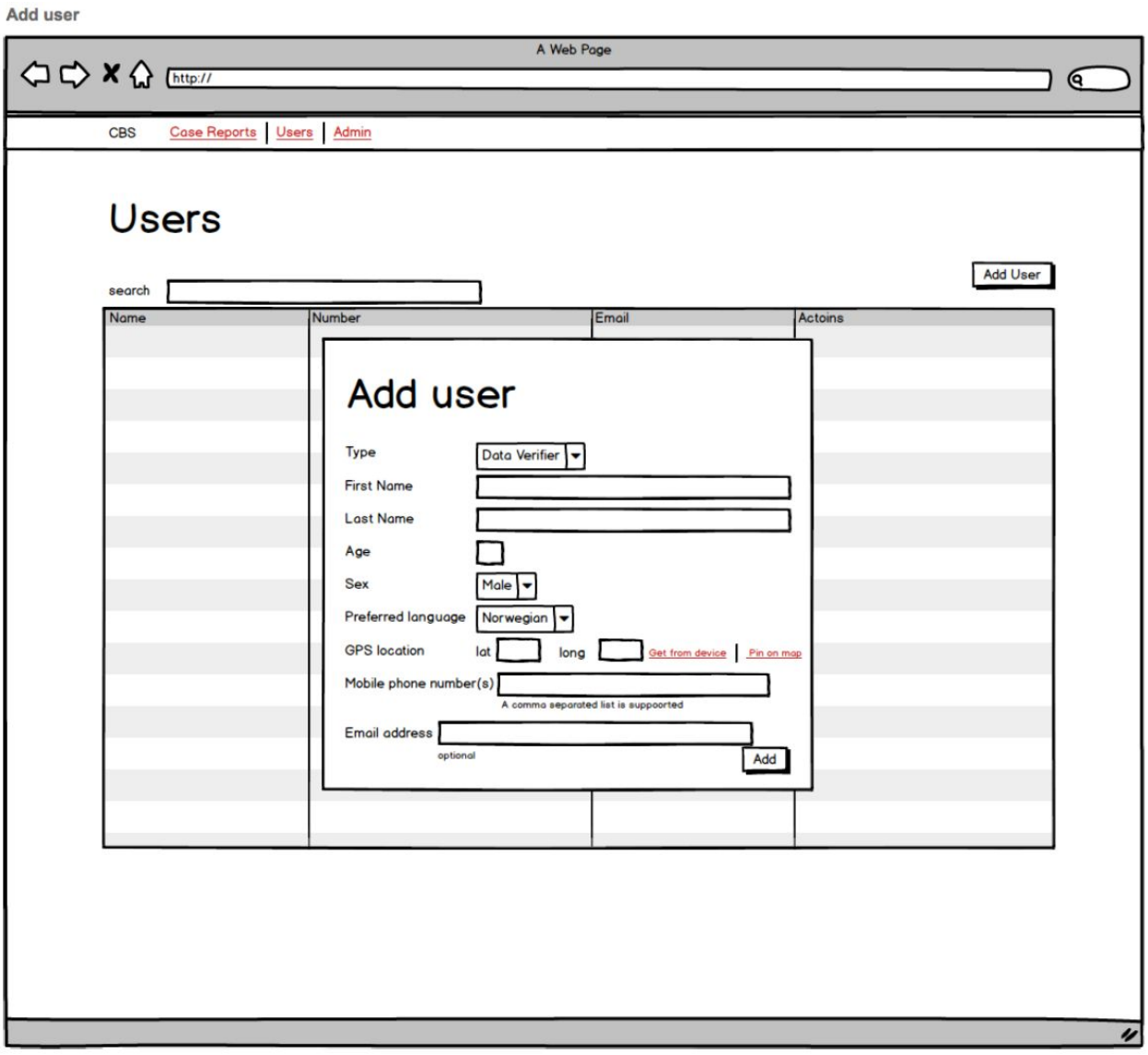
The data owner can register new data verifiers to their data repository. To add a new data verifier, the data owner must supply the mandatory fields given in the role-information matrix above. The new data verifier will be registered and placed below the data owner in the user hierarchy. The data verifiers, can in turn, register new data collectors. This is detailed in chapter P03 - Data collector registration.
The user hierarchy from data owner, through data verifiers (levels 3-1) to data collectors determines the escalation path for alerts. Read more on this in chapter P08 - Alerts.

P03 – Data collector registration

Registering a data collector is the process of recording information that will put the events the data collector reports in context, like placing it on a map. Data collectors are typically registered after or during a training session held in the field by the Red Cross.

User story #	Activity	Role	User Story	Functional requirements (System shall...)
P03.01	Input data collector information	Data verifier	As a data verifier I want to register a data collector from my smart device, so that the information the data collector reports can be put in context and we have the contact details for providing feedback.	- have a survey tool application installable on smart devices - record the data collectors' full name, display name, age, sex, preferred language, location/GPS-location, mobile phone number - be configurable to record any additional information required
P03.02	Input data collector information	Data verifier	As a data verifier, I want to be able to work offline when registering data collectors so that I can work in places without connectivity.	- have a survey tool that can collect data offline
P03.03	Received registration feedback	Data Collector	As a data collector, I want to receive a confirmation of my registration so that I know I am enrolled and have the contact details to my designated data verifier.	- send an SMS to the data collector with confirmation and the contact details of the data verifier responsible in the area the data collector is operating

Use stories and functional requirements of data collector registration (P03)



Conceptual mockup of form for user registration

P04 – Data collector status update

If the data collector for some reason no longer want to be an active member of CBS, the system will allow the data collector to self-deactivate. For Red Cross, this serves as an important feature since good surveillance coverage is important and recruiting efforts will be undertaken if certain areas are below what is acceptable.

User story #	Activity	Role	User Story	Functional requirements (system shall...)
P04.01	Update data collector status	Data Collector	As a data collector, I want to set my status to passive so that I do not receive any more requests from RC.	- respond to a pre-defined trigger word "set status to passive" sent by SMS and set the data collector's status to passive - not send information to data collectors with passive status

P04.02	**Feedback**	Data Collector	As a data collector, I want to receive feedback that my status has been updated so that I can know if my update was successful.	- send confirmation by SMS if the data collector sent the pre-defined trigger word for "set status to passive" and the system set the data collector's status to passive. - send feedback if the trigger-word is not in the system's vocabulary

Use stories and functional requirements of data collector status updates (P04)

P05 – Data collector information update

There are many situation where a data collector needs to update Red Cross with current information. This would typically be if the data collector moves to a new location or changes cell phone number. The information provided by the data collector is what puts the case reports in context (metadata). Incorrect metadata will consequently place the reports in the wrong context, e.g. the wrong location.

User story #	Activity	Role	User Story	Functional requirements (system shall…)
P05.01	Send contact request	Data Collector	As a data collector, I want to have someone call me and update my information so that it is correct.	- respond to a pre-defined trigger word for "callback" sent by SMS by a data collector
P05.02	Feedback	Data Collector	As a data collector, I want to received feedback that my SMS was received and with information on who will contact me.	- send information on who will make contact by SMS if the data collector sent the pre-defined trigger word for "callback". - send feedback if the trigger-word is not in the system's vocabulary
P05.03	Contact data collector	Data verifier	As a data verifier, I want to update the information registered on a data collector so that it is correct	- send an SMS to the data verifier with a request to callback the data collector and the contact details of the data collector - send a link of the data collector's previously recorded details that opens in the survey tool - update the information on the data collector when new information is saved in the survey tool

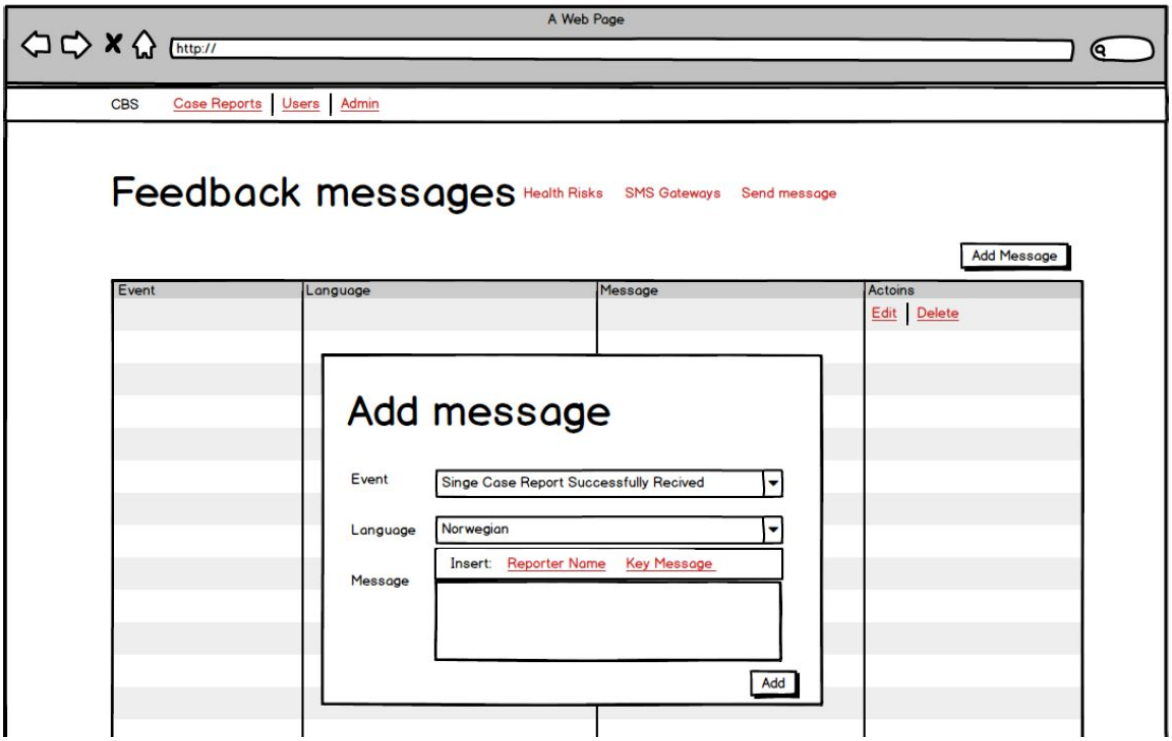
Use stories and functional requirements of data collector information update (P05)

P06 – Regular feedback

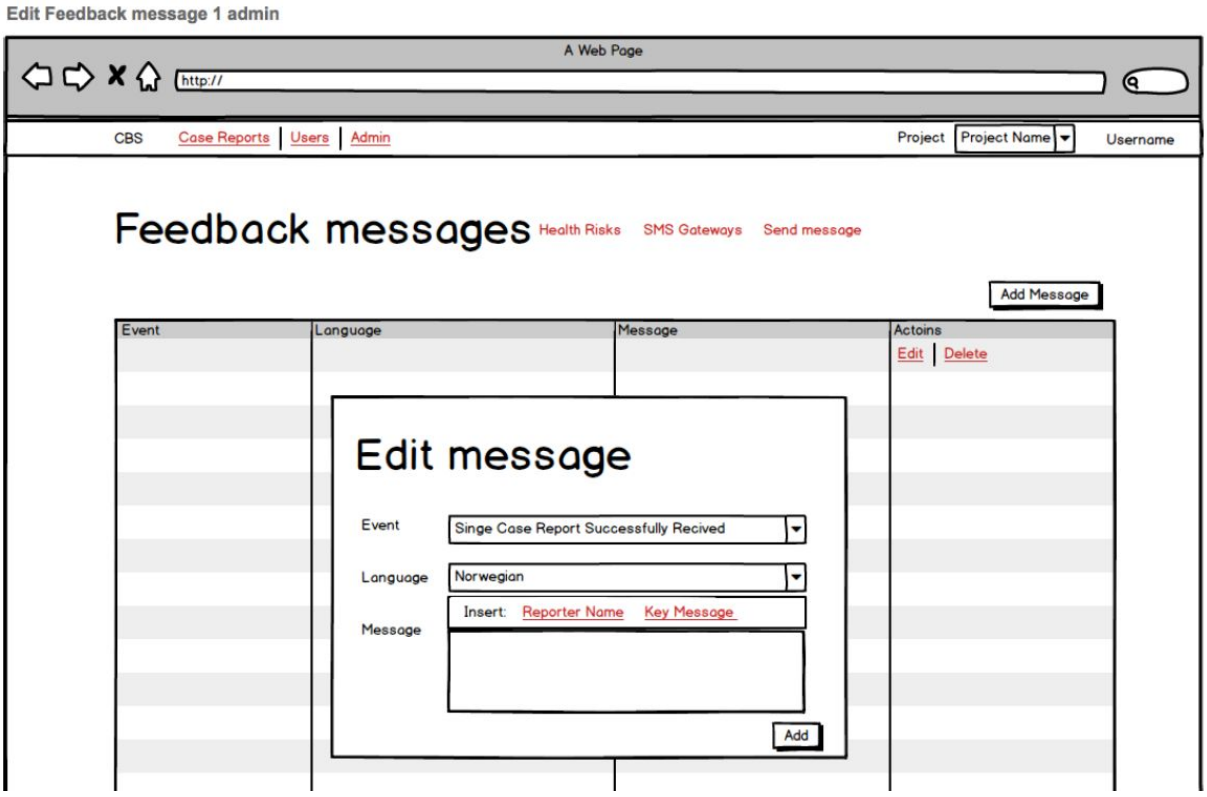
The Red Cross relies heavily on the data collectors to perform their tasks. To improve chances of sustained activity and motivation, the system must interact with the data collectors through regular and ad-hoc feedback. In situations where large outbreaks are on the rise, Red Cross quickly needs to send information to larger groups of data collectors in the affected areas.

User story #	Activity	Role	User Story	Functional requirements (system shall...)
P06.01	Bulk message data collectors	Data verifier/owner	As a data verifier/owner, I want to have an easy way to manually send SMS' to data collectors so that I can give them (custom) feedback or information of e.g. ongoing epidemics.	- provide an interface for filtering data collectors by data verifier, data owner, location and name - provide an interface for entering manual text to be sent to the filtered data collectors - send the manually entered text to the filtered data collectors by SMS
P06.02	View conversation	Data verifier	As a data verifier, I want to view and respond to a conversation with a data collector by SMS so that I can follow up on any information or questions they have.	- provide an interface with an overview of the conversation with a specific data collector - include a field to respond to the conversation with the data collector
P06.03	Send regular feedback to data collectors	Data Collector	As a data collector, I want regular feedback on my performance - e.g. how many reports I have sent the last week.	- send pre-defined performance reports by SMS, customized per data collector

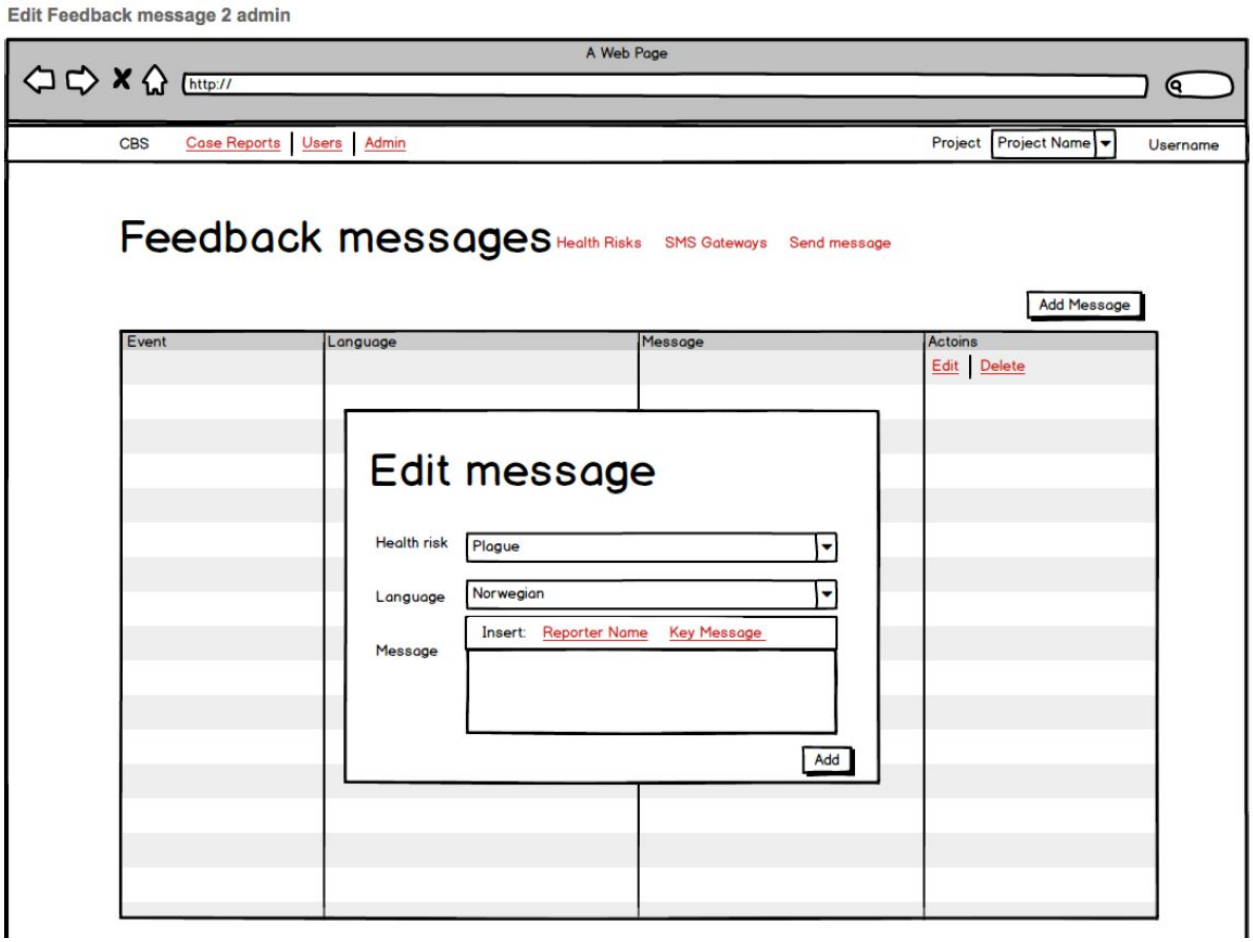
Use stories and functional requirements of data collector registration/manual feedback (P06)



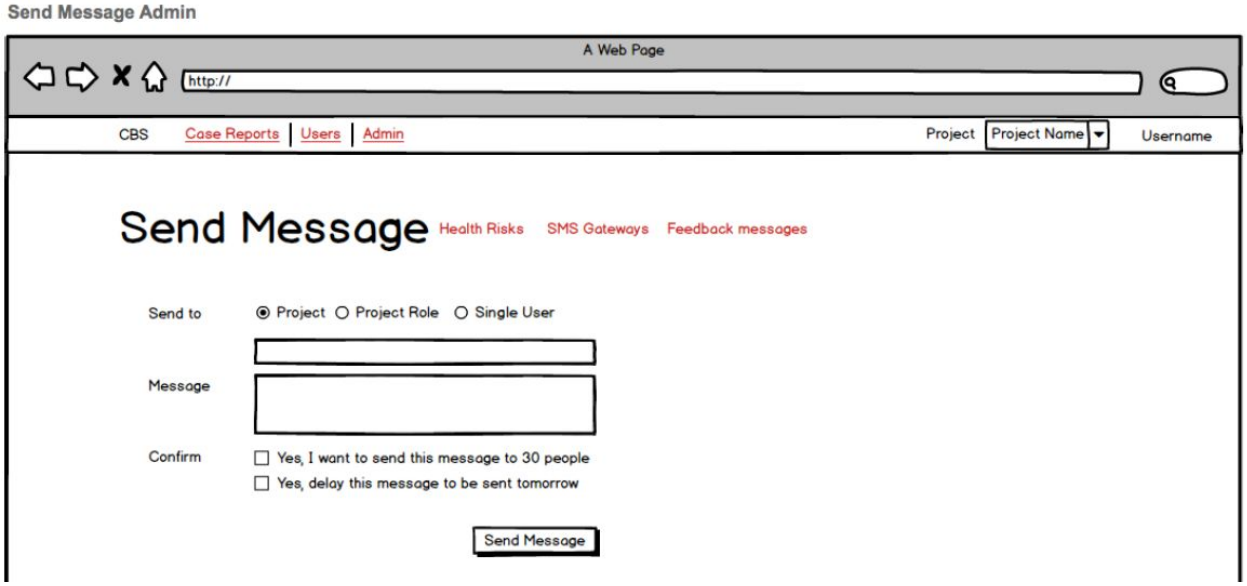
Conceptual mockup of interface for adding feedback messages



Conceptual mockup of interface for editing feedback messages



Conceptual mockup of interface for editing SMS feedback messages



Conceptual mockup of interface for sending SMS messages

P07 – Case reporting by data collectors

The backbone of CBS is the case reporting performed by the data collectors in the field. Elementary to this, is that the data reported is of high quality. The system must therefore validate the input and provide feedback if the data does not validate when entered. Likewise, it is important to provide feedback if the report does validate so to assure the data collector that the report has been registered and provide information on how to handle the reported case.

SMS reports can be sent in three different formats, non-human health risks, single reports and aggregated reports.

Non-human health risks

Structure: [Event]

- Field 1: Events are pre-assigned numbers for a health risk. Only numbers for non-human health risks are allowed, like fire and flood. See list of health risks in appendix
- Example: **13** (Plague)

Single report

Structure: [Event]#[Sex of case]#[Age group]

- Field 1: Events are pre-assigned numbers for a health risk. See list of health risks in appendix.
- Field 2: Sex of case can be either 1 (male) or 2 (female)
- Field 3: Age group can be either 1 (0-4 years) or 2 (5 years and up)
- Example: **3#1#2** (Hepatitis A, Male, 5 years and up)
- Both # (hash) and * (star) are valid delimiters
- If Field 1 is a non-human health risk, we allow Field 2 and 3 to be 0. Otherwise they have to have the values 1 or 2. Negative numbers are not allowed in any field.

Aggregated report

Structure: [Event]#[Number of male cases 0-4 years old]#[Number of male cases 5 years and up]#[Number of female cases 0-4 years old]#[Number of female cases 5 years and up]

- Field 1: Events are pre-assigned numbers for a health risk. See list of health risks in appendix.
- Field 2: Number of cases detected in **males**, from **0-4** years
- Field 3: Number of cases detected in **males**, from **5** years and up
- Field 4: Number of cases detected in **females**, from **0-4** years
- Field 5: Number of cases detected in **females**, from **5** years and up
- Example: **3#1#0#4#2** (Hepatitis A, one case of male 0-4 years, no cases of male 5 years and up, four cases of female 0-4 years, and two cases of female 5 years and up)
- Both # (hash) and * (star) are valid delimiters
- If Field 1 is a non-human health risk, we allow all other fields to be 0. Otherwise, at least one must be a positive integer. Negative numbers are not allowed in any field.

User story #	Activity	Role	User Story	Functional requirements (system shall...)
P07.01	Report cases	Data Collector	As a data collector, I want to report a case so that Red Cross can take action if necessary.	- accept SMS messages from data collectors
P07.02	Receive confirmation	Data Collector	As a data collector, I want to receive confirmation if my report was successful so that I know the message was received.	- validate case reports sent by data collectors - send a confirmation by SMS if the validation was successful
P07.03	Receive feedback if report is unsuccessful	Data Collector	As a data collector, I want to receive feedback if my report was badly formatted so that I can resend the report in the correct format.	- validate reports - send feedback by SMS on what data fields did not validate if validation is unsuccessful
P07.04	Receive information	Data Collector	As a data collector, I want to receive information on any steps to take in relation to the report I just sent, so that I can support my community.	- send an SMS with a pre-defined key message for the case type reported

Use stories and functional requirements of data collector case reporting (P07)

P08 – Alerts

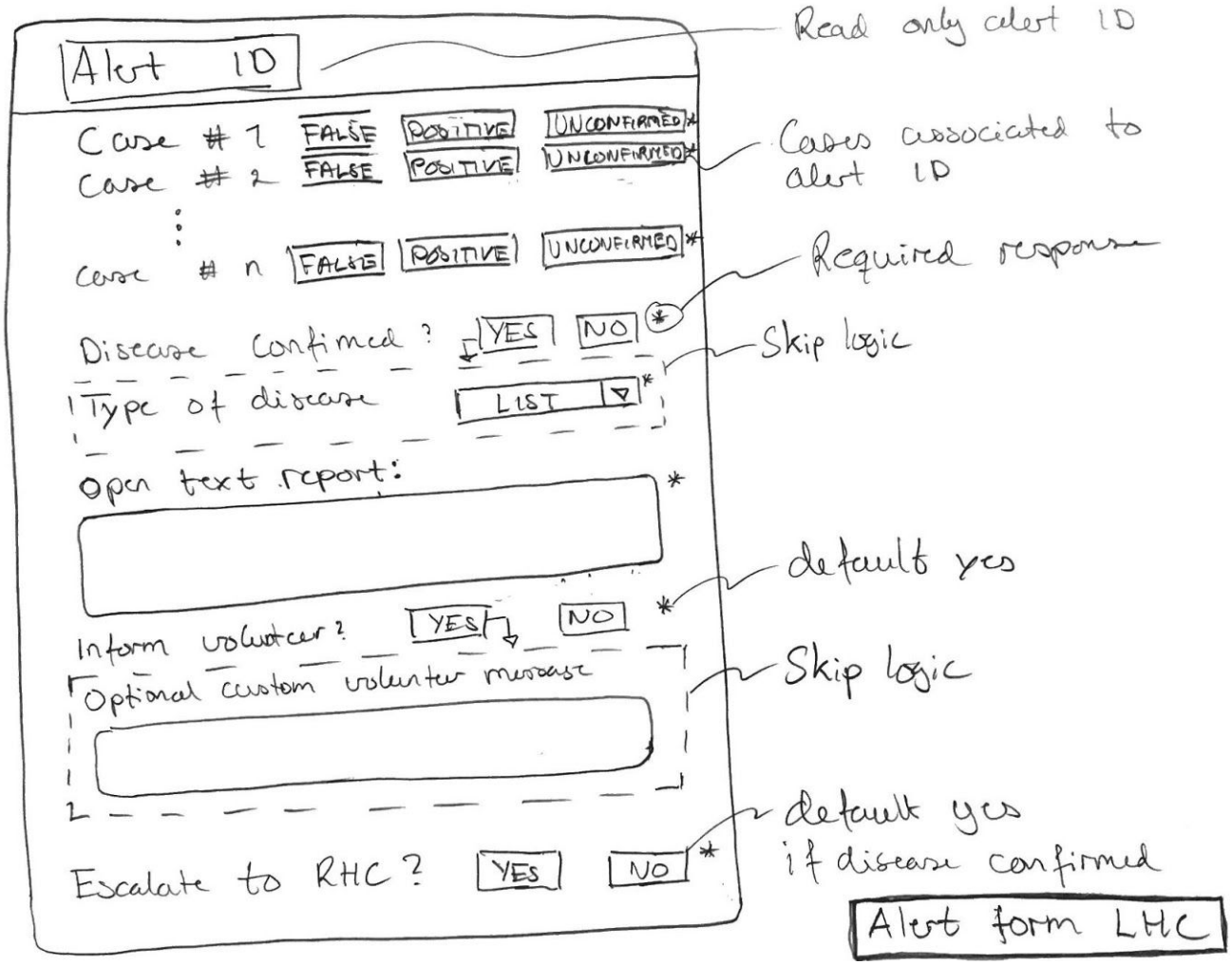
In the event that a pre-defined business rule issues an alert, a workflow for handling such an alert must be in place. This is necessary both to ensure that all the required actions are taken in multi-alert situations while ensuring data collection in a structured manner. The data collected can be a highly valuable source for post-situation analysis and possibly enhancement of prediction models, as well as being a resource for epidemiological research.

User story #	Activity	Role	User Story	Functional requirements (system shall…)
P08.01	Receive a message when an alert is issued	Data Collector	As a data collector, I want to know if an alert has been triggered based on my reporting, who is responsible to follow up on it and what I should do so that I can know what response to expect and if I should take any actions.	- send an SMS to the data collectors that reported the cases that triggered the alert with information on who has been assigned and a pre-defined message for the type of alert
P08.02	Receive a message when an alert is issued	Data verifier (level 1)	As a data verifier, I want to receive alerts immediately so that I know what and where the situation is, who will follow up when and if I need to follow up.	- send an SMS to the data verifier with information on what kind of alert has been triggered and at what location
P08.03	Report outcome of investigation	Data verifier (level 1)	As a data verifier, I want to receive a link to a pre-filled form in case of alert so that I do not have to spend time on looking them up myself and can concentrate on adding additional details.	- generate a form or reopen an existing with pre-filled information related to the alert - generate a link to the form that opens in the mobile app

				- send a link to the pre-filled generated to the data verifier by SMS
P08.04	Evaluate cases related to the alert	Data verifier (level 1)	As a data verifier, I want to have access to each case related to the alert so that I can follow up on every one of them and register if the case was a true or false positive.	- generate a form/entry for each of the cases linked to an alert with a positive/negative confirmation option.
P08.05	Escalate alert to higher level verifier	Data verifier (level 1)	As a data verifier, I want to be able to escalate the alert to the next level so that the higher level data verifier is made aware of the situation.	- provide an option to the data verifier to escalate the alert (or not)
P08.06	Inform data collector of outcome	Data verifier (level 1)	As a data verifier, I want to inform the data collector about the outcome of my investigation so that they know that we are responding.	- provide a field for the data verifier to add a custom message to the data collectors - send an SMS to the data collectors that registered the cases related to the alert with information on the outcome and the customized message from the data verifier, if provided
P08.07	Report outcome of investigation	Higher level data verifier (level 2 or 3)	As a higher level data verifier, I want to receive a link to a pre-filled form if the lower level data verifier has escalated an alert so that I do not have to spend time on looking them up myself and can concentrate on adding additional details.	- generate a form or reopen an existing (details provided in appendix) with pre-filled information related to the alert - generate a link to the form that opens in the mobile app - send a link to the pre-filled form to the data verifier by SMS
P08.08	Evaluate cases related to the alert	Higher level data verifier (level 2 or 3)	As a higher level data verifier, I want to have access to each case related to the alert so that I can follow up on every one of them and register if the case was a true or false positive, given this has not already been registered or if I come to another conclusion.	- generate a form/entry for each of the cases linked to an alert with a positive/negative confirmation option
P08.09	Escalate alert to data owner	Higher level data verifier (level 2 or 3)	As a higher level data verifier, I want to be able to escalate the alert to the next level so that the data owner is made aware of the situation.	- provide an option to the data verifier to escalate the alert (or not)
P08.10	Inform data collector of outcome	Higher level data verifier (level 2 or 3)	As a higher level data verifier, I want to inform the data collector about the outcome of my investigation so that they know that we are responding.	- provide a field for the higher level data verifier to add a custom message to the data collectors - send an SMS to the data collectors that registered the cases related to the alert with information on the outcome and the customized message from the data verifier, if provided

P08.11	Inform data verifier of outcome	Higher level data verifier (level 2 or 3)	As a higher level data verifier, I want to inform the lower level data verifiers about the outcome of my investigation so that they know that we are responding.	- provide a field for the higher level data verifier to add a custom message to the lower level data verifiers - send an SMS to the data verifier that escalated the alert with information on the outcome and the customized message from the higher level data verifier, if provided
P08.12	Report outcome of investigation	Data owner	As a data owner, I want to receive a link to a pre-filled form if the data verifier has escalated an alert so that I do not have to spend time on looking them up myself and can concentrate on adding additional details.	- generate a form or reopen an existing (details provided in appendix) with pre-filled information related to the alert - generate a link to the form that opens in the mobile app - send a link to the pre-filled form to the data owner by SMS
P08.13	Evaluate cases related to the alert	Data owner	As a data owner, I want to follow up on each case related to the alert and register if the case was real or a false positive given this has not already been registered or if I conclude differently.	- generate a form/entry for each of the cases linked to an alert with a positive/false/unconfirmed confirmation option
P08.14	Inform data collector of outcome	Data owner	As a data owner, I want to inform the data collector about the outcome of my investigation so that they know that we are responding.	- provide a field for the data owner to add a custom message to the data collectors - send an SMS to the data collectors that registered the cases related to the alert with information on the outcome and the customized message from the data owner, if provided
P08.15	Inform data verifier of outcome	Data owner	As a data owner, I want to inform the data verifier about the outcome of my investigation so that they know that we are responding.	- provide a field for the data owner to add a custom message to the data verifier - send an SMS to the data verifier that escalated the alert with information on the outcome and the customized message from the data verifier, if provided
P08.16	Inform data verifier of outcome	Data owner	As a data owner, I want to inform the data verifier about the outcome of my investigation so that they know that we are responding.	- provide a field for the data owner to add a custom message to the data verifier - send an SMS to the data verifier that escalated the alert with information on the outcome and the customized message from the data owner, if provided

Use stories and functional requirements of alert workflow



Conceptual mockup of alert form

PS! Some mockups use outdated wording. LHC is now called Data Verifier, RHC is Data Verifier (higher level verifier). Volunteer is Data Collector.

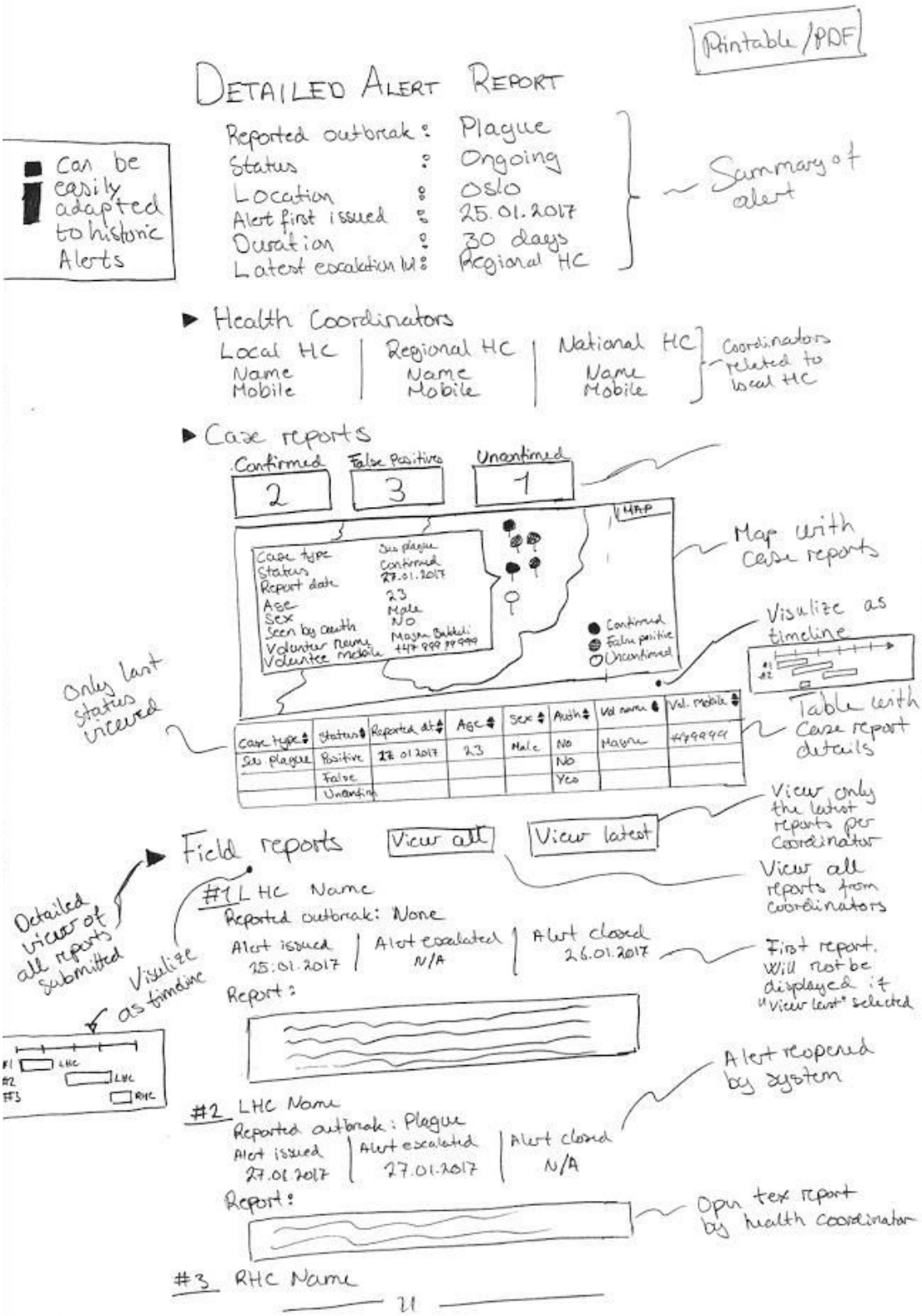
P09 – Reporting

Reporting is the process of transforming data into actionable intelligence and serves as an important part of the surveillance and response mechanisms in CBS.

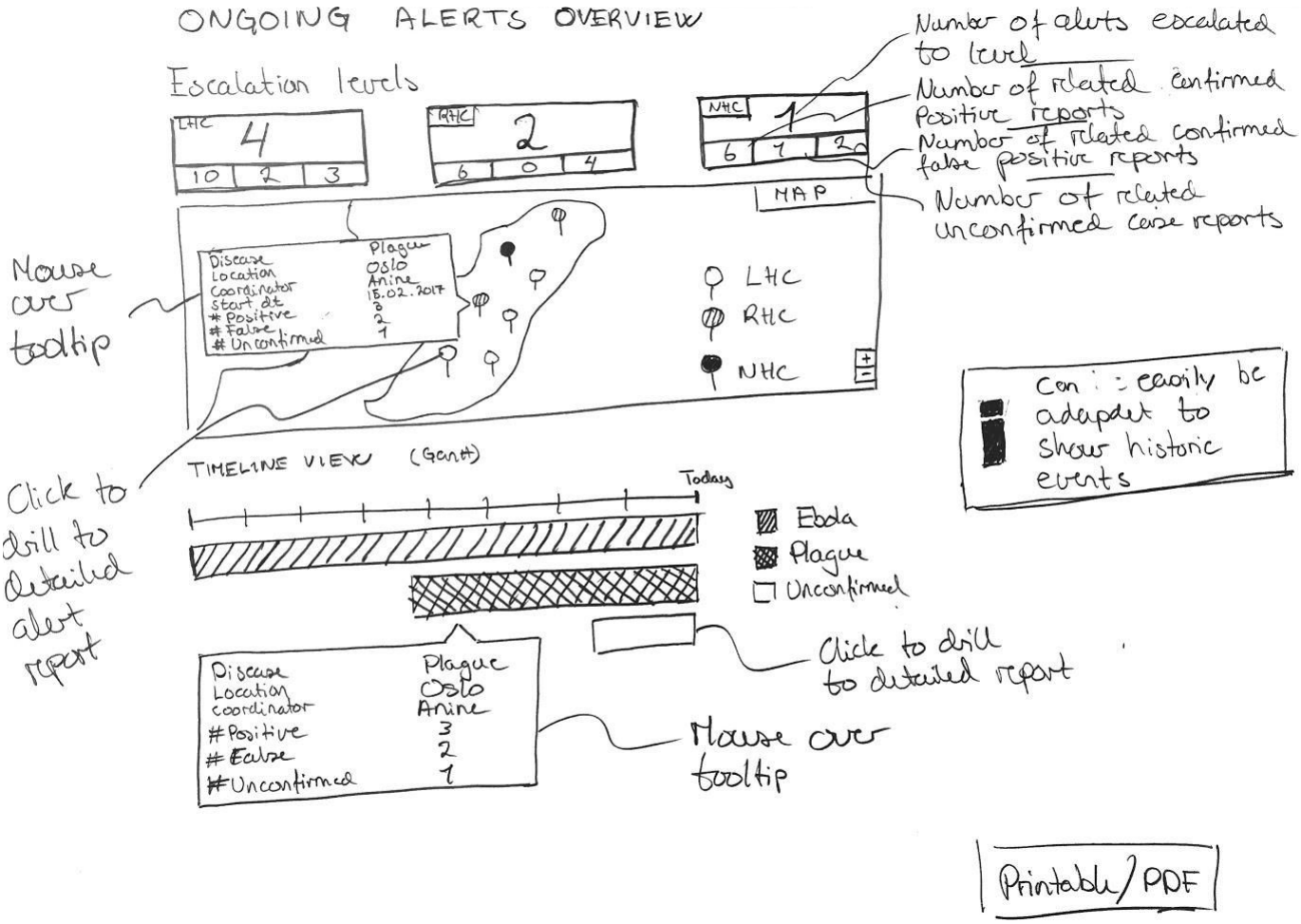
User story #	Activity	Role	User Story	Functional requirements (system shall…)
P09.01	Overlay GIS-data on situational map	Data owner	As a data owner, I want to overlay 3rd party GIS-data such as weather and hospitals on my situation map so that I can take decisions that are more informed.	- have mapping technology that can overlay 3rd party GIS-data
P09.02	Situational intelligence	Data owner	As a data owner, I want to have an overview of ongoing alerts with contact information to the response team so that I can follow up with them directly.	- provide a report or dashboard with contact information to the individuals responding to an alert
P09.03	Ongoing and historic alerts	Data owner	As a data owner, I want to have an overview of all active and historic alerts with status and outcome so that I can get a sense of the overall situation and how we are responding.	- provide a report or dashboard displaying all ongoing and historic alerts with corresponding outcome status and information on investigations and cases related to the alerts
P09.04	Have an overview of false alert trends	Data owner	As a data owner, I want to have an overview of false alerts so that I can understand if the alert definition has the correct sensitivity.	- provide a report with details on alerts confirmed to false positives
P09.05	Surveillance coverage	Data owner	As a data owner, I want to know how many data collectors are active and in what area so that we can focus our recruiting efforts on areas lacking surveillance coverage.	- provide a report displaying active data collectors
P09.06	Passive data collector follow up	Data owner	As a data owner, I want to know what data collectors are passive so that I can follow up on why they are passive.	- provide a report displaying data collectors with status passive and data collectors that have not sent reports for a user defined number of days
P09.07	Share intelligence with authorities	Data owner	As a data owner, I want to send a weekly report of trends, alerts and outcomes to the national health authority so that we are transparent and builds trust.	- provide an export functionality to PDF of reports
P09.08	Export data repository information	Data owner	As a data owner, I should be able to export a subset of the national society data repository summary page to PDF and print it.	- provide PDF report with the following data repository information: National Society, data owner, Name of data repository, Surveillance context: single / aggregate reports, SMS report formats, Health risks, Case definitions, Thresholds, Location

P09.09	Define new reporting project	Data owner	As a data owner, I should be able to create a new project filter and share it with other users. A project filter should limit which case reports are shown based on either time, geographical area, health risk, data collector, data verifier, data owner, or a combination of these.	- provide an interface where the user can create a customized filter - be able to name the filter - be able to share the filter with other users

Use stories and functional requirements of reporting



Conceptual mockup of detailed report of ongoing/historic alerts



Conceptual mockup of report overviewing ongoing/historic alerts

P10 – Configure alert definitions

In order to ensure rapid response, data owners should be able to set alert thresholds that triggers automatic notifications.

User story #	Activity	Role	User Story	Functional requirements (system shall...)
P10.01	Alter alert definitions	Data owner	As a Data owner, I want to change the parameters that define the threshold of when an alert should be issued so that the alert-sensitivity is improved.	- provide an interface to change the parameters that define an alert

Use stories and functional requirements of configuration of alert definitions

P11 – User access and Identity Management

User story #	Activity	Role	User Story	Functional requirements (system shall...)
P11.01	User access management	System configurator	As a system configurator, I want to administer user access to the private site and any restricted modules within them so that only the user with authorization can access.	- provide a user management interface to define roles and access level to the different part of the system

Use stories and functional requirements of user access and identity management

P12 – System monitoring

User story #	Activity	Role	User Story	Functional requirements (system shall...)
P12.01	System monitoring	System administrator	As a system administrator, I want to know if some of the components have failed so that I can fix them.	- log system component status - show systems component status

Use stories and functional requirements of system monitoring

Non-functional requirements

Security

- Secured against unauthorized access to both the different components and the data flows between them.
- Configurable with different access levels per user and role.
- Data collection, processing and use shall adhere to relevant data protection laws and legal guidelines for the collected data.
- Data flows and storage shall be logically separated per deployment.

Performance

- Outbound/inbound SMS rate 1500 per hour per deployment/gateway.
- Flexible system resource management scalable to multi-site deployments.

Integrity

- All response forms must validate user input real time.
- Pre-populated fields should be used wherever possible, e.g. geographic location
- The data model should reflect the historic status at any given point in time, e.g. store changes in data collector GPS location.
- The data collected has to be linked by keys, so that it is ready for analysis. E.g. the recorded response from the data verifier when an alert is issued, must be connected to the data collector report that issued the alert.

Usability

- User-friendly user interfaces for reporting and data collection.
- Multilingual support in all communication and user interfaces, configurable per deployment.

Recovery

- All data should be backed up daily and stored for 30 days.

Documentation

- System and detailed technical documentation for CBS technical staff.
- High-level user documentation for CBS non-technical staff.

Deployment

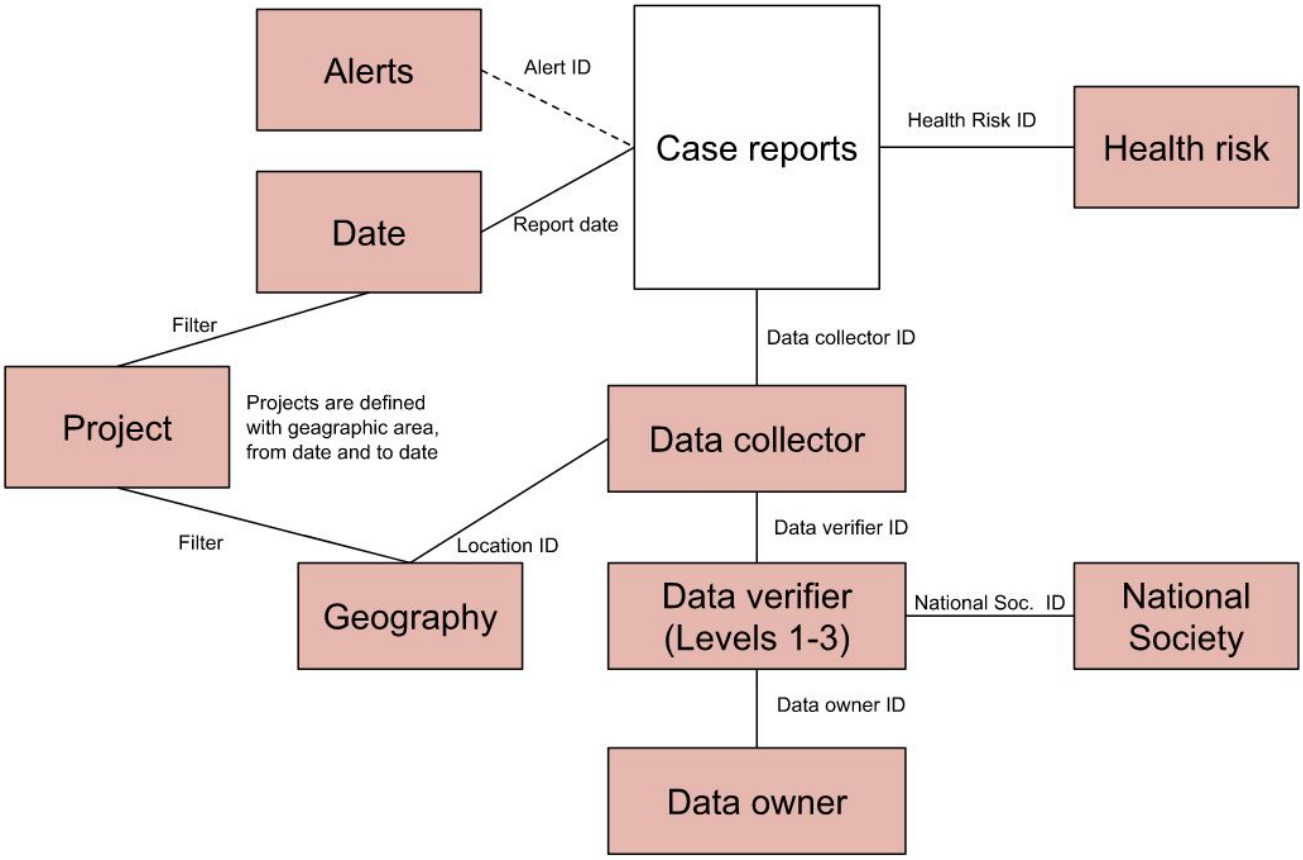
- Inbound and outbound SMS-messages must relayed through a local mobile telephone number.
- The system must be deployable to locations with unreliable internet connectivity.

High-level system requirements

Components

[Samson to add]

Data model



High-level data model for reporting

In order to simplify the development of reports, the system should structure data in a robust dimensional model on the database. This strategy also ensures that any business logic implemented on the raw data is placed in one central location, ensuring correctness in all connected reports if errors are corrected at a later stage.
The conceptual model illustrated above is a preliminary sketch, and should be reviewed before work starts on reporting.

Case reports are the central object in the data model, and will be connected to the following dimensions:

- **Health Risk** - Which health risk is reported in the case report
- **Data Collector/Verifier/Owner** - Hierarchical dimension showing who collected the data (data collector), who is responsible for verifying the report (data verifier), and who is responsible for the data (data owner). There can be up to three levels of data verifiers between the data collector and data owner.
- **National Society** - The national society where the data verifier is registered. This could also be deduced from data collector or data owner.

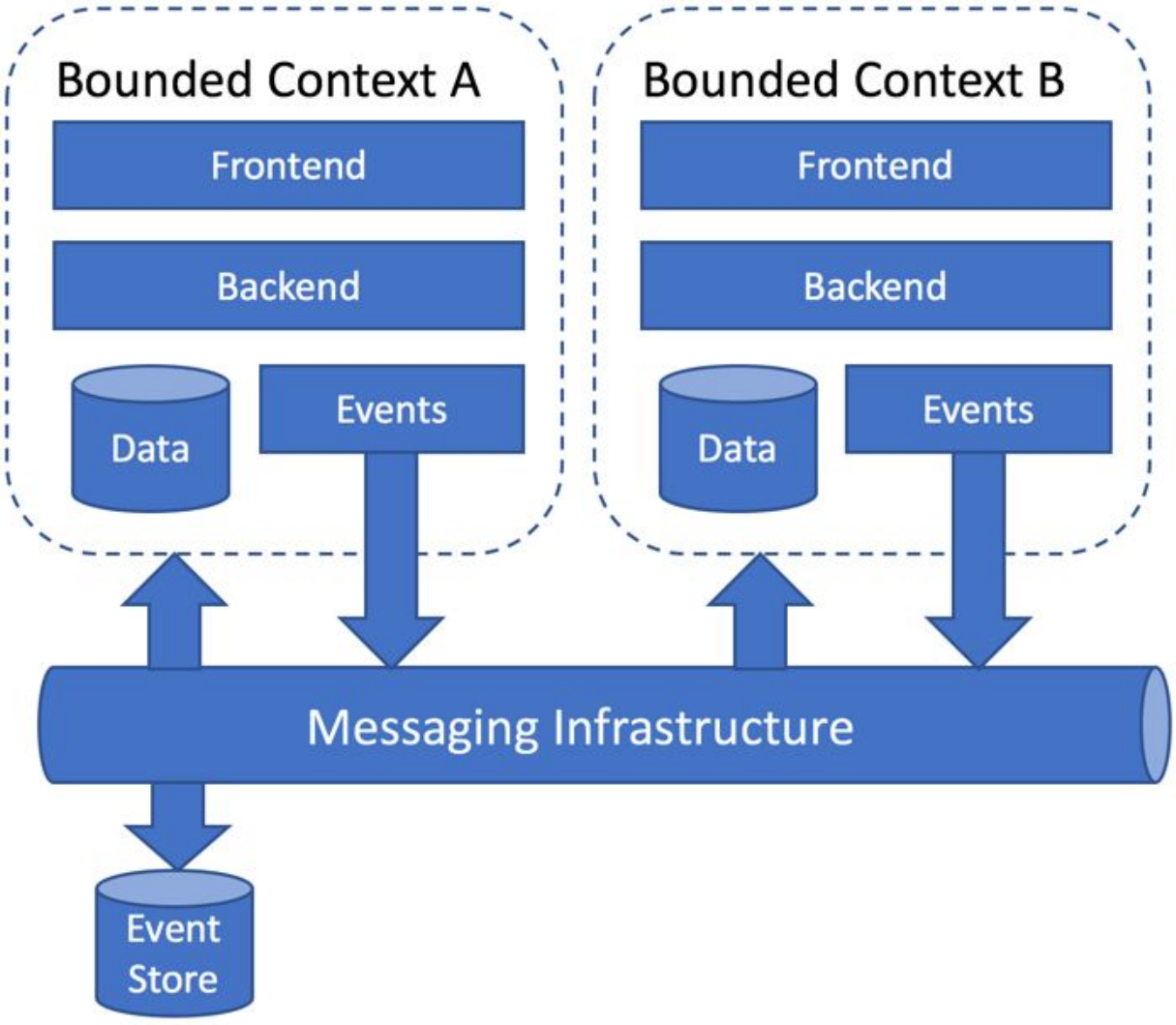
- **Geography** - Where the report is sent from. This is the location registered on the data collector.
- **Date** - When the report sent/received by the CBS system
- **Project** - Projects are not relevant in the data collection phase, but will be added in reporting in order to limit the data presented. The projects will be defined using filtering on time and geographic area
- **Alerts** - An alert is triggered if the defined health risk thresholds are met. The report(s) that triggered the alert will be marked with an Alert ID. If new cases of the same health risk is reported, these will also be marked with the same Alert ID.

Technical infrastructure

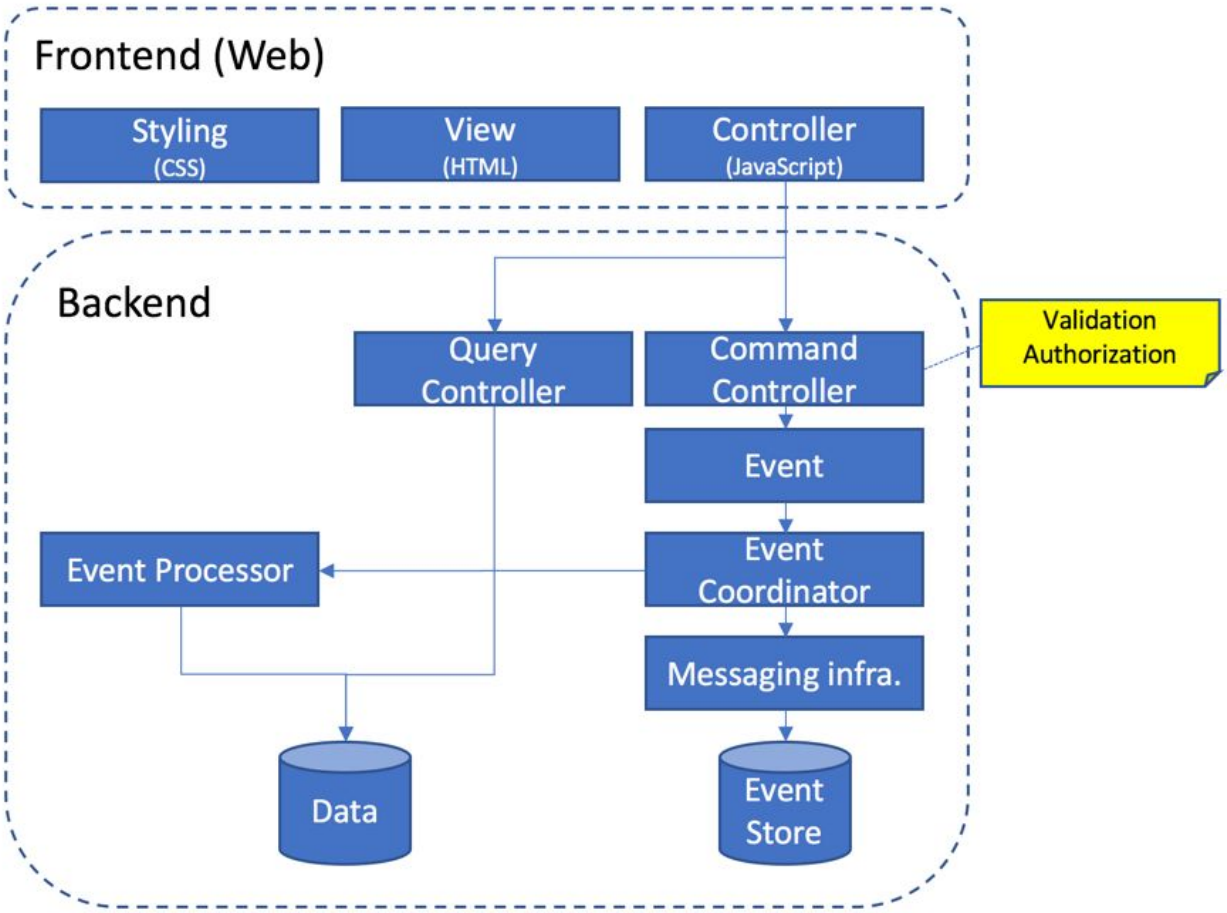
This chapter outlines some of the core components and concepts used in the CBS system and how they are implemented in the project.

Bounded contexts - conceptual description

The CBS system is design on the principle of bounded contexts. The core principle is to keep the different parts of your system apart and not take any dependency on any other contexts.



Diving into the architecture within a bounded context, you'll find the following:



Bounded contexts - CBS implementation

This section describes the different bounded contexts that are defined for the CBS project. The contexts are divided into categories based on priority. The first step in creating the CBS application is developing a MVP (minimum viable product). This is a version of the application which only includes the crucial components needed for the system to operate. Later on, additional bounded contexts will be built into the system in order to add new functionality. The following bounded contexts are defined for the CBS application:

Bounded contexts included in MVP scope

Volunteer Reporting

The volunteer reporting bounded context is responsible for processing all incoming text messages from data collectors in the field.
The module also supports manual sending of SMS messages to data collectors, with a web UI for the sending, as well as customization of the SMS messages sent as feedback to the user.

Admin

Web-based interface for system admins where they define the global configuration within CBS, such as alert thresholds, health events, SMS gateway to use etc. They also have the ability to create new CBS projects.

User management

Web-based user management, where data collectors, data managers, data coordinators etc are associated with one or several CBS projects.

Portal and infrastructure

"Glue" for navigating between bounded context.

Bounded contexts not included in MVP

Alerts

Case report escalation when an alert threshold is reached. Escalation in this case can mean notifying nearby data collectors of health events, notifying data verifiers and notifying local authorities such as the Ministry of Health.

Reporting

Web-based visualization of all incoming case reports. The level of detail within a report is dependent on the "role" of the user.

CBS data flow

Get from Samson

CBS system architecture

Get from Samson

Appendix A - List of health risks

Health risk number	Health risk name	Type of health risk
1	Acute watery diarrhoea	Human
2	Cholera	Human
3	Hepatitis A	Human
4	Hepatitis E	Human
5	Typhoid Fever	Human
6	Acute Respiratory Infections preventable by vaccine (Diphtheria, Mumps, Rubella, Whooping cough, Chickenpox)	Human
7	Measles	Human
8	Meningococcal Meningitis	Human
9	Polio	Human
10	Chikungunya	Human
11	Dengue fever	Human
12	Malaria	Human
13	Plague	Human
13	Plague	Animal
14	Yellow fever	Human
15	Zika virus infection	Pregnant women
16	Acute Respiratory Infections	Human
17	Hand, foot and mouth disease (HFMD)	Human
18	Ebola	Human
19	Lassa Fever	Human
20	Marburg	Human
21	Unusual event	Human, animal, environment
22	Anthrax	Animal
23	Hantavirus pulmonary syndrome	Human
24	Leptospirosis	Human
25	Middle East respiratory syndrome coronavirus	Human

26	Monkeypox	Human
27	Rift Valley fever	Animal
28	Moderate Acute Malnutrition	Human
29	Severe Acute Malnutrition	Human
30	Normal weight	Human

The list of health risks is a living document, and the most updated version can be found at https://docs.google.com/spreadsheets/d/1bfbfaTr6jx3ia7tOEZxDMDk-qrWAfS9vCoH2N-TG9zM/edit#gid=1036114658

Appendix B - SMS Eagle specs

CBS is using a SMSEagle NXS-9750 3G (dual modem)

SMS Eagle software features

- Sending & Receiving SMS (managing messages with Inbox, Outbox, Sent Items)
- Sending to single users or groups of users
- Sending SMS at specified date and time (SMS scheduling)
- Smartphone-like conversation mode (messages are nicely grouped by phone number). You can easily track history of what you send and receive to each user
- Support of different message types (normal SMS/multipart SMS/flash SMS/binary SMS/USSD-code/WAP Push link)
- Message templates
- Phonebook (single users, groups)
- Importing contacts from CSV file
- Monitoring services (eg Web server, Mail server) and SMS alerting
- Auto-reply to incoming SMS (mulitple autoreply rules)
- Email to SMS forwarding
- SMS to Email forwarding
- Email2SMS Poller for converting incoming email to SMS messages.
- Periodic SMS to send SMS messages at a desired time interval.
- Shift management to assign Phonebook contacts to working shifts
- Forward incoming SMS to remote script (callback URL)
- Digital input and output controlled via SMS
- Temperature & humidity SMS alerts (for products in NXS-line of devices)
- Multiuser support (each user has access to a private Inbox, Outbox, Sent Items)
- Unicode support (support of national characters)
- Multipart SMS message support
- HTTP/HTTPS API for sending SMS from external applications & systems
- Multilanguage (English, German, Polish) web-interface
- NTP client installed
- SNMP agent installed
- HTTPS support
- Delivery reports support (selected products only)
- Watchdog mechanisms for GSM/3G modem (automatic modem health control)
- Modem failover mechanisms (for products with 2 or more modems)
- Device failover support – HA cluster of 2 devices possible

Sending/Receiving Throughput

- Incoming transmission rate: up to 30 SMS/min (multiplied by number of GSM/3G modems) **SMS Eagle used by CBS has two modems → 60 incoming per minute**
- Outgoing transmission rate: up to 20 SMS/min (multiplied by number of GSM/3G modems) **SMS Eagle used by CBS has two modems → 40 outgoing per minute**
- API sends SMS requests: up to 200 SMS/min (messages are queued for sending in a database)

Software platform

- OS: Linux
- Built-in Apache2 web server
- Built-in PostgreSQL database server
- Built-in Postfix email server
- Modern responsive web interface
- Watchdog mechanisms for GSM/3G modem

SNMP agent capabilities

- Control of Linux host MIB
- Control of SMSEagle specific metrics:
- GSM/3G signal strength
- Number of SMS messages in Outbox (outgoing queue length)
- Number of SMS messages sent within last 24 hours
- Number of SMS messages sent within last month
- Number of SMS messages in Inbox folder

Technical specs

Hardware

- Model Type: NXS-9750-3G Rev. 2
- Processor type: ARM A53 1.2GHz (quad-core)
- Internal storage: 4GB Flash drive
- 2 x 3G modem wavebands:
    - UMTS 800/850/900/AWS1700/1900/2100 MHz
    - GSM/GPRS 850/900/1800/1900 MHz
- SIM card standard: 2x SIM card (mini)
- RTC Clock: RTC 240B SRAM, Watchdog timer

External antenna

- 2 x Antenna: Omnidirectional 3.5dBi antenna with magnetic foot
- Connector: SMA
- Cable length: 3m

General

- Noise level: Fanless
- Dimensions: (width x depth x height) 35 x 120 x 101 mm
- Weight: 350g
- Casing: ABS, DIN rail installation (Rack mountable)
- Operating parameters:
    - Operating temperature: 0 ~ 60°C
    - Humidity: 5 ~ 95% RH (no condensation)
- Power consumption: max 47W
- Power supply:
    - Voltage ranges: 100–240 V AC
    - Frequency: 50–60Hz
    - Euro plug

- Additional connectors:
    - LAN Ethernet (RJ45) 10/100Mbps
    - HDMI
    - USB
    - 2x RS-232
    - 2x DI
    - 2x DO
- Linux Kernel: 4.4
- Approvals: CE, FCC, IC, RoHS, GCF (for RF-module), PTCRB (for RF-module), RCM (for RF-module)

Appendix C – Trigger rules for alerts

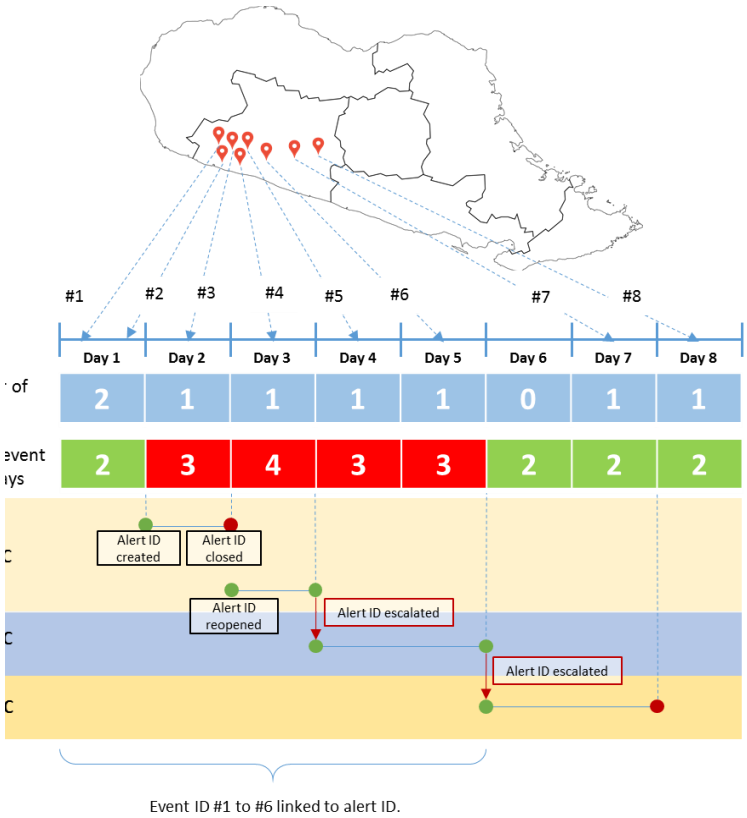


Figure 10 Illustration of hypothetical alert workflow and case report linking to alert IDs

Hypothetical scenario

"If the sum of events the last three days exceeds 3, issue an alert."

Day 1
Two events are reported, but an alert is not issued.

Day 2
The alert triggers a message to the level 1 data verifier and an alert ID is created. The data verifier investigates, but concludes the same day that the alert should not be escalated and submits the form, closing the alert ID. Events #1-3 are linked to the alert ID.

Day 3
The alert ID from day 2 is reopened since a new event has been registered and the number of events still is above three. The level 1 data verifier decides to submit her new findings and escalates the alert ID to the level 2 data verifier. Event #4 is linked to the alert ID.

Day 4 and 5
New events are reported, but since the alert from day 3 is still active, a new alert is not issued. The level 2 data verifier spends day 5 to investigate the alert. On day 6, he decides to submit his findings and escalate the alert to the data owner. Events #5 and #6 are linked to the alert ID.

Day 6 and 7
The data owner takes swift action and decides on day 7 that the alert is a false positive. The data owner submits her findings and the alert is closed. Since the number of alerts are within normal, event #7 is **not** linked to the alert ID.

Day 8
The event does not trigger a new alert since the sum of events are under the set threshold value.

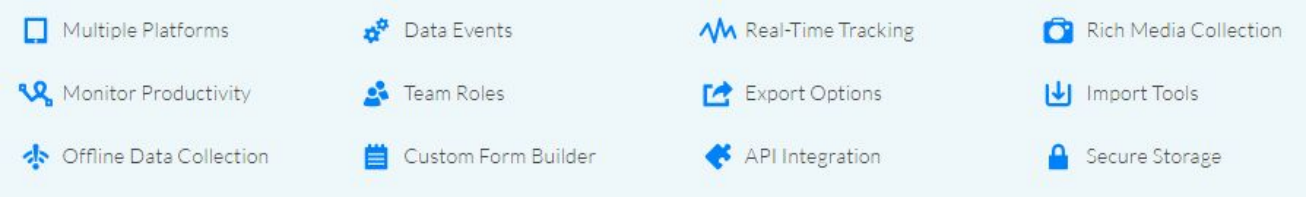
Appendix D – Note on specific technology suppliers

Developing applications in-house can be time consuming, costly and expensive to manage when in production. Therefore, one should seek to take advantage of professionally developed software as a service (SaaS) that covers specific parts of the required functionality, and put the effort into integrating these components seamlessly with the rest of the system. During the, and leading up to, the creation of this document, the author has undergone a wide technology search. Combined with the process of documenting the functional requirements and the research performed on different vendors, some specific SaaS-vendors seems to be better suited than others are. A semi-(un)structured bullet point summary of the research is presented in this appendix. Note that this is not a recommendation, but can serve as an input to a system design phase.

Fulcrum App – Survey tool

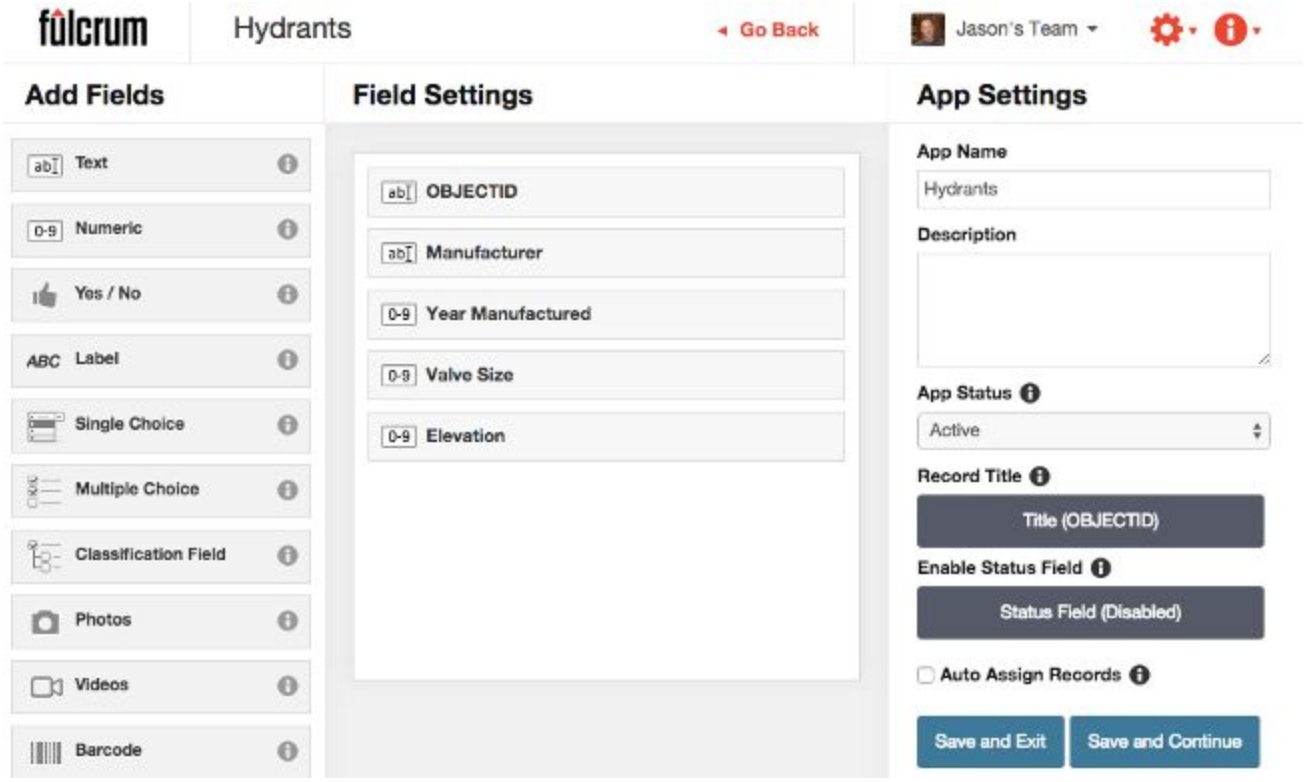
http://www.fulcrumapp.com/
http://help.fulcrumapp.com/
http://www.fulcrumapp.com/blog/looking-ahead-to-2017/

Fulcrum is a hosted mobile forms platform that enables you to build custom apps for capturing information from the field. Design your forms using the intuitive, web-based drag-and-drop designer and deploy to your mobile workforce for gathering information like Text, Photos, Spatial, Video, Spatial, Audio, Signatures, Barcodes, GPS Location, and more.



- Modern and user friendly interface in both mobile client and designer
- Very flexible designer that can be extended with custom code if necessary
- Classification sets in Fulcrum let you create predefined hierarchies and schemas for classifying data into a standard format from the field. Can be used in several apps – updates are reflected in all apps.
    - E.g. region/district/commune/fokotany hierarchies
- Record fields from one app can be linked within another form
    - E.g. case reports linked to a specific alert can be displayed in an alert form to enable the user to confirm cases.
- Works offline/online
- Mobile client can store maps offline
- Location is set with pinch-and-tap in a map – no need to manually enter coordinates
- Link to (prefilled) form can be sent by SMS and opened in the app
- Excellent user management interface

- Records can be assigned to users
    - For instance a pre-filled alert form can be assigned to a data verifier
- Projects can be used to separate data into different groups. Once projects have been created and permissions granted to members, members can tag a record with one of the created projects.
    - Data can be filtered by projects.
    - Only members that have permission to a project will be able to see the data captured under that project.
- Direct access to specific forms (e.g. alert forms) from home screen on mobile phone via add-on
- Most functionality in the app can be controlled through the API
- Data events can easily be transferred to a database via webhooks
- Multi-step rule-based workflow management in development (2017)



Telerivet – SMS gateway integration tool and web management interface

https://telerivet.com/
http://support.telerivet.com/
https://telerivet.com/api

Telerivet makes it easy to send and receive SMS messages, but it is not just another SMS gateway API. With Telerivet, you can build powerful mobile messaging services in just a few

lines of code. Our world-class web messaging dashboard, contact and group management, and data storage is built right in – there is no need to build everything from scratch.

- Integrates with all gateway-providers, including their own android-app, SMSSync, Twilio, Nexamo, local network provider (through SMPP API or HTTP API)
- Powerful business rules editor for handling incoming data in a graphic rules editor or with custom code (JavaScript), hosted on GitHub if wanted.
    - Send SMS reply
    - Send SMS
    - Send SMS to group
    - HTTP requests to other service
    - Add contact to group
    - Remove contact from group
    - Use another contact
    - Set contact name
    - Set contact variable
    - Block sending to contact
    - Send USSD request
    - Send email
    - Send airtime
    - Post tweet
    - Add label to message
    - Star message
    - Set variable
    - Cancel scheduled messages
    - Notify webhook URL
    - Show log message
    - Run JavaScript code
    - Condition
    - Stop processing rules
    - Copy message to project
    - Set message variable
    - Trigger service for contact
    - Wait for response
    - Run subroutine
    - Call contact back
- "iPhone-style" conversation overview of all communication with every individual phone number
- Easy to send SMS to a large group of recipients, with custom filtering and variable text merge
- Extensive API that exposes most of the application features, so that it can be managed externally
    - Client Libraries
    - Authentication
    - Request Format

- Errors
- Storing Custom Data
- Retrieving Objects
- Filtering Queries
- Messages
- Contacts
- Broadcasts
- Projects
- Labels
- Groups
- Phones
- Data Tables
- Data Rows
- Scheduled Messages
- Services
- Contact/Service State
- Message Routes
- Mobile Money Receipts
- Variable Reference

- Voice-capabilities – both pre-recorded and text to speech
- Send AirTime to fill up pre-paid cards