SABO MOBILE IT GMBH

ZenMobile

Technical Whitepaper

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1 Purpose

ZenMobile is a mobile application that integrates the Zenon SCADA system,[1] developed by SABO Mobile IT and the Everywhere App, developed by Copa-Data.

This document provides a detailed overview of the design and architectural features of the ZenMobile application.

2 Overview

The mission of ZenMobile is to provide users access to the Zenon SCADA system on their smartphones and tablets. The application enables users to fully monitor and control their equipment remotely, using either Wide Area Networks (WANs) or secure VPN connections when on mobile cellular networks.

The intention is to provide users with the majority of the SCADA functions that they can do on their desktops in Zenon Runtime, as well as extending the experience to smartphone technologies, creating more powerful use cases, like QR-Code or RFID scanning-based navigation, biometric authentication, location awareness or integration with other apps on the smartphone.

3 Architecture

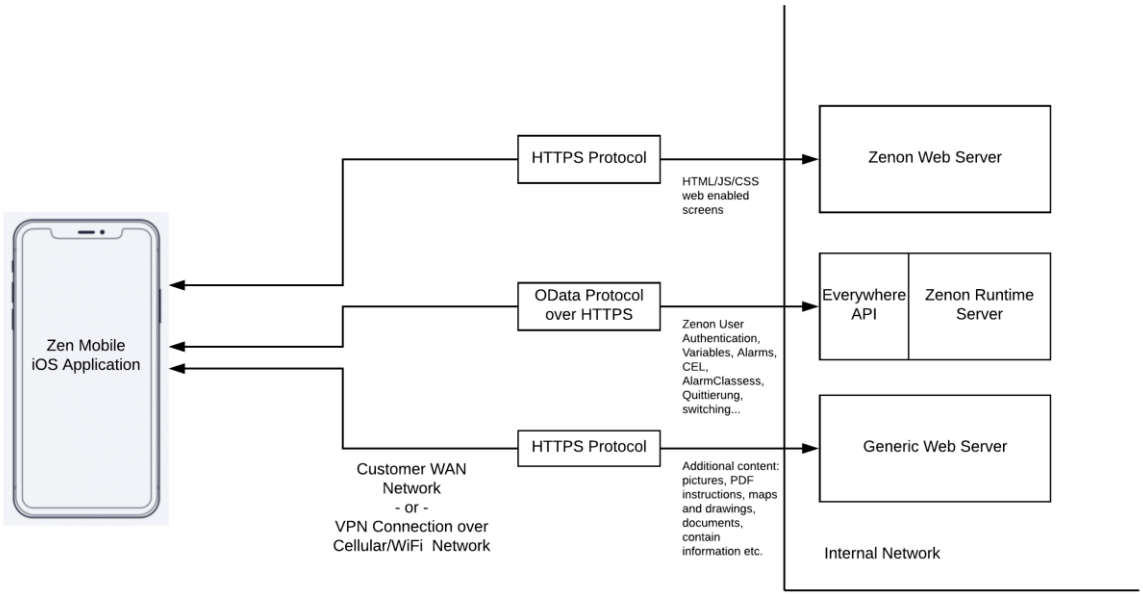
3.1 Backend Services

ZenMobile requires the Everywhere Server to be installed, configured and started for Zenon projects.

It can also communicate to the Zenon Web Server to provide user-defined process visualization in the app using web-enabled screens in the project.

If the customer wishes, it can also connect to additional web servers to obtain content to be merged with data and screens of the main application, providing additional instructions, pictures, and information that is currently not available in Zenon.

[1] Trade Mark of COPA-DATA GmbH



3.2 Data Model and Protocol

HTTPS and OData protocols are used to exchange data between Backend and the mobile application. ZenMobile currently supports the full data model of the Everywhere Server. It can read and display all information from Zenon Runtime that is available through the Everywhere Server. Additionally, it can write information into Zenon Runtime, namely set variable values (i.e. for device control switching, or comment and acknowledge single or multiple alarms).

3.3 Development Framework

ZenMobile is developed using Reactive Functional Programming and frameworks to enable easy decomposition of asynchronous operations and event/data streams. A reactive approach is platform independent, thus allowing for an easier adoption of additional platforms.

3.4 Supported Platforms

It is currently supported on Apple's iOS platform (iPhones and iPads) and there are intentions to also provide an Android version.

4 ZenMobile Components

4.1 Standard Components

The application was designed to use standard components that are designed, developed and maintained by SABO. This was done to ensure that the application is reliable and powerful, and also to enhance the users experience and lower the costs involved. The data model, Backend communication, data processing, equipment model abstraction, authentication, alarms and CEL events are examples of the standard building blocks every customer can reuse to get the best possible function and to lower the cost of development.

4.2 Customizations and Extensions

The customer-specific parts of the application are customized according to the needs and requirements of the individual customer. It is also possible to extend the scope of the application based on the requirements of the client.

4.3 Standard User Interface (UI)

Standard components are also provided in a form of a standard UI/UX. If the standard UI is satisfactory in selected application areas, the customer can re-use these standard UI components and further reduce the cost of the application development and maintenance.

4.4 Building customer application with standard Components and Customizations

The following table shows a list of standard components and shows which parts of the application can be customized according to customer needs.

	Backend Integration & Data Model	Application Logic	User Interface & Control
Environments	Standard	Standard + Custom	Standard + Custom
Authentication	Standard	Standard + Custom	Standard + Custom
Biometrics	Standard	Standard + Custom	Standard + Custom
Connection Observer	Standard	Standard + Custom	Standard + Custom
Plant/Device Navigation	Standard + Custom	Standard + Custom	Standard + Custom
Device List & Detail	Standard + Custom	Custom	Custom
Device Control	Standard + Custom	Custom	Custom
Filtering	Standard	Standard + Custom	Standard + Custom
Alarms	Standard	Standard + Custom	Standard + Custom
Alarm Acknowledging	Standard	Standard + Custom	Standard + Custom
CEL list	Standard	Standard + Custom	Standard + Custom
Trend Charts	Standard	Standard + Custom	Standard + Custom
URL Opener	Standard	Standard + Custom	Standard + Custom
QR-Code Scanner	Standard	Standard + Custom	Standard + Custom
Remote Support	Standard	Standard + Custom	Standard + Custom

Process variables naming conventions vary greatly between Zenon customers. ZenMobile comes with suggestions and guidelines for process variables naming, grouping and equipment modelling to achieve effective navigation through factory hierarchies and device lists.

The visual design of the device representation on the list and its detailed information are almost always prepared according to a specific customer process and needs.

In all other parts of the application, customers can either use ZenMobile standard components for a particular part of the application, or customize either the logic, user interface or both of that part.

For example, the customer can re-use ZenMobile standard components for all parts of the application, except for Alarms, where the customer wants to define their own icons and layout of the alarm list and alarm detail.

5 Features

5.1 Authentication

5.1.1 Entering Credentials

Users are required to enter their credentials. The password is entered using Secure Text Entry (dots hide real characters when typing). The login button is disabled until satisfactory credentials are entered or when the device enters a Network Offline state.

Users are allowed to login by tapping the enter/return key on their soft or hardware keyboards to speed up the login process.

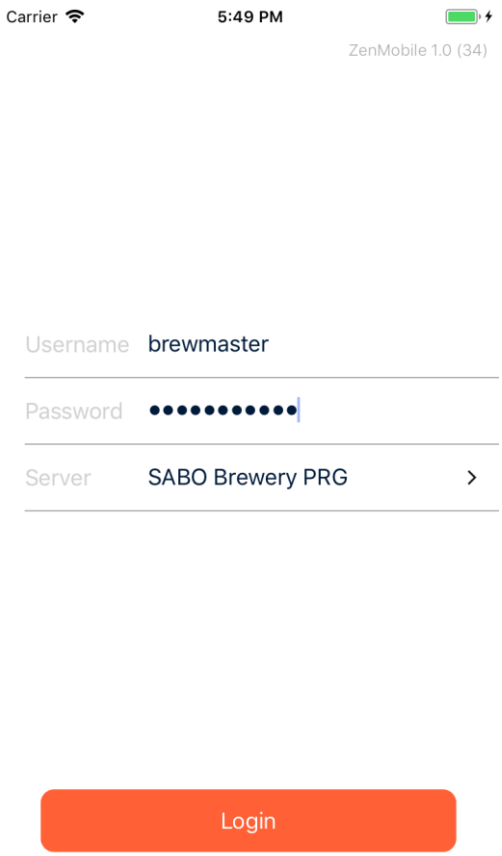
5.1.2 Authentication Error Handling

After unsuccessful login attempts the user is shown an error message explaining the reason for failed authentication:

- Incorrect credentials
- Network Connection Error (server not reachable)
- Network Offline (lost network connection during login evaluation)

5.1.3 Storing Username and Password

Some customers require the storing of their username and password in the application after the first successful login. This option can be enabled for the customer in the application configuration during development.

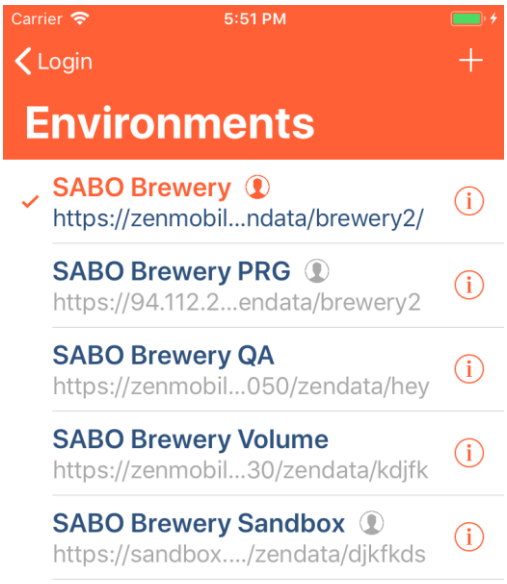


5.2 Environment Switching

5.2.1 Managing and Switching between Environments

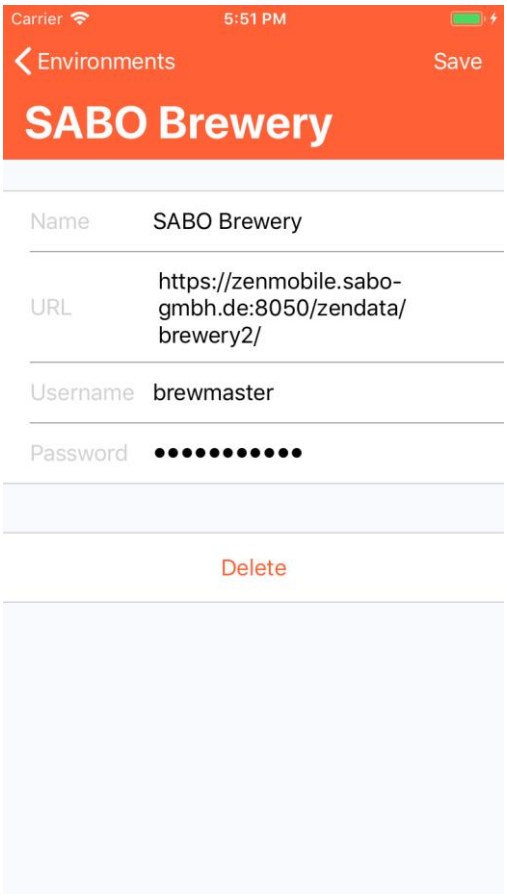
The application requires defining at least one server/project environment that it will connect to. The login screen holds the name of the initial or last selected server/project environment, and users have the option to see a list of available predefined environments, select a different environment for login and/or define their own environment.

Environment management and switching are good for faster application testing when the application needs to be run against various test/development environments as well as against production servers.



5.2.2 Defining own Environment

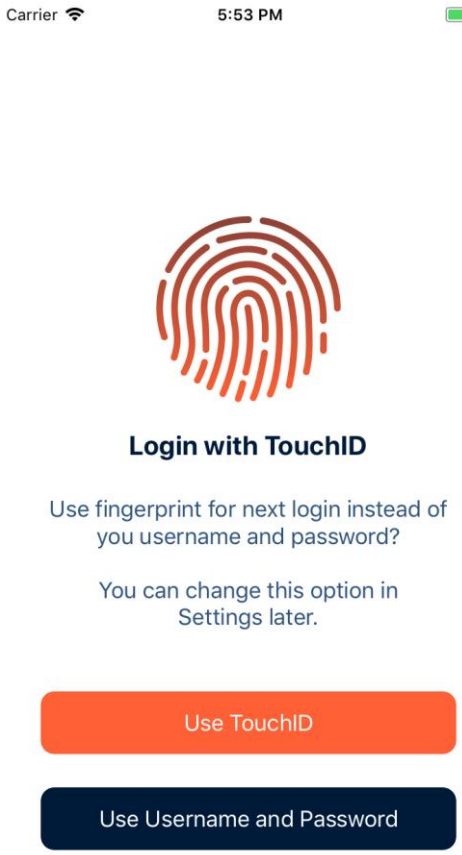
The user has the option to define their own server URL and to provide a name to be shown on the list of environments and on the login screen. Optionally, the user can predefine credentials (username and password) when in development distribution to further speed up the login process during application testing.



Stored credentials feature is only available in development distribution builds to speed up application testing and is not available in production distributions.

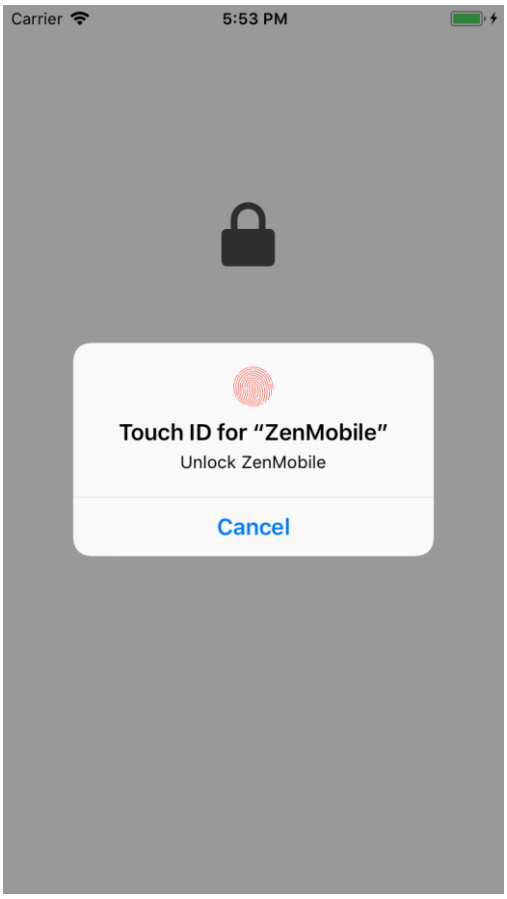
5.3 Biometric Authentication

ZenMobile supports authentication using biometric hardware, namely TouchID and FaceID on iPhones and iPads. If the device uses either fingerprint or face to unlock the device, the application will ask the user after the first successful login, if they want to use this biometric authentication for all subsequent logins.



5.3.1 Biometric Authentication Settings

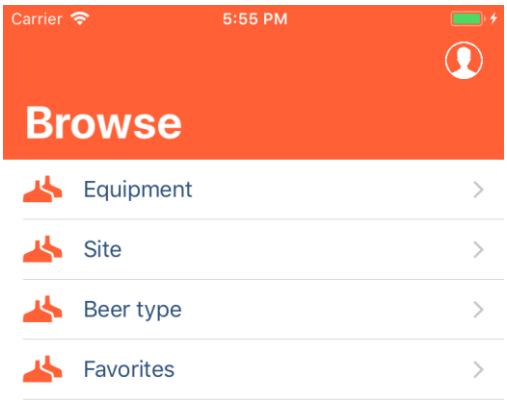
This feature can be also enabled/disabled in the application settings.



5.4 Connection Observer

After a successful login to the application, the application presents the first screen with the main navigation. On the bottom, there is a main TabBar used to quickly jump to the desired function (plant/device, alarms, CEL, trend, and search).

Above the TabBar and on the bottom of nearly every screen a tiny status area is shown.



5.4.1 Connection Observer Options

The area informs the user about the presence and quality of the network connection. Its purpose is to provide an independent network connection indicator for the user that is always visible and blends with the TabBar when the connection is online and fast so that the user is not distracted.

The status area turns yellow for delayed connection when the app starts to receive responses from the Everywhere Server that are longer than 5 seconds. This indicates to the user that the app is connected to Zenon and that user can see and manipulate the data, but that it takes more time to see up to date information or that the information on the screen might be more than 5 seconds old.

When the status area turns gray and displays either Network Error or Network Offline, it indicates to the user that the connection to Zenon is broken. The user needs to restore Wi-Fi or mobile connectivity to Zenon Server or alternatively check the status of the VPN connection if that is used.

5.5 Plant and Device Navigation

The user's navigation throughout the plant, logistics complex, manufacturing, utility processes or whatever structure the project defines is probably the most variable part of every SCADA project.

ZenMobile, however, offers 3 ways to define the project navigation structure and helps the mobile user to quickly find devices they are looking for.

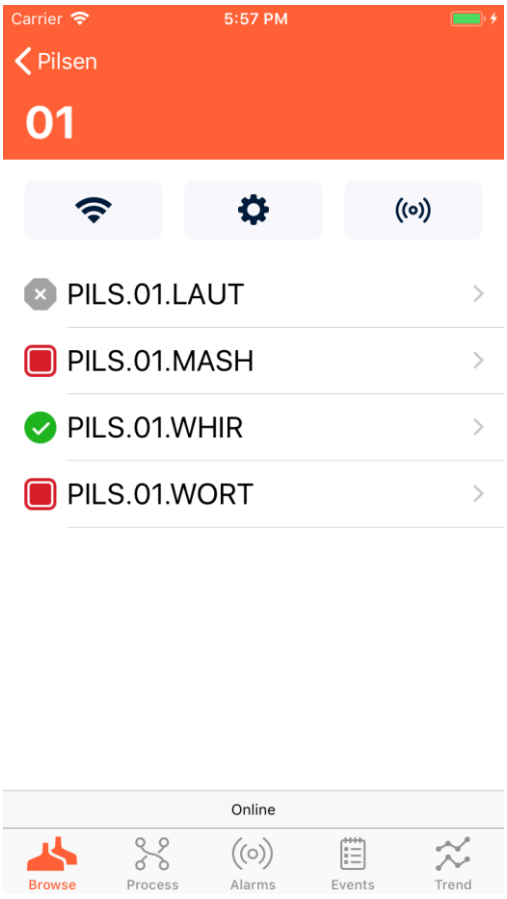
5.5.1 Using Equipment Model for navigation

The easiest way to build a mobile navigation menu quickly is to use the Equipment Modeling feature of Zenon. Users are free to build their own tree hierarchy of buildings, production lines, technologies, sites, product types, etc.

ZenMobile uses smart parsing to read and adopt this navigation structure, so it will dynamically read and present each step on the hierarchy tree on a single screen until the end of the tree branch is reached. The app then shows a list of devices assigned to this Equipment Group.

Users can easily and quickly define their own structures in Zenon Editor. They can also make sure proper devices are shown for each navigation screen by adding variables to these Equipment Groups.

Equipment Model based navigation is actually a standard component and works out-of-the-box when Devices' Variables are assigned proper Equipment Groups.



5.5.2 Using Variable Naming Conventions for Navigation

Another option to build a navigation hierarchy is to adopt proper Variable naming conventions. For example, the tree hierarchy can be presented in the Variable names like this:

Variable name	PILS.01.MASH_VOLU_AP
Site	PILS (Pilsen)
Product Line	01
Device/Equipment	MASH (Mash Kettle)

In this example, we used dot notation to separate the device's site, production line, and device type.

When such naming conventions are used the app builds the hierarchy navigation tree by reading and parsing the Variable names' dot notation syntax. The convention and the syntax are freely definable with the client and become part of the Device Name constructor within part of the navigation component.

Note: The Equipment Model hierarchy tree can be effectively combined with the Variable naming convention to speed up variable creating, and achieve better parametrization and re-use in both Zenon Runtime screens as well as in the ZenMobile application.

5.5.3 Custom Navigation Patterns

Some customers will not use any of these options and will simply define their own custom navigation using screens, menus, and buttons in Zenon Editor. This custom navigation logic is then recreated in the mobile application as part of the customization of the app navigation.

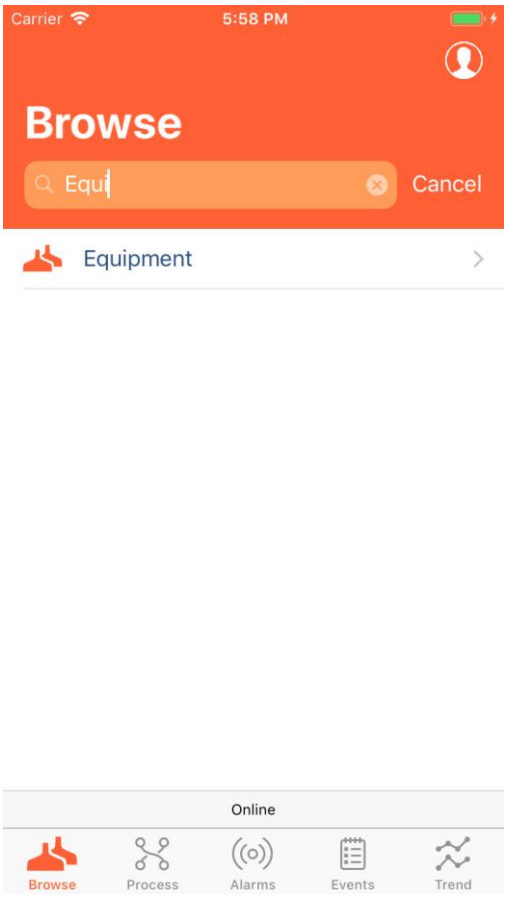
5.6 Searching and Filtering

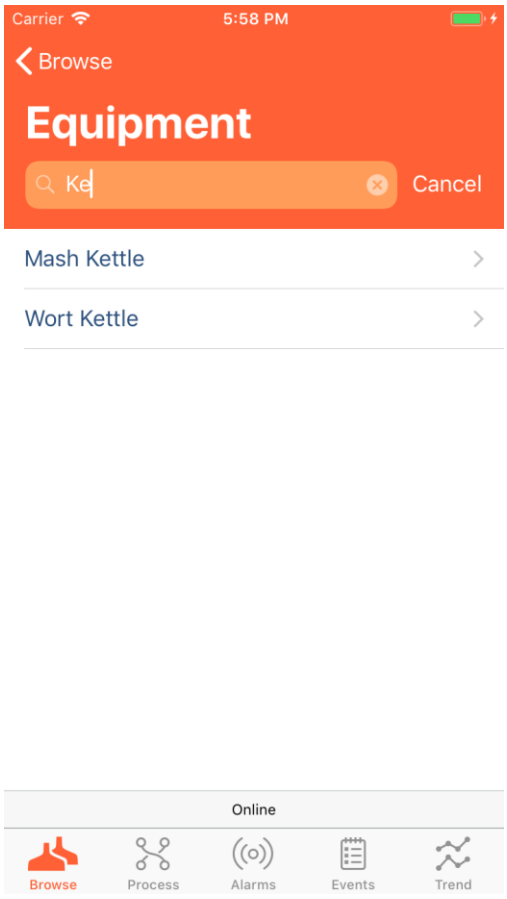
Searching and Filtering of lists is available on the following screens:

1. Navigating through Plant hierarchy using either Equipment Model or Naming Conventions – on every dynamically populated screen of the hierarchy tree
2. Device List
3. Alarm List
4. CEL List
5. Trend Diagrams List

5.6.1 Searching Through Plant Navigation, Trend List

On the Plant navigation screen the user can reveal the search bar and start typing text. The displayed text is immediately filtered, with only the matching rows being shown.



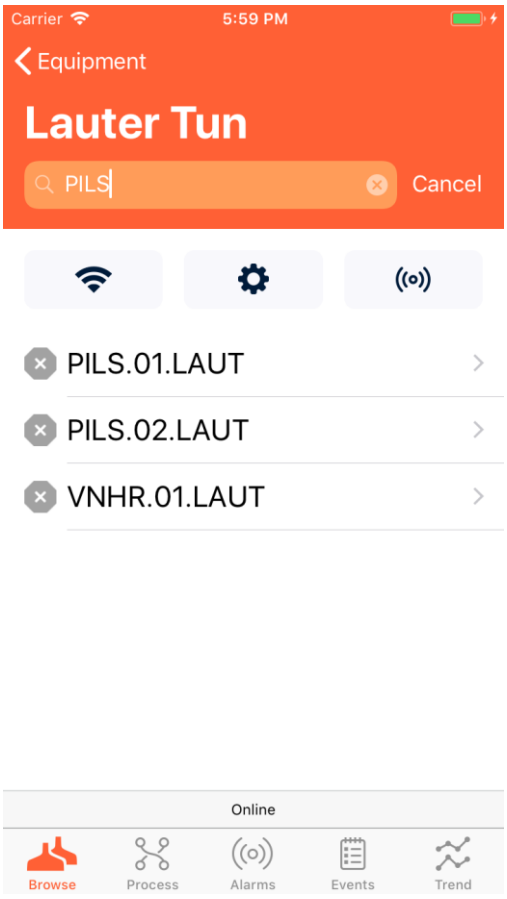


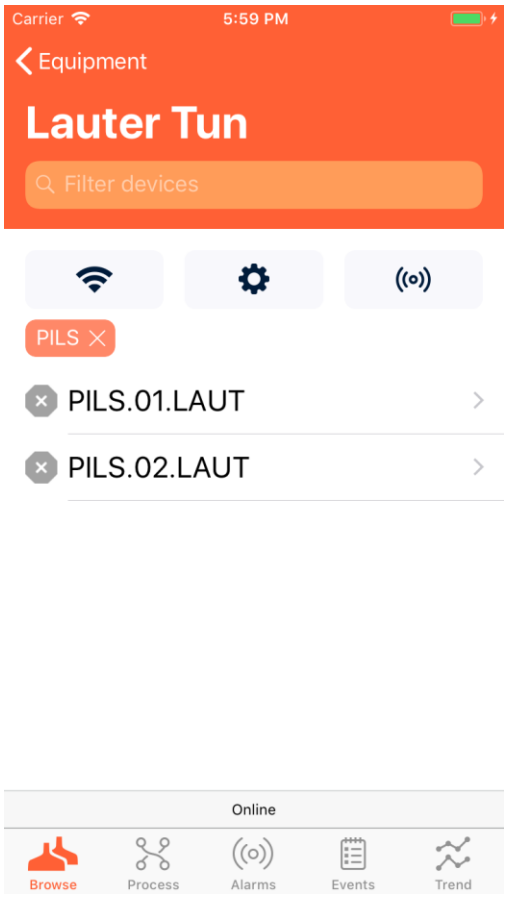
Similarly, the searching is also available on the Trend list screen.

5.6.2 Fast and Advanced Filtering of Devices, Alarms and CELs

For the Device List, Alarms and CEL List, the search functionality is combined with additional filtering buttons to create fast and advanced filtering capabilities of these lists.

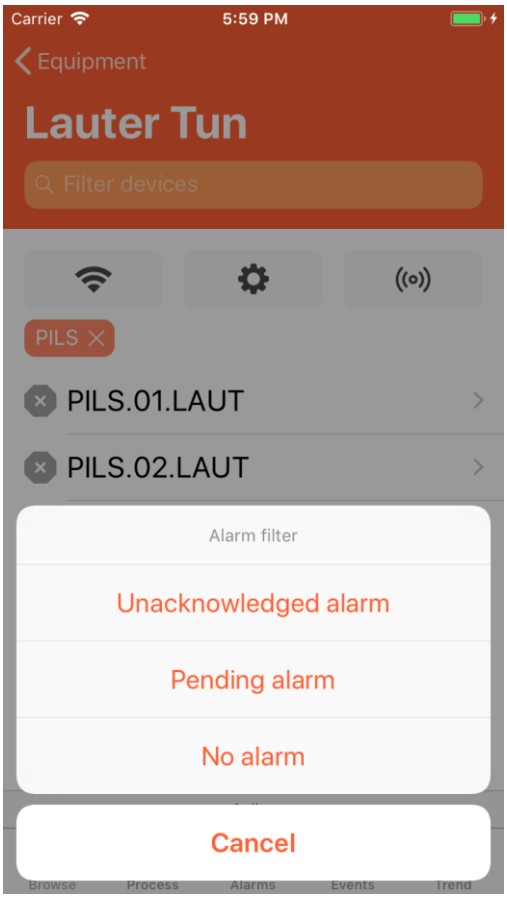
Typing search text into the search bar on these screens, then tapping return will add the search text as a filter text and combine it with other filter queries using ‘and’ operand.

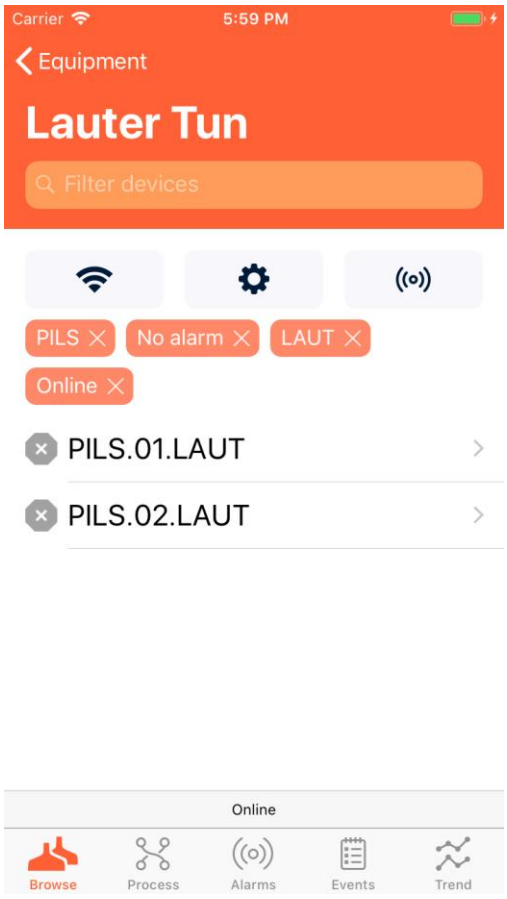




Each filter query is indicated on the filter bar under the search bar. The user has the option to remove the filter query by tapping on its cross symbol.

The user can add an unlimited number of additional text queries using the search bar and combine queries with context filtering for each screen. Context filter queries are available under the search and filter bar as context filter buttons. By tapping on the button the user is presented with context options for the most important queries for each screen.





5.6.3 Device List Filter Queries

The Device List holds the following context filter queries:

- Connection stability filter
  a. Connection failure
  b. Connection stable
- Operation failure filter
  a. Operation failure
  b. No failure
- Pending alarm filter
  a. With pending alarm
  b. Without pending alarm

5.6.4 Alarm List Filter Queries

The Alarm List holds the following context filter queries:

- Date range filter
  a. Last hour
  b. Last 12 hours

    c. Last 24 hours
    d. Last 48 hours
    e. Last week
    f. Last month
    g. Last year
- Acknowledge filter
    a. Only acknowledged
    b. Only not acknowledged
- Category filter (fully user defined)
    a. Category filter is dynamically populated from Alarm Classes
    b. Alternatively, it can be constructed from Alarm Groups

5.6.5 CEL List Filter Queries

The CEL List holds the following context filter queries:

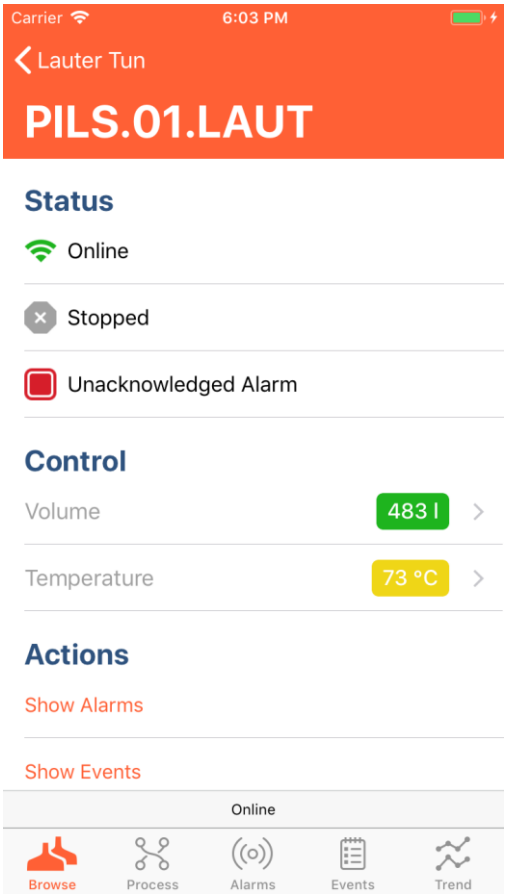
- Date range filter
    a. Last hour
    b. Last 12 hours
    c. Last 24 hours
    d. Last 48 hours
    e. Last week
    f. Last month
    g. Last year
- Event type filter
    a. Only system
    b. Only process

5.7 Device Status

By tapping the device row in the list, the user is presented with a detail screen of all device status and measured parameters, which are customized for specific customer needs.

In the SABO Brewery project, the screen shows:

1. Section of main status information
    a. Connection Status (Online, Offline)
    b. Failure Status (Operating, Failure)
    c. Alarm Status (No Alarms, Some Alarms, Acknowledged/Unacknowledged Alarms)
2. Section of measured analog parameters with the option to control associated equipment (pumping up, pumping out, heating and cooling) on a separate control screen
    a. Volume in liters
    b. Temperature in degrees of Celsius
3. Section of links to related alarms and CEL events for the device
    a. Alarms
    b. CEL events

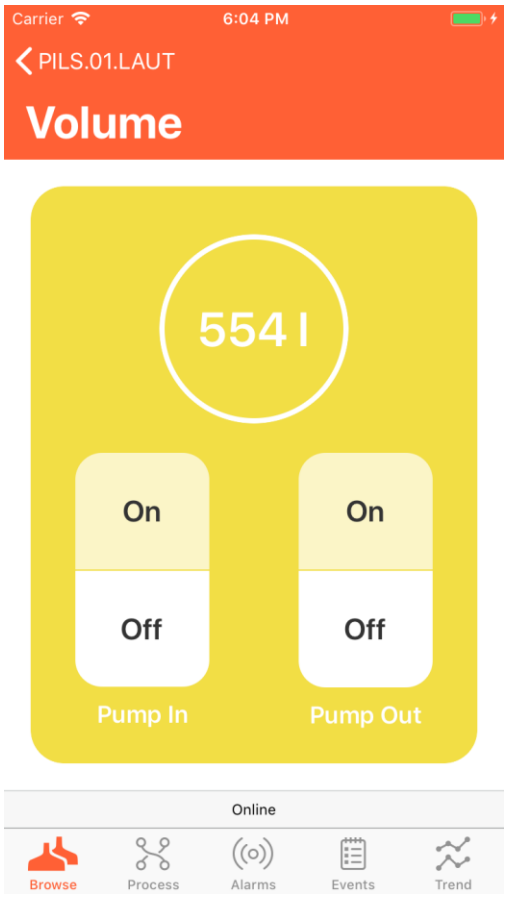


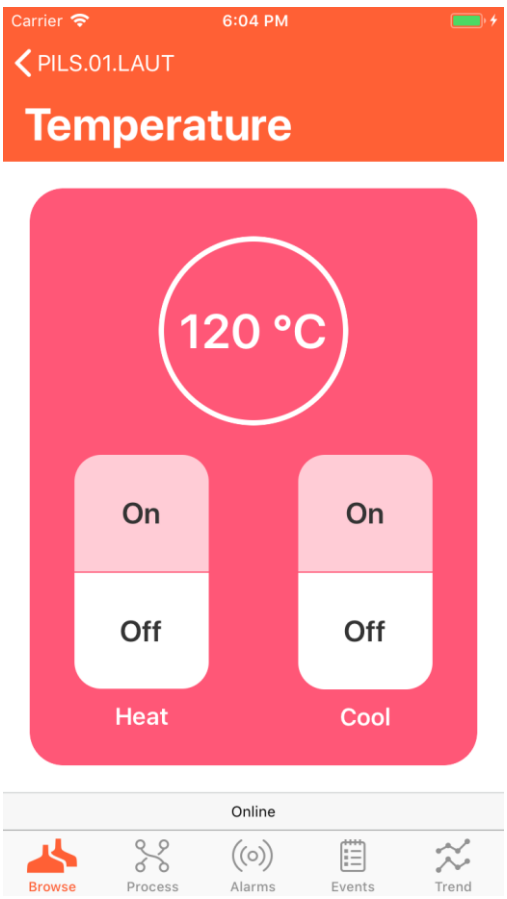
All presented statuses and parameters are updated in real-time on the screen.

5.8 Device Control

By tapping on a row in the Control section (Volume or Temperature), a detailed control screen is presented to the user for particular equipment. The user can observe values in real-time and can control the equipment (e.g. pumps for filling and emptying the kettle, heating and cooling) using corresponding switches.

Carrier
6:03 PM
PILS.01.LAUT
Volume
483 l
On
Off
Pump In
On
Off
Pump Out
Online
Browse
Process
Alarms
Events
Trend


Carrier
6:04 PM
PILS.01.LAUT
Volume
554 l
On
Off
Pump In
On
Off
Pump Out
Online
Browse
Process
Alarms
Events
Trend

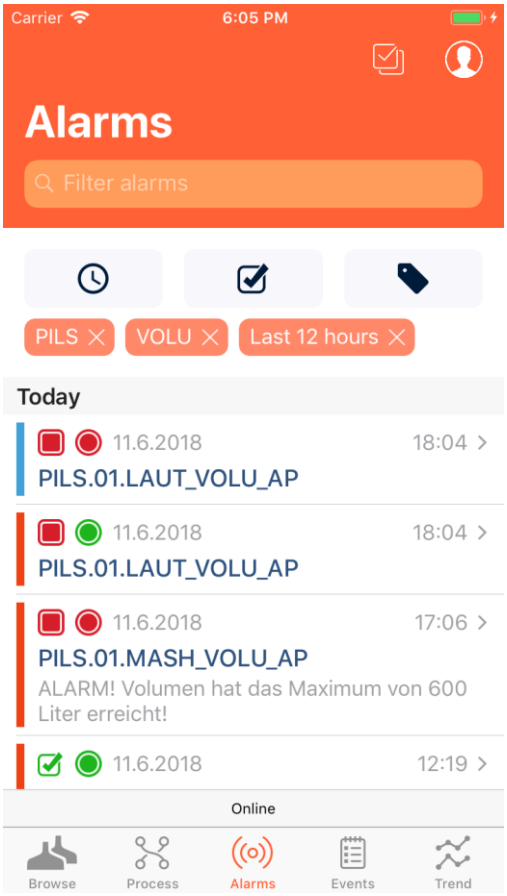

Carrier
6:04 PM
PILS.01.LAUT
Temperature
120 °C
On
Off
Heat
On
Off
Cool
Online
Browse
Process
Alarms
Events
Trend

5.9 Alarms

5.9.1 Alarm List

Alarms are loaded from the ring buffer and the top 50 alarms are shown on the list. Every 10 seconds the list is refreshed for new alarms, with the new alarms being added to the top of the list.

If the user scrolls to the bottom of the list an additional page of 50 alarms is loaded and added to the end of the list.



5.9.1.1 Sorting

Alarms are sorted by time, with the newest to the top. In the case of repeating alarms the time of the repeat is used for sorting.

5.9.1.2 Alarm Colors

Alarms in the list have colored backgrounds according to their priority, as taken from the associated AlarmClass:

Red color - AlarmClass with Name: 'Priority 1'

Orange color - AlarmClass with Name 'Priority 2'

Yellow color - AlarmClass with Name 'Priority 3'

Light blue color - AlarmClass with Name 'Priority 4'

White color - no AlarmClass assigned

5.9.1.3 Alarm Icons

Alarms in the list have color icons on the left side with the following meaning:

Red icon - Unacknowledged pending alarms (in Alarm API indicated by 'acknowledged = false' and 'deleted = false')

Yellow icon - Acknowledged pending alarms (in Alarm API indicated by 'acknowledged = true' and 'deleted = false')

Green icon - Cleared alarms (in Alarm API indicated by 'acknowledged = any value' and 'deleted = true')

5.9.1.4 Alarm Filtering

As described in the chapter Searching and Filtering, Alarm List filtering combines text queries from the Search Bar input field, which is revealed when scrolling to the top of the list, with filter queries on the 3 filter buttons below the search bar.

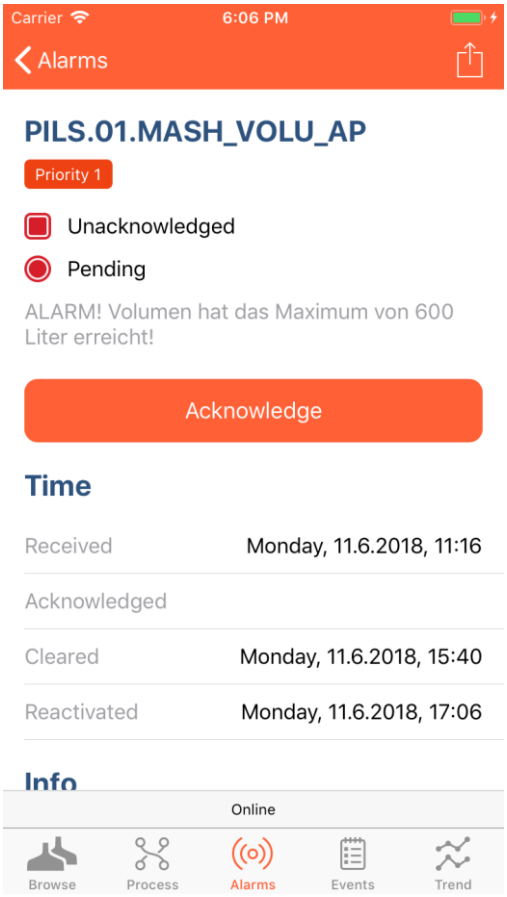
All query conditions are presented on the filter bar and combined. The user has the possibility to remove unwanted queries or replace existing queries with updated values.

With the resulting query, a new Backend request is made and the updated list is presented to the user. This is important as the Ring buffer may contain several tens or hundreds of alarms, while the mobile app shows only the first 50 on the initial load. Therefore with an updated filter query a new request needs to be made to retrieve the new page of alarms that comply with the updated filter query.

5.9.2 Alarm Detail

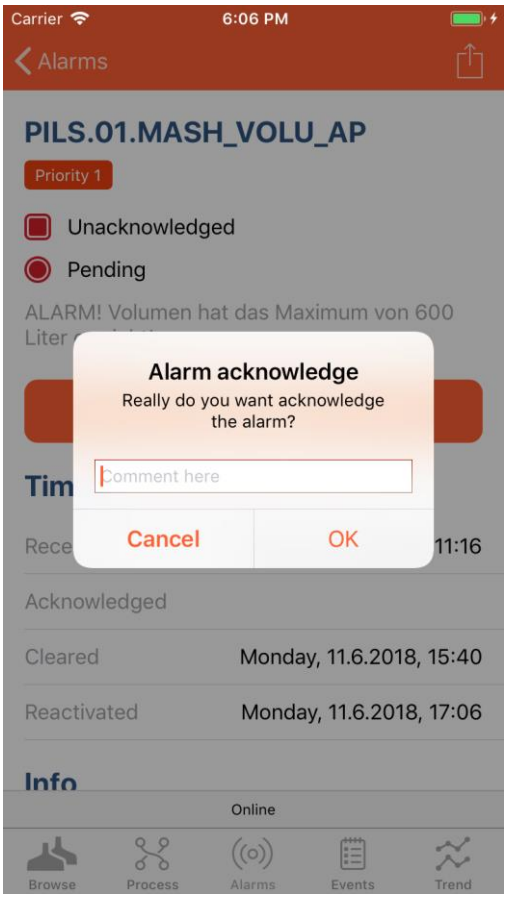
The Alarm detail screen shows additional information about the alarm

- Status icon of the alarm with textual description whether the alarm is pending or cleared
- Number of alarm reactivations
- Time of receiving the alarm
- Time of the re-appearing of the alarm
- Time of clearing the alarm
- Time of acknowledging the alarm
- Status row of the Device that triggered the alarm with up to date values
- Alarm text and identification
- Value of the alarm when it was originally triggered
- Unit
- Comment

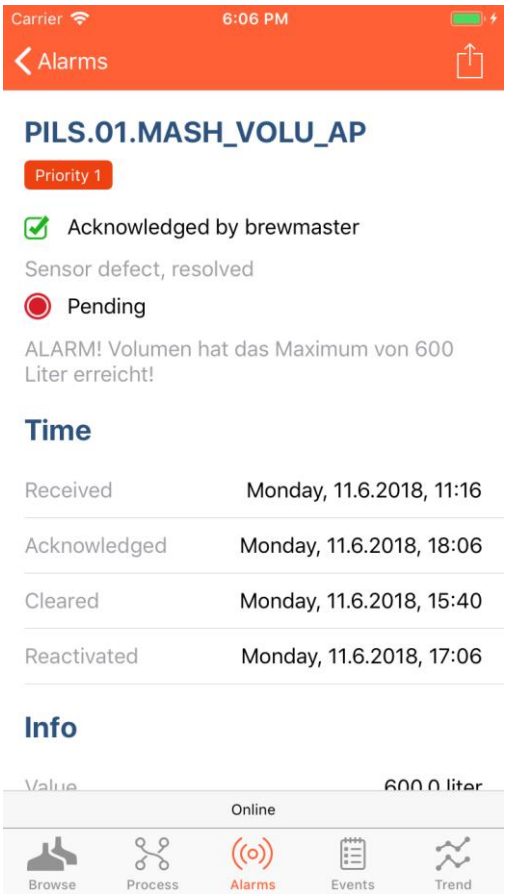


5.10 Single and Multi-Alarm Acknowledging

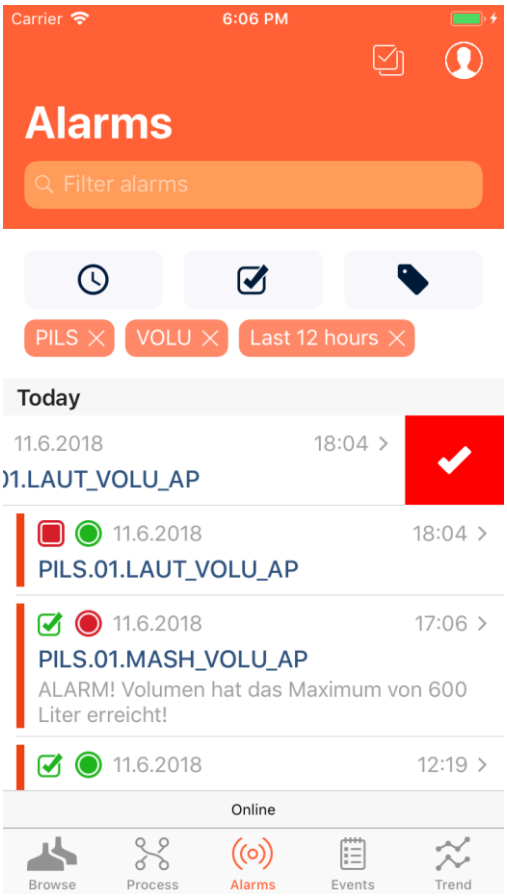
Unacknowledged alarms can be acknowledged on the detail screen by tapping on the Acknowledge button on the top. The user has to confirm this action on the next popup screen and has the option to provide a comment.



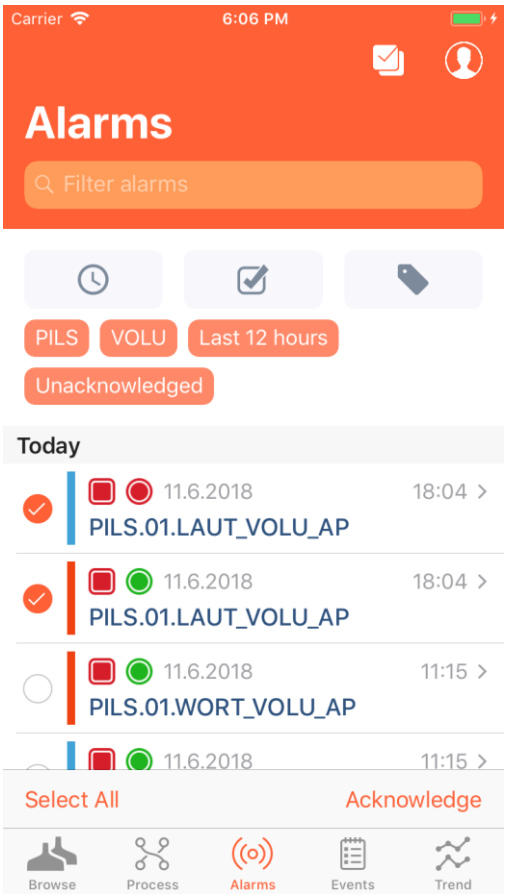
When the Alarm is successfully acknowledged, the detail screen is updated to reflect the new state and the Acknowledge button disappears.



When on the Alarm List, the user has a faster option to acknowledge the Alarm directly from the Alarm list by swiping left on the alarm row. The Acknowledge button is revealed on the row and by tapping on it. The user then has to confirm the action on the popup screen and is given the option to provide a comment.



Similarly, the user has the option to enter Multi-Select mode and acknowledge several or all alarms at once. In the Multi-Select Mode, the user can also mark as many unacknowledged alarms as he or she wants. Acknowledging alarms needs to be confirmed on the popup screen and the option to provide a comment is also given.



After the communication to Zenon is completed, the user is shown a report popup confirming the number of successfully acknowledged alarms, potential errors and the Alarm list is then updated accordingly.

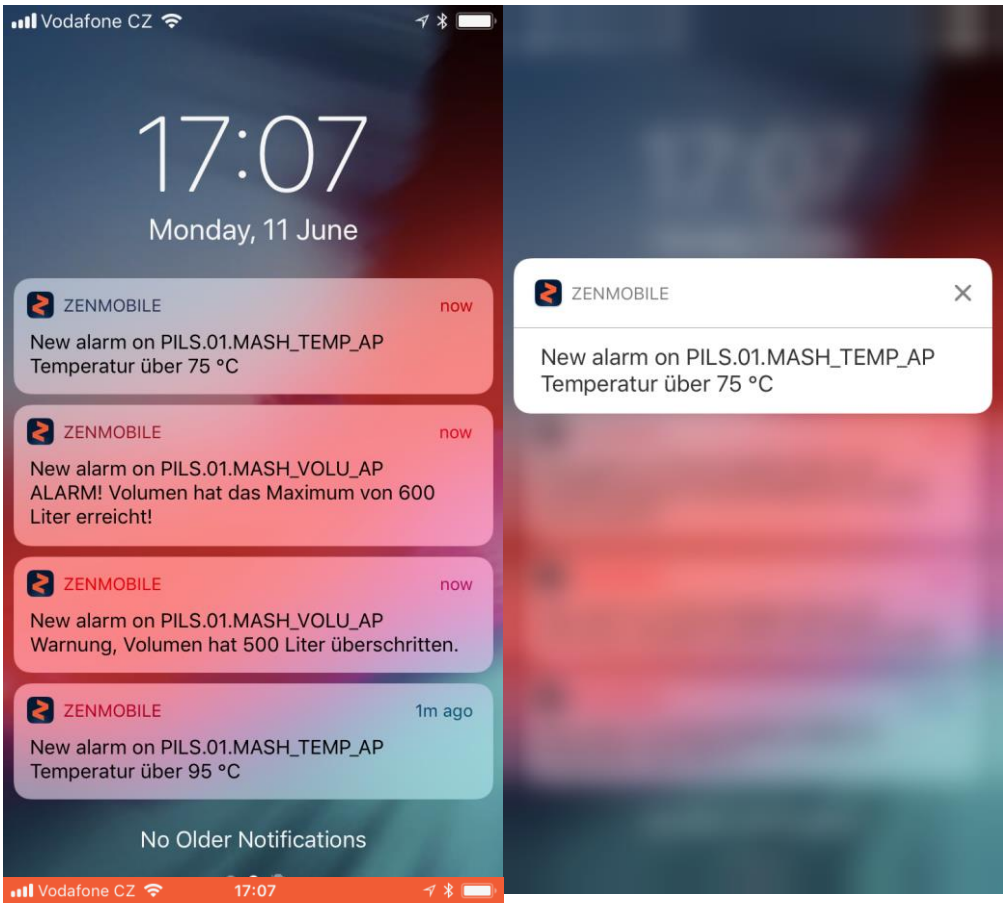
5.11 Push Notifications for Alarms

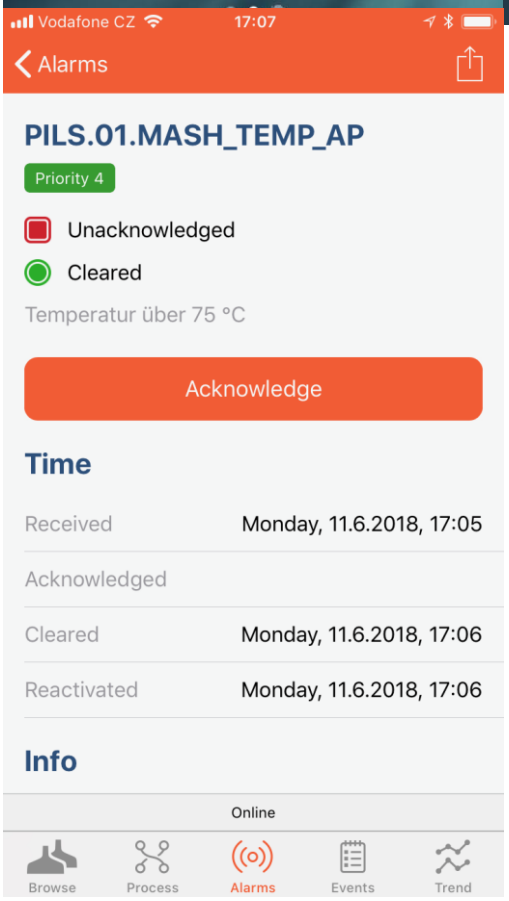
ZenMobile supports Push Notifications for notifying users about new incoming alarms. Push Notifications submodule currently uses Message Control module of zenon to fully configure and control which alarms will notify which users using Push Notifications.

Once Message Control is set up, the user is asked for permission to allow sending push notifications to his or her device. Once this permission is granted, new alarms will be announced tot he user even if ZenMobile is not currently running in the foreground on the device.

User can simply dismiss incoming Notifications, or by tapping on the Notification, ZenMobile launches and opens the alarm that has been tapped on.

User can control permission for Push Notifications in Settings, where he or she can Disable or Enable receiving of Push Notifications from zenon.


Vodafone CZ
17:07
Monday, 11 June
ZENMOBILE now
New alarm on PILS.01.MASH_TEMP_AP
Temperatur über 75 °C
ZENMOBILE now
New alarm on PILS.01.MASH_VOLU_AP
ALARM! Volumen hat das Maximum von 600 Liter erreicht!
ZENMOBILE now
New alarm on PILS.01.MASH_VOLU_AP
Warnung, Volumen hat 500 Liter überschritten.
ZENMOBILE 1m ago
New alarm on PILS.01.MASH_TEMP_AP
Temperatur über 95 °C
No Older Notifications
ZENMOBILE
New alarm on PILS.01.MASH_TEMP_AP
Temperatur über 75 °C

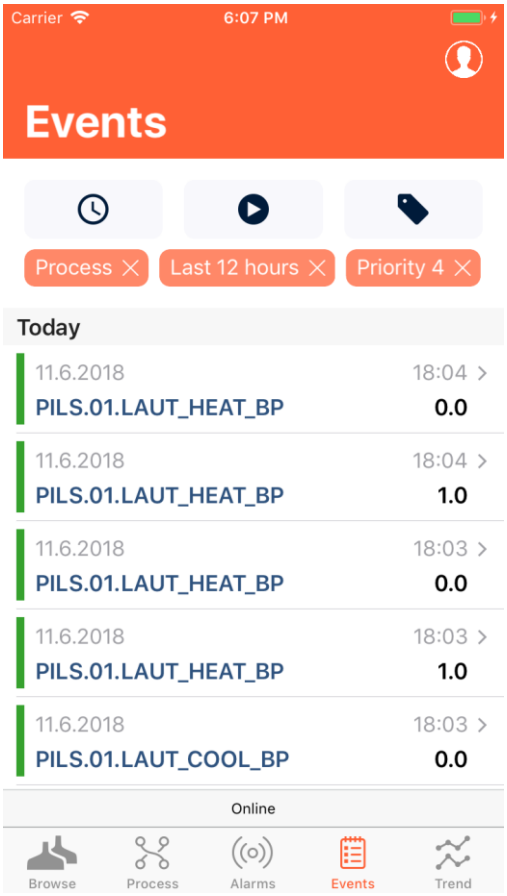

Vodafone CZ 17:07
Alarms
PILS.01.MASH_TEMP_AP
Priority 4
Unacknowledged
Cleared
Temperatur über 75 °C
Acknowledge
Time
Received Monday, 11.6.2018, 17:05
Acknowledged
Cleared Monday, 11.6.2018, 17:06
Reactivated Monday, 11.6.2018, 17:06
Info
Online
Browse
Process
Alarms
Events
Trend

5.12 Chronological Event List (CEL)

5.12.1 CEL

CEL are loaded from the Ring buffer and the top 50 events are shown in the list. Every 10 seconds the list is refreshed for new events and the new events are added to the top.

If the user scrolls to the bottom of the list, an additional page of 50 events is loaded and added to the end of the list.



5.12.1.1 Sorting

Events are sorted by time, with the newest to the top.

5.12.1.2 CEL Filtering

As described in the chapter Searching and Filtering, CEL filtering combines text queries from the Search Bar input field that is revealed when scrolling to the top of the list with filter queries on the two filter buttons below the search bar.

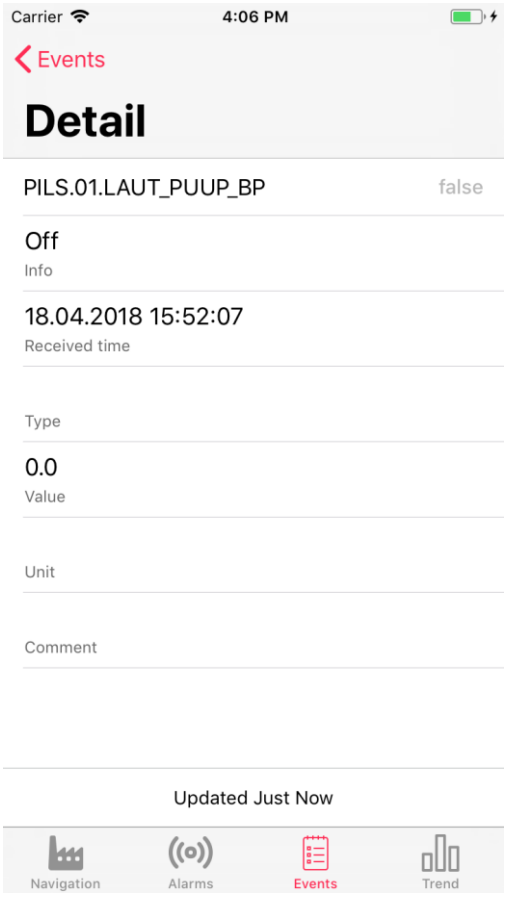
All query conditions are presented on the filter bar and combined. The user has the possibility to remove unwanted queries or replace existing queries with updated values.

With the resulting query, a new Backend request is made and the updated list is presented to the user. This is important as the Ring buffer may contain several tens or hundreds of events while the mobile app shows only the first 50 on the initial load. Therefore, with the updated filter query a new request needs to be made to retrieve the new page of events that comply with the updated filter query.

5.12.2 CEL Detail

The Event detail screen shows additional information about the event

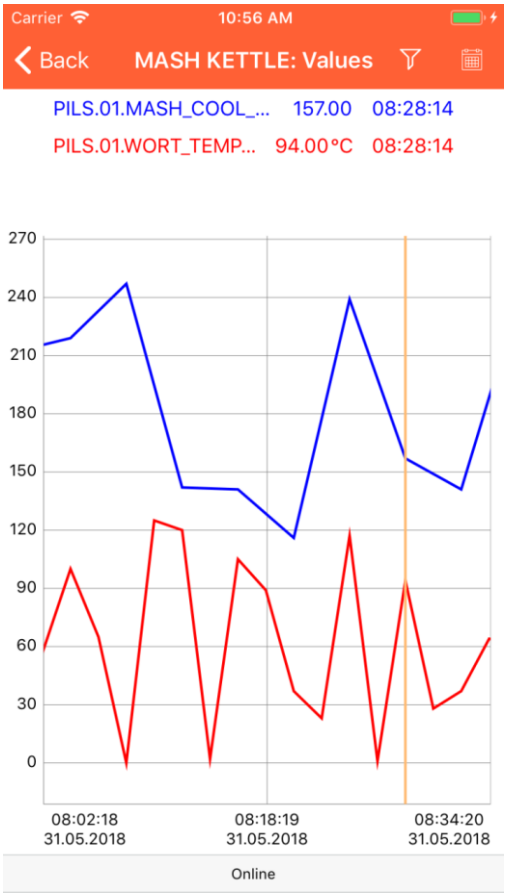
- Name of the related process variable
- Event information
- Time of receiving the event
- Type
- Value of the event variable
- Unit



5.13 Trend Diagrams

For demonstration purposes, a dedicated Trend tab presents a list of all available Archives of Historian in the Zenon Project. After selecting an

Archive from the list, the user is presented with a chart with the plotted lines of all the variables in the selected Archive.



The user has the option to pan and zoom through the chart using gestures.

It is also possible to tap on the chart to show detailed information on the top of the screen for the selected point in time.

By tapping on the filter icon on the top right, the user can select or deselect certain variables values from the chart, so that only those selected are plotted.

By tapping on the calendar icon on the top right, the user can change the time range of the plotted diagram.

5.14 URL Opener: Integration with 3rd Party Apps

ZenMobile supports the URL scheme and can be opened from other applications and links. The application can open the following screens:

5.14.1 Device Detail

URL: zenmobile://?devicename=MUNI.01.LAUT

zenmobile://	application's registered URL scheme
devicename	a parameter that specifies that the Device Detail screen is opened when the requested device name is found
MUNI.01.LAUT	name of the device that will be queried for existence

If the application finds the requested device, it opens the Device Detail screen and shows the device's current status and values. If the device is not found, an error message is presented.

5.14.2 Alarm Detail

URL:	zenmobile://?alarmid=185

zenmobile://	application's registered URL scheme
alarmid	a parameter that specifies that the Alarm Detail screen is opened when the requested alarm is found
185	Alarm ID that will be queried for existence

If the application finds the requested alarm, it opens the Alarm Detail screen and shows the Alarm. If the alarm is not found, an error message is presented.

5.14.3 Alarm List

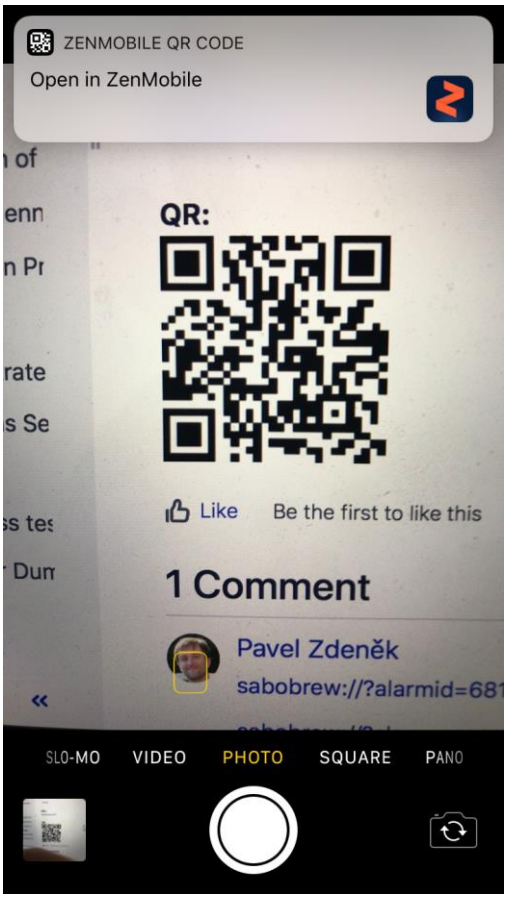
URL:	zenmobile://?alarmvarname=PILS.02.WORT_VOLU_AP

zenmobile://	application's registered URL scheme
alarmvarname	a parameter that specifies that the Alarm List screen is opened with the requested alarms
PILS.02.WORT_VOLU_AP	Variable name that will be queried for existence

The application opens the Alarm List and shows all the alarms related to the given variable. If there are no alarms for this variable the list is empty.

5.15 Using Camera for QR-Code Fast Opening

iOS 11 brought a new feature to the built-in camera application, which is to recognize scanned QR codes. It is therefore much easier to scan QR code directly from the lock screen by opening the camera with a gesture and pointing the camera to the QR code.



When the QR code is scanned and recognized the system then offers to open the registered application with the content of the QR code as a parameter.

To support this functionality the generated QR code must have one of the supported URL links described above. It is, therefore, possible to quickly open the Device detail using the QR Code, or check for existing alarms for a given variable.

5.16 Remote Application Support

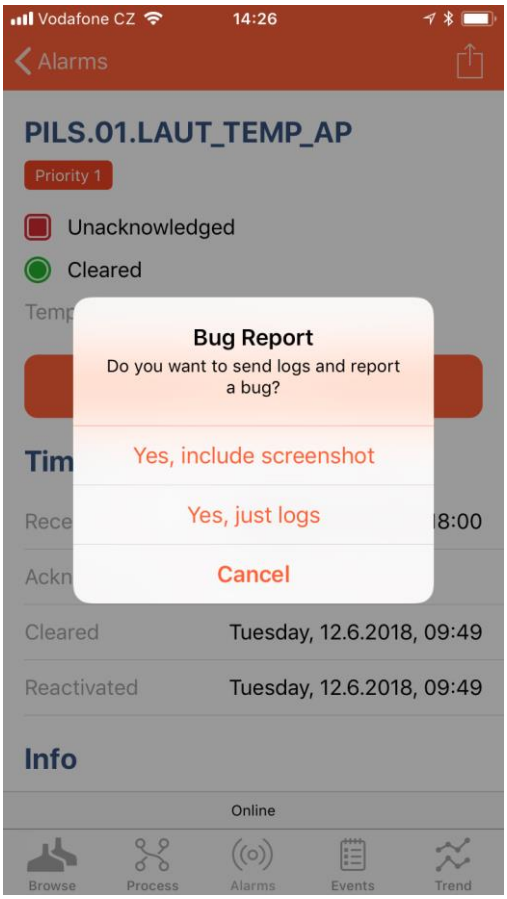
SCADA applications are often run on secured internal corporate networks with forbidden communication to external services. For remote debugging and support purposes the application can store debugging information and share the log files with the development and support organization for remote analysis.

The application has 2 types of logs:

- Application and system debugging messages
- Customer sensitive messages

Customer sensitive messages can contain certain variable names or values and are disabled by default. It can be enabled in testing releases or upon request in production distributions as well.

The application keeps 7 days of logged messages and upon request from the account/settings screen can share (via email or other supported sharing applications) the logged files with the developer or support.



ZenMobile also supports sending application screenshots for extended debugging. When the user takes a screenshot in the application, he or she is offered an option to share the screenshot along with the compressed log messages.

6 Features in next releases

SABO Mobile IT plans to include the following functionality into future releases of ZenMobile:

1. Push Notifications – this functionality is on the roadmap and further described in Annex [1].
2. Process Visualization – visualization of the process defined by the client in Zenon Editor (currently supported in Zenon by HTML screens)
3. Enhanced Trend Diagrams
4. Updates to Everywhere API Data Model

7 Related Documents

[1] ZenMobile.PushNotifications.Concept