BEMO-COFRA

Brazil-Europe Monitoring and Control Framework

(Project No. 288133)

D5.2.2 Final Administration Tool

Published by the BEMO-COFRA Consortium

Dissemination Level: Public

SEVENTH FRAMEWORK PROGRAMME

CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico

European Commission Information Society and Media

Project co-funded by the European Commission within the 7th Framework Programme
and
Conselho Nacional de Desenvolvimento Científico e Tecnológico
Objective ICT-2011-EU-Brazil

Document version: 1.0

Submission date: 2014-03-11

Document control page

Document file:	D5.2.2 Final Administration Tool v1_0.docx
Document version:	1.0
Document owner:	Markus Taumberger (VTT)
Work package:	WP5 – Distributed Control Logic and Enabling Features
Task:	T5.2 – Monitoring and control of WSANs
Deliverable type:	P
Document status:	☒ approved by the document owner for internal review **X** approved for submission to the EC

Document history:

Version	Author(s)	Date	Summary of Changes made
0.1	Markus Taumberger	2013-09-05	Initial version
0.2	Janne Raappana	2013-11-16	Architecture description
0.3	Markku Savela	2014-02-27	Implementation added
1.0	Markus Taumberger	2014-03-07	Updated according review comments

Internal review history:

Reviewed by	Date	Summary of comments
Peeter Kool	2014-03-11	Approved

Legal Notice

The information in this document is subject to change without notice.

The Members of the BEMO-COFRA Consortium make no warranty of any kind with regard to this document, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The Members of the BEMO-COFRA Consortium shall not be held liable for errors contained herein or direct, indirect, special, incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Index:

1. Executive summary

This document describes the initial and final administration tool prototypes for the BEMO-COFRA platform. The final prototype is mainly targeted for the final review demo and supports the visualization of the WSAN of the BEMO-COFRA resources in real-time together with additional information. It supports the administration protocol developed in WP4.

Both tools interface with the BEMO-COFRA environment through the event manager of the underlying LinkSmart platform. In the visualization, active components are highlighted in green when working within expected parameters and red when an error occurs.

2. Introduction

This document specifies the administration and monitoring tool for the BEMO-COFRA system. Chapter 3 presents the background for the work: the requirements and proposed architecture. Chapter 4 presents the implementation of the tool and describes how it is used in the final demo. The final chapter 5 discusses planned future extensions of the administration tool.

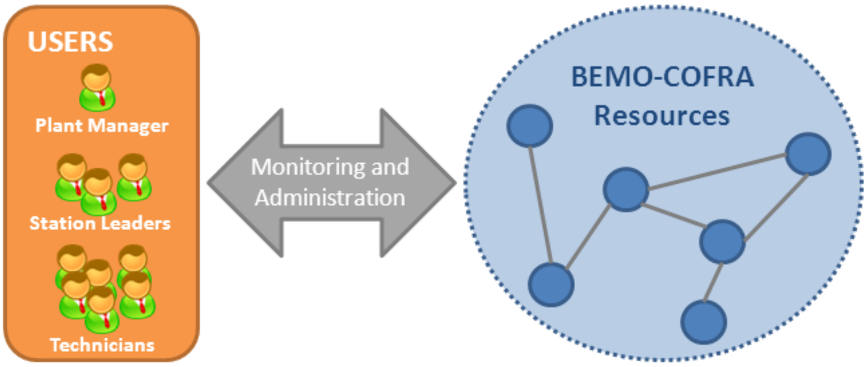


Figure 2-1: Stakeholders running the BEMO-COFRA system

There are different stakeholders, depicted in *Figure 2-1*, that need to monitor and administer different parameters of a BEMO-COFRA environment. The ultimate goal of the administration tool is to serve all those users with their various demands and to present only relevant data in their view.

3. Specification

3.1 Requirements

The requirements identified for the tool are as follows:

- Visualization of the high level state of the system [fulfilled]
- Visualization of network management and resource monitoring data of the WSAN [fulfilled]
- Enable notifications to the user [partly fulfilled]
- Allow setting of WSAN parameters [partly fulfilled]
- Running on a portable device (Mobile phone / Tablet) [fulfilled]

3.2 Baseline

Based on the existing work, we conclude that we require a possibly simplified browser-based interface as it is widely accepted format used by the existing monitoring tools. In addition, to present e.g. a 3D representation of the high-level system state, standalone version must be supported on the main mobile and desktop platforms. This requirement suggests the usage of a platform-independent framework that introduces minimal code porting overhead.

In order to achieve a maximum of supported platforms the administration tool is implemented with Unity3D and can be run on Android, iOS, Windows and as web application.

3.3 Architecture

Here we present two architectures: the first is the Unity3D based web application, which shows the high level state. The second is a lighter browser (HTML5/Javascript) application, which currently shows the state of the system controlled by the WP4 administration protocol.

3.3.1 Architecture

The administration tool consists of three elements, the *Web Service Client*, the *Event Processing* and the *GUI Engine*, see *Figure 3-1*.

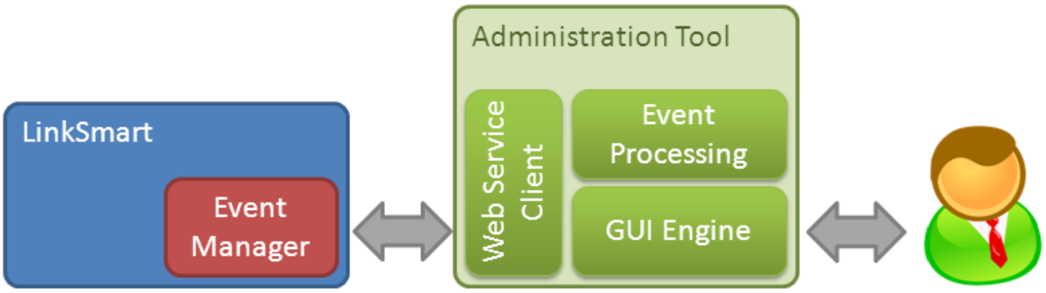


Figure 3-1: Administration tool architecture

The *Web Service Client* is used to connect with the BEMO-COFRA environment through the Event Manager of the LinkSmart platform. It subscribes to the events of interest and passes them on to the *Event Processing*.

The *Event Processing* unit creates a new object instance to represent new resources, if an event comes from a resource that is not known by the administration tool yet. In all other cases the current state of the resource representation is updated according the received events.

Finally the visualization of the BEMO-COFRA environment is generated by the *GUI Engine* that is responsible for the interaction with the user.

3.3.2 Architecture for the browser based tool

The administration tool consists of three elements, the *Administration Tool Manager,* the *Event Processing* and the *GUI Engine*, see *Figure 3-2***Error! Reference source not found.**.

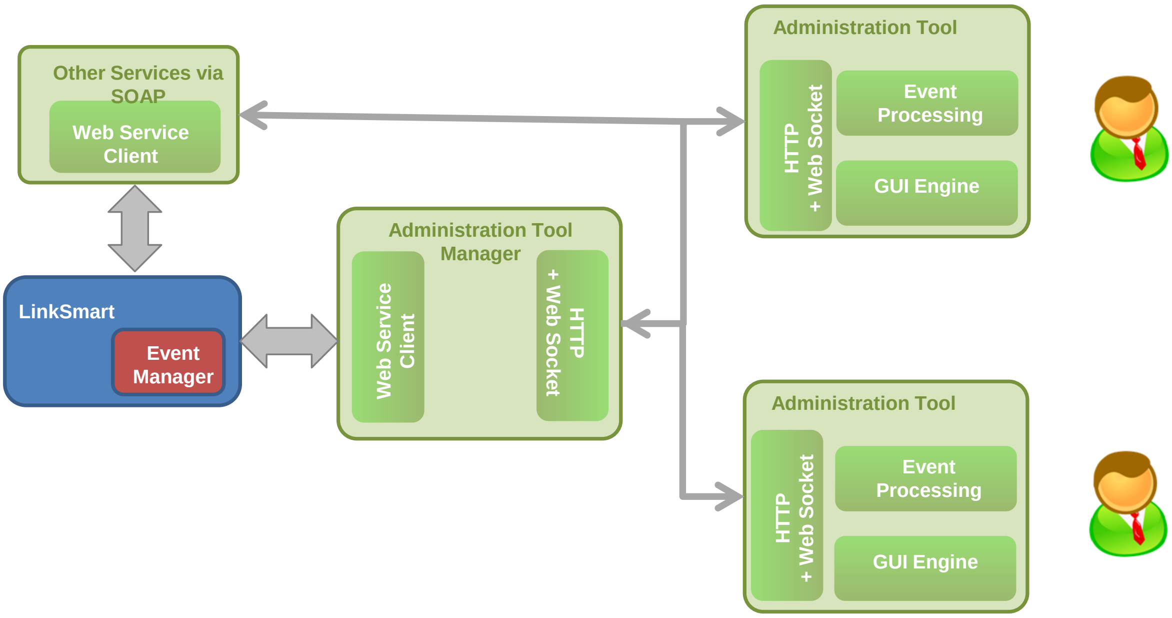


Figure 3-2: Administration tool architecture

The *Administration Tool Manager* serves the web content (HTML5 and Javascript) representing the *Administration Tool* to the client browsers. The *Administration Tool* can access LinkSmart resources through the use of SOAP API, and optionally also receive asynchronous events over the WebSocket connection, if it becomes available in the BEMO-COFRA platform.

The *Event Processing* creates a new object instance to represent new resources, if an event comes from a resource that is not known by the administration tool yet. In all other cases the current state of the resource representation is updated according the received events.

Finally the visualization of the BEMO-COFRA environment is generated by the *GUI Engine* that is responsible for the interaction with the user.

4. Implementation

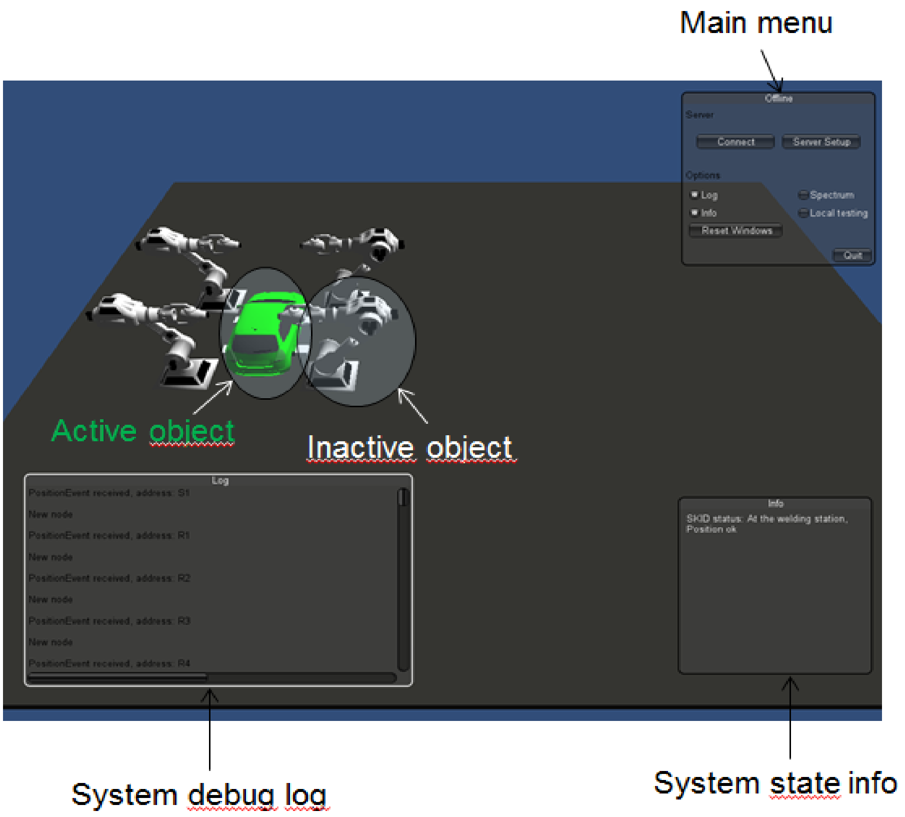
4.1 Overview

The application was implemented using the Unity3D cross-platform game engine [Unity3D]. For scripting, Unity3D uses Mono [Mono], an open source implementation of the .NET framework. Mono has been ported to several operating systems such as Windows, Linux, Android, OS X etc. In addition Unity3D features a Web Player that can be used to run the application inside a web browser. The usage of Mono ensures that the tool is portable with little effort to the aforementioned platforms and more. During the M12 demo at the review in Bonn, the tool was shown running simultaneously on a Windows PC and an Android tablet

The tool communicates with the rest of the BEMO-COFRA components by utilizing the LinkSmart eventing system that allows the tool to subscribe to events of interest and publish administrative events towards the other components. For this purpose, it uses Mono's web service capabilities. The web service –based connectivity also provides remote-monitoring; multiple instances of the application can be run remotely and connect to the BEMO-COFRA installation via the appropriate LinkSmart Event Manager.

4.2 Graphical User Interface

The Graphical User Interface (GUI) of the tool is shown in Figure 4-1. It visualizes the monitoring information gathered from the BEMO-COFRA installation in a continuous-time 3D representation. The screenshot features the main objects used in the M12 demo: the car body, welding robots, and the grippers. Detailed information about each object is available when clicking or touching them on the screen. Active objects are rendered in green colour whereas idle objects are rendered in grey and objects that are in erroneous state are rendered in red.



```
PositionEvent received, address: S1
New node
PositionEvent received, address: R1
New node
PositionEvent received, address: R2
New node
PositionEvent received, address: R3
New node
PositionEvent received, address: R4
```

SKID status: At the welding station, Position ok

Figure 4-1: GUI implementation on Unity3D

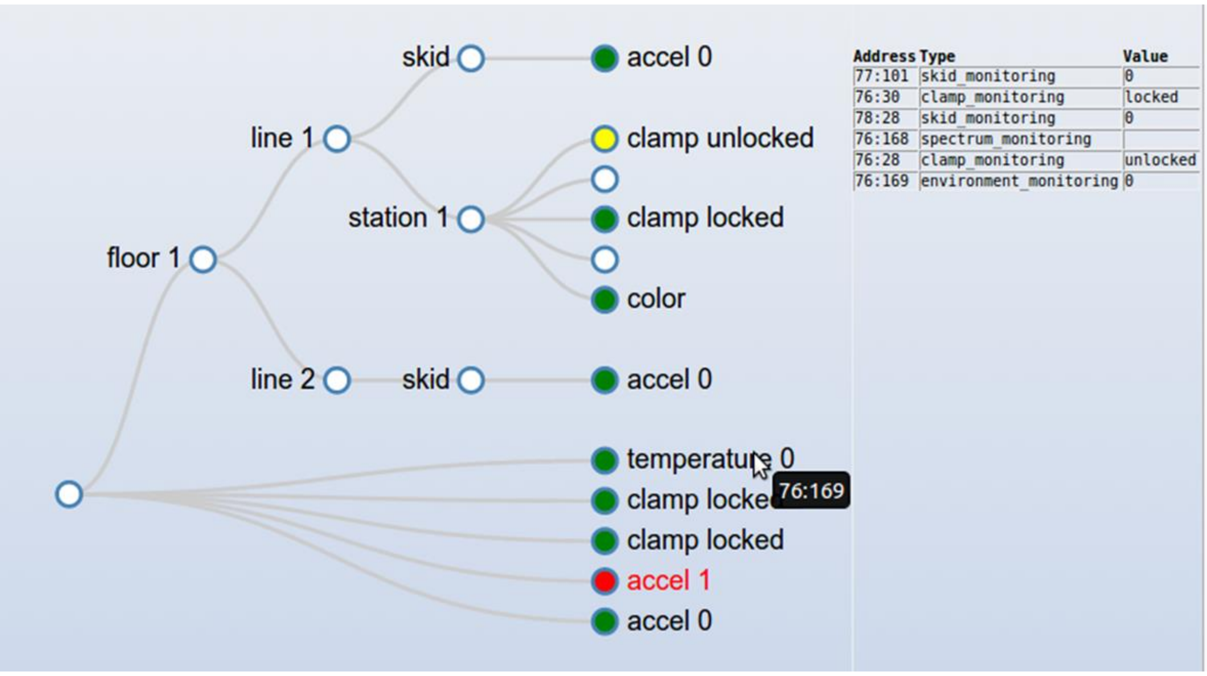
The menus feature a server setup, where one can define the Uniform Resource Identifier (URI) of the LinkSmart Event Manager to connect to, and several subwindow toggles. In the screenshot, a debug log window, showing all the received and sent events is shown in the lower left corner. This information is mainly targeted for a technician providing means for detailed troubleshooting. The lower right corner features a system state info window that summarizes the high-level state of the system (car body location, robots and grippers active / idle etc.).

4.3 Browser based Graphical User Interface

The browser based application is implemented using the HTML5 (Javascript). The usage of HTML5 ensures that the tool is usable or adaptable to any platform.

The tool communicates over the HTTP connection with the rest of the BEMO-COFRA via Web Service components.

The Graphical User Interface (GUI) of the tool is shown in *Figure 4-2*. The tool retrieves the status information from the WSANProxyMultiRadio using the SOAP API, and the response is processed as a set of events. The *GUI Engine* (based on d3js library) visualizes the resulting state in real time as a tree (dendrogram).



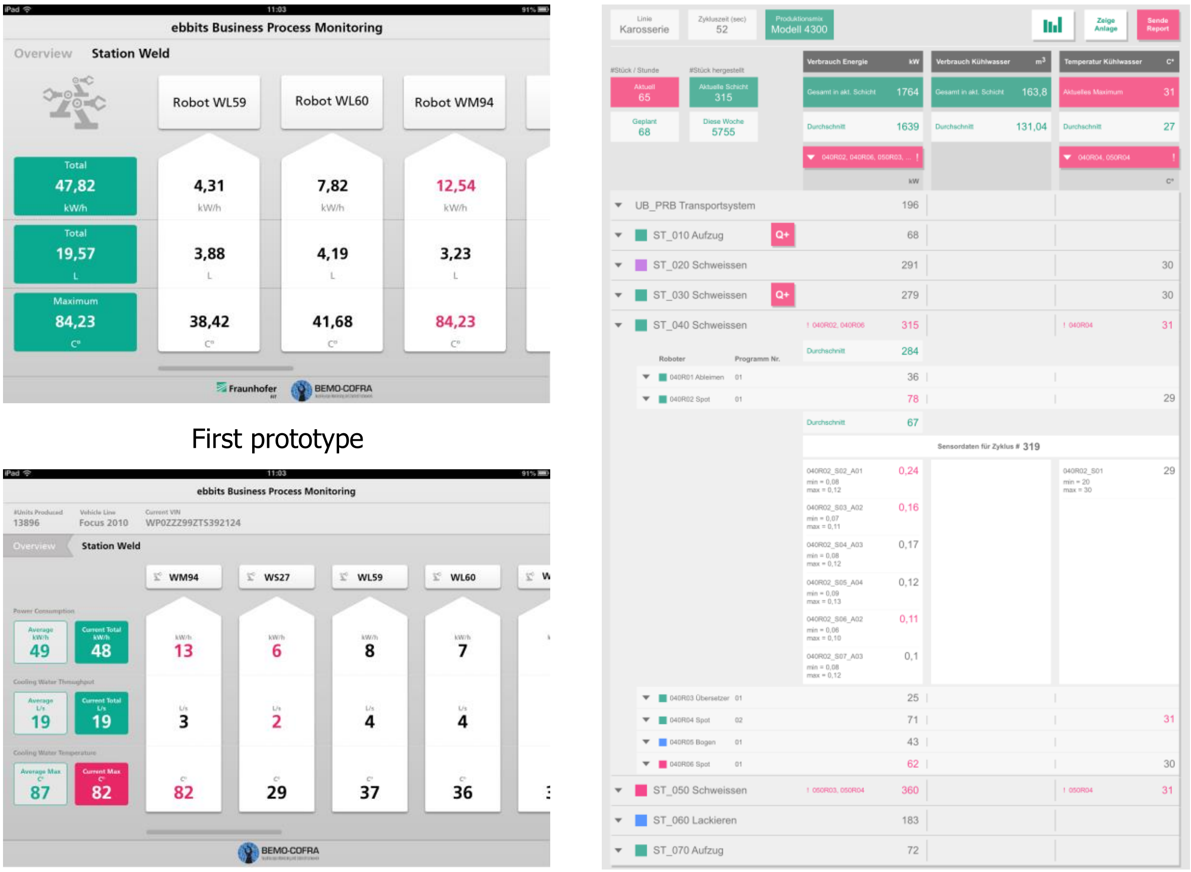
Address	Type	Value
77:101	skid_monitoring	0
76:30	clamp_monitoring	locked
78:28	skid_monitoring	0
76:168	spectrum_monitoring	
76:28	clamp_monitoring	unlocked
76:169	environment_monitoring	0

Figure 4-2: GUI view

4.4 iPad native user interface

The iPad user interface is intended for the line manager who supervise the manufacturing lines. After conducting interview, we concluded that the line managers need different level of information. Firstly, they need to know a global overview of the line performance including the number of cars have been produced, and the cycle time. In the future when energy consumption is a key factor that needs to be optimized, they would also like to have an overview of the total energy consumptions, and the average consumptions required to produce a type of a car. Moreover they would also to get a notification if there is a faulty condition in one of the station so they could call the right technician to fix the faults.

Based on these requirements several prototypes of the iPad user interface (Depicted in Figure 4-3) were designed and validated to the users.



iPad 11:03 91%

ebbits Business Process Monitoring

Overview Station Weld

	Robot WL59	Robot WL60	Robot WM94
Total 47,82 kW/h	4,31 kW/h	7,82 kW/h	12,54 kW/h
Total 19,57 L	3,88 L	4,19 L	3,23 L
Maximum 84,23 C°	38,42 C°	41,68 C°	84,23 C°

First prototype

iPad 11:03 91%

ebbits Business Process Monitoring

#Units Produced 13896 Vehicle Line Focus 2010 Current VIN WP0ZZZ99ZTS392124

Overview Station Weld

			WM94	WS27	WL59	WL60
Power Consumption	Average kW/h 49	Current Total kW/h 48	kW/h 13	kW/h 6	kW/h 8	kW/h 7
Cooling Water Throughput	Average L/s 19	Current Total L/s 19	L/s 3	L/s 2	L/s 4	L/s 4
Cooling Water Temperature	Average Max C° 87	Current Max C° 82	C° 82	C° 29	C° 37	C° 36

Second prototype

Linie Karosserie Zykluszeit (sec) 52 Produktionsmix Modell 4300

Zeige Anlage Sende Report

#Stück / Stunde: Aktuell 65, Geplant 68

#Stück hergestellt: Aktuelle Schicht 315, Diese Woche 5755

Verbrauch Energie kW	Verbrauch Kühlwasser m³	Temperatur Kühlwasser C°
Gesamt in akt. Schicht 1764	Gesamt in akt. Schicht 163,8	Aktuelles Maximum 31
Durchschnitt 1639	Durchschnitt 131,04	Durchschnitt 27
040R02, 040R06, 050R03, ... !		040R04, 050R04 !

	kW		C°
UB_PRB Transportsystem	196		
ST_010 Aufzug Q+	68		
ST_020 Schweissen	291		30
ST_030 Schweissen Q+	279		30
ST_040 Schweissen	! 040R02, 040R06 315		! 040R04 31
	Durchschnitt 284		
Roboter / Programm Nr.			
040R01 Ableimen 01	36		
040R02 Spot 01	78		29
	Durchschnitt 67		
Sensordaten für Zyklus # 319			

	040R02_S02_A01 0,24
	min = 0,08
	max = 0,12
			040R02_S01 29
			min = 20
			max = 30

	040R02_S03_A02 0,16
	min = 0,07
	max = 0,11		

	040R02_S04_A03 0,17
	min = 0,08
	max = 0,12		

	040R02_S05_A04 0,12
	min = 0,09
	max = 0,13		

	040R02_S06_A02 0,11
	min = 0,06
	max = 0,10		

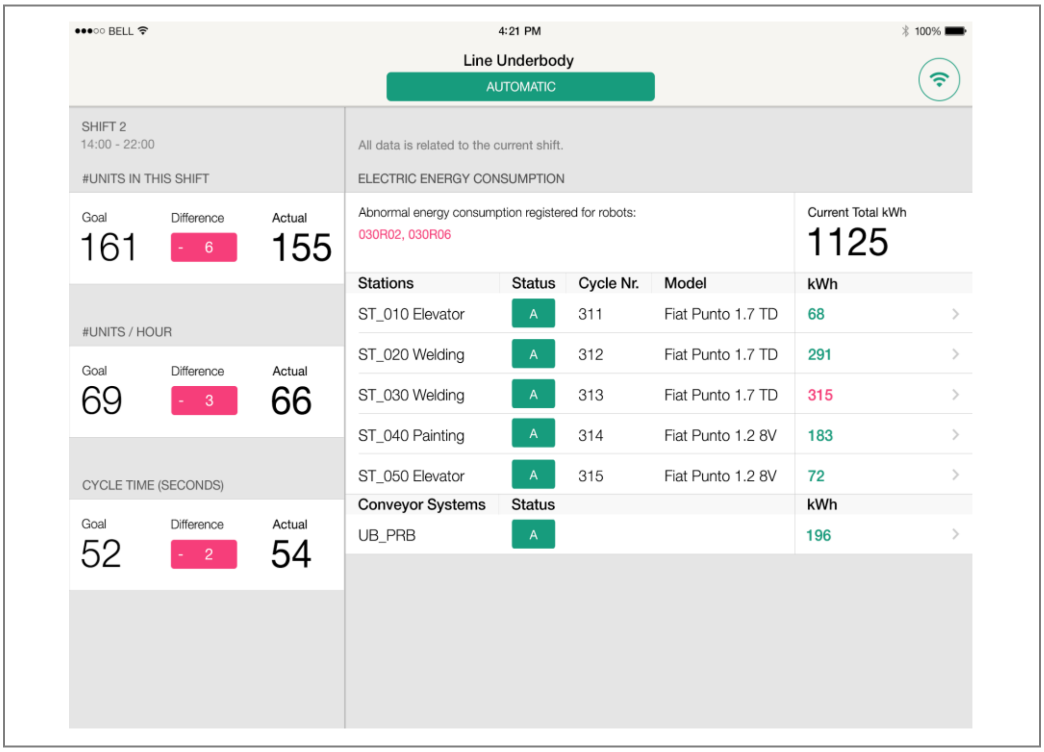
	040R02_S07_A03 0,1
	min = 0,08
	max = 0,12		

040R03 Übersetzer 01	25		
040R04 Spot 02	71		31
040R05 Bogen 01	43		
040R06 Spot 01	62		30
ST_050 Schweissen	! 050R03, 050R04 360		! 050R04 31
ST_060 Lackieren	183		
ST_070 Aufzug	72		

Third prototype

Figure 4-3: Prototypes of the user interface for line monitoring

After several iterations, as shown in Figure 4-4 the final design was adjusted and approved.



●●●○○ BELL 4:21 PM 100%

Line Underbody

AUTOMATIC

SHIFT 2
14:00 - 22:00

#UNITS IN THIS SHIFT

Goal	Difference	Actual
161	- 6	155

#UNITS / HOUR

Goal	Difference	Actual
69	- 3	66

CYCLE TIME (SECONDS)

Goal	Difference	Actual
52	- 2	54

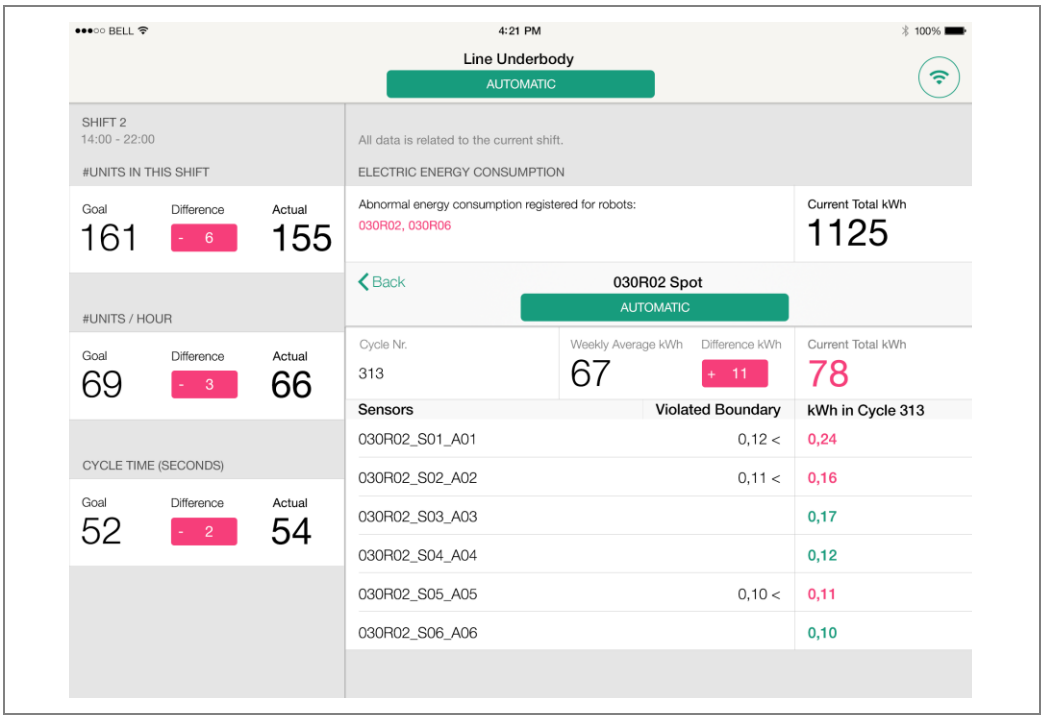
All data is related to the current shift.

ELECTRIC ENERGY CONSUMPTION

Abnormal energy consumption registered for robots:
030R02, 030R06

Current Total kWh
1125

Stations	Status	Cycle Nr.	Model	kWh
ST_010 Elevator	A	311	Fiat Punto 1.7 TD	68
ST_020 Welding	A	312	Fiat Punto 1.7 TD	291
ST_030 Welding	A	313	Fiat Punto 1.7 TD	315
ST_040 Painting	A	314	Fiat Punto 1.2 8V	183
ST_050 Elevator	A	315	Fiat Punto 1.2 8V	72
Conveyor Systems	**Status**			**kWh**
UB_PRB	A			196



Line Underbody

SHIFT 2
14:00 - 22:00

#UNITS IN THIS SHIFT

Goal	Difference	Actual
161	- 6	155

#UNITS / HOUR

Goal	Difference	Actual
69	- 3	66

CYCLE TIME (SECONDS)

Goal	Difference	Actual
52	- 2	54

All data is related to the current shift.

ELECTRIC ENERGY CONSUMPTION

Abnormal energy consumption registered for robots:
030R02, 030R06

Current Total kWh
1125

030R02 Spot

Cycle Nr.	Weekly Average kWh	Difference kWh	Current Total kWh
313	67	+ 11	78

Sensors	Violated Boundary	kWh in Cycle 313
030R02_S01_A01	0,12 <	0,24
030R02_S02_A02	0,11 <	0,16
030R02_S03_A03		0,17
030R02_S04_A04		0,12
030R02_S05_A05	0,10 <	0,11
030R02_S06_A06		0,10

Figure 4-4: The final user interface design

4.5 Event specifications

Table 1 lists the events that were subscribed to in the M12 demo by the tool. In addition the table specifies the actions that the tool will take upon the reception of each event.

Table 1: List of subscribed events and corresponding actions

Name	Description	Action
PowerConsumption	The power consumption of the last welding cycle in Wh.	Value shown in the welding robot info window.
bemocofra/event/WSN	Spectrum occupancy values and car body acceleration from the wireless sensors.	Occupancy plotted in spectrum window. Acceleration shown in the car body info window.
SkidWeldingPosition	Car body in the welding station.	Car body model moved to the welding station position and stopped.
MoveSkidBack	Car body leaves the welding station.	Car body model starts to move towards the start position. Car body object state is set to idle.
SkidStartPosition	Car body at the starting position.	Car body model moved to the starting position and stopped.
MoveSkid	Car body leaves the starting position.	Car body model starts to move towards the welding station position.
SkidWeldingPositionOk	Car body position correct at the welding station.	Car body object state is set to active if the car is at the welding station.

SkidWeldingPositionError	Car body position error at the welding station.	Car body object state is set to error if the car is at the welding station.
ConfirmClamps	Grippers closed.	Gripper objects' states are set to active.
ConfirmClampsOpen	Grippers open.	Gripper objects' states are set to idle.
ClampsError	Grippers in error state.	Gripper objects' states are set to error.
StartWelding	Welding robots start welding.	Welding robot objects' states are set to active.
StopWelding	Welding robots stop welding.	Welding robot objects' states are set to idle.

5. Future work

The browser based Administration Tool can expand further to include views that can approximate the Unity3D GUI. However this requires a support of WebSocket BEMO-COFRA/LinkSmart for delivering asynchronous messages to the browser.

References

(Android) Android homepage, http://www.android.com/

(d3js) Data-Driven Documents, http://d3js.org

(iOS) Develop for iOS, https://developer.apple.com/technologies/ios/

(Unity3D) http://www.unity3d.com