Contract No. H2020 – 730617

Development of Functional Requirements for Sustainable and Attractive European Rail Freight

D2.8 – Modified IT system with all required parameters to compare actual values and thresholds and to deduct maintenance tasks

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EXECUTIVE SUMMARY

Within the previous tasks the components of locomotives which are especially interesting for CBM were determined. Here certain circumstances, that are visualizable due to data calculations and visualizations, give hints for a preventive maintenance action to prevent foreseen failures of these components. In a drop-down menu aggregation levels for each locomotive or fleet are also given to show the relevance of possible failures.

In this report examples of different monitoring dashboards visualized in Tableau are explained. Irregularities can be detected by the persons who are regularly working with these dashboards. Based on this information maintenance actions can or should be ordered to avoid most likely and cost-intensive failures.

ABBREVIATIONS AND ACRONYMS

BI	Bussiness Intelligence

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1. INTRODUCTION

A prototype of a user-friendly web-interface will be developed for displaying the relevant locomotive status information. The data sent by the locomotives is processed in advance and visualized with the BI software Tableau on web-based sites.

A continuously opportunity to observe the conditions of the most important fleets, locomotives and their components is essential for the development of working CBM processes. With this overview one can get an impression of the occurring conditions and values sent by the locomotives an it`s components, the primary defined thresholds concerning these values can be optimized and special maintenance rules can be developed as a following action.

In this report an insight of the visualization with the Tableau software is given.

2. MODIFIED IT SYSTEM WITH REQUIRED PARAMETERS TO COMPARE ACTUAL VALUES AND THRESHOLDS

The break down of the monitoring visualization of the dashboards is shown in Figure 1. From the landing page it is possible to click down to fleet, locomotive and component views.

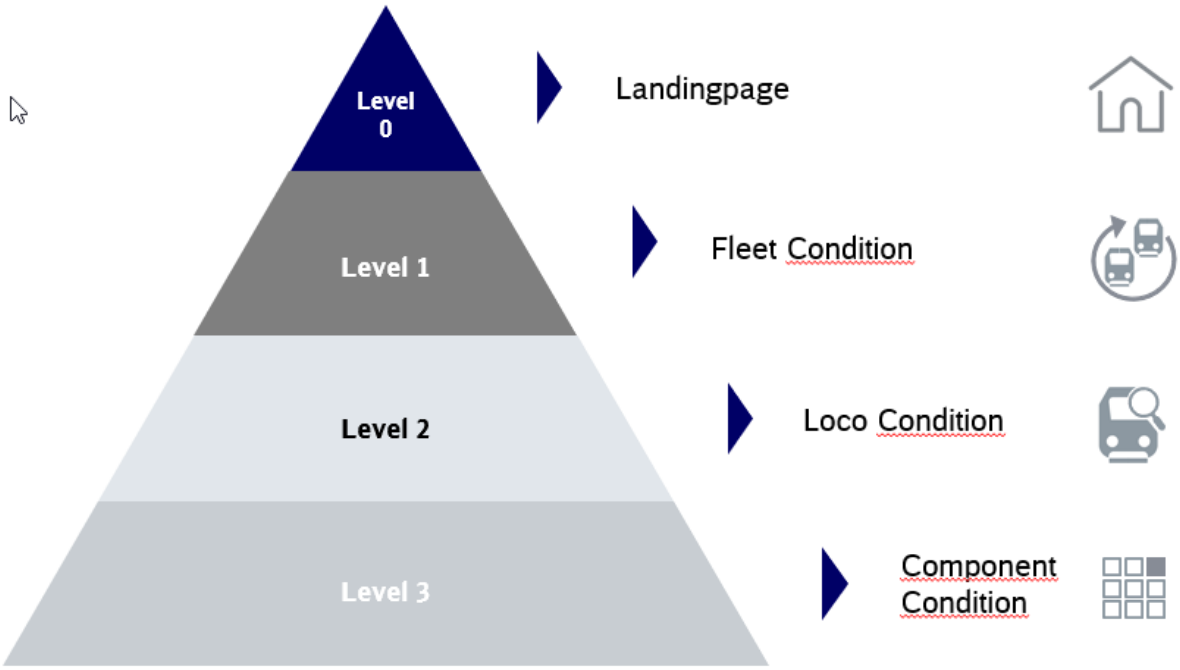


Figure 1: Logic IT Monitoring System

The main navigation options are shown in Figure 2. Beside the landing page (Home) a fleet overview (Flottenübersicht), loco overview (Lokübersicht) and a component overview (Komponentenübersicht) can be chosen. Furthermore links to an incident management site (Störfallmanagement) and to general information (Information) about the shown KPIs and figures are given.

Figure 2: Main navigation list

Within the “current fleet overview” as a part of the fleets` overview the percentage of locomotives, which have at least one alarm or warning is demonstrated. Moreover it is shown how many percent of the fleet did not send any data or sent everything as expected (condition: OK; see Figure 3).

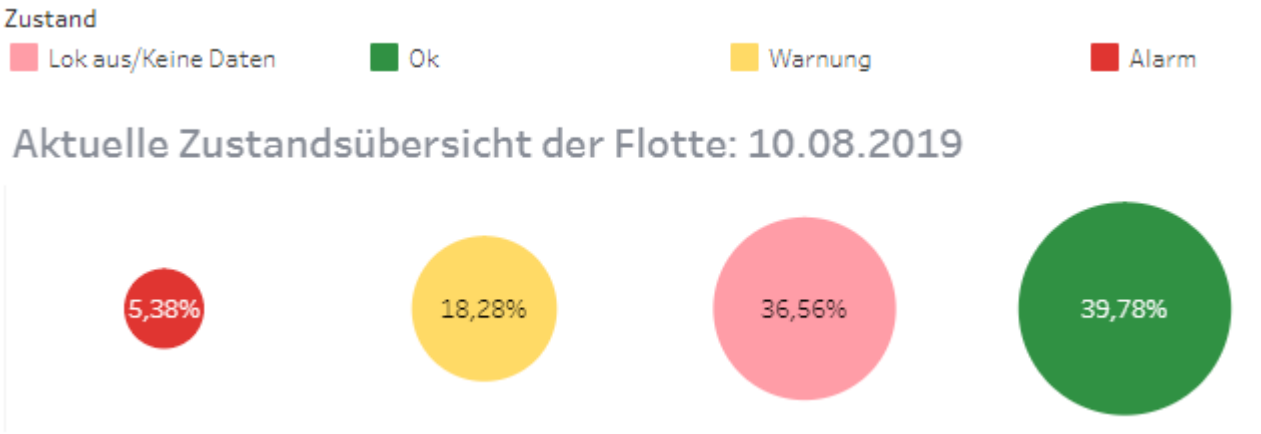
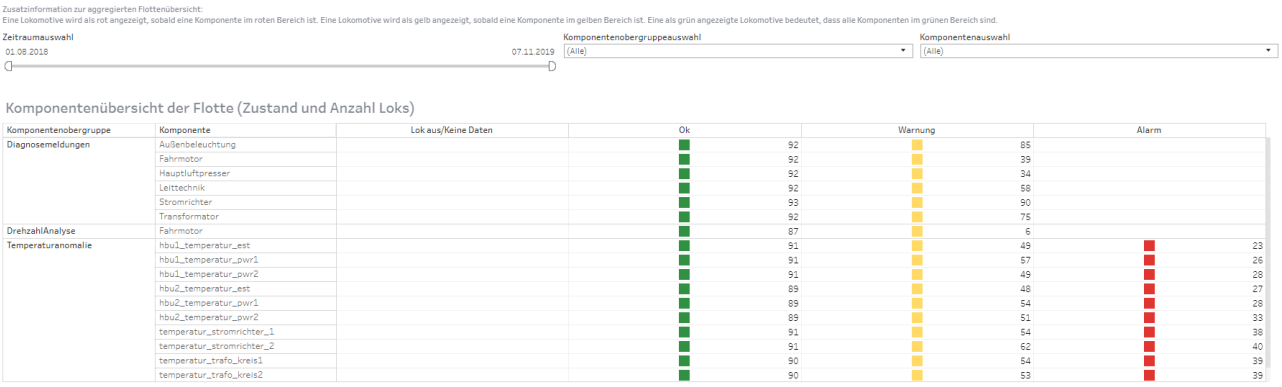


Figure 3: Current fleet overview

The fleet overview in detail shows the different conditions of each component and their defined subcomponents. These can be for example single temperature sensors or others that are able to describe partly the condition of a component (see Figure 4). The number and percentage of the affected locomotives of a fleet is named for each component/subcomponent.



Komponentenobergruppe	Komponente	Lok aus/Keine Daten	Ok	Warnung	Alarm
Diagnosemeldungen	Außenbeleuchtung		92	85	
	Fahrmotor		92	39	
	Hauptluftpresser		92	34	
	Leittechnik		92	58	
	Stromrichter		93	90	
	Transformator		92	75	
DrehzahlAnalyse	Fahrmotor		87	6	
Temperaturanomalie	hbu1_temperatur_est		91	49	23
	hbu1_temperatur_pwr1		91	57	26
	hbu1_temperatur_pwr2		91	49	28
	hbu2_temperatur_est		89	48	27
	hbu2_temperatur_pwr1		89	54	28
	hbu2_temperatur_pwr2		89	51	33
	temperatur_stromrichter_1		91	84	38
	temperatur_stromrichter_2		91	62	40
	temperatur_trafo_kreis1		90	54	39
	temperatur_trafo_kreis2		90	53	39

Figure 4: Fleet overview detail

Within the loco overview (see Figure 5) the condition for each component/subcomponent over the relevant time interval is visualized in bar graphs.

In the component view (see Figure 6) the different condition stati of the power converter of a certain locomotive is illustrated within a chosen time interval. At the same time, it can be checked when maintenance actions took place at the selected locomotives, what kind of maintenance category it was and what was repaired or substituted. The bar graph in the middle shows the status of the power converter for each day of chosen time interval.

Figure 5: Loco overview

In Figure 6 only the stati “Ok” and “warning” occurred for the selected locomotive. The bar graph at the left bottom of Figure 6 shows the duration of the alarms concerning the selected component. In general, these alarms occur if certain thresholds of defined values are crossed. A value is calculated out of the raw data of the components by certain algorithms. On the right bottom the amount and costs of maintenance actions - including spare parts and services - is illustrated.

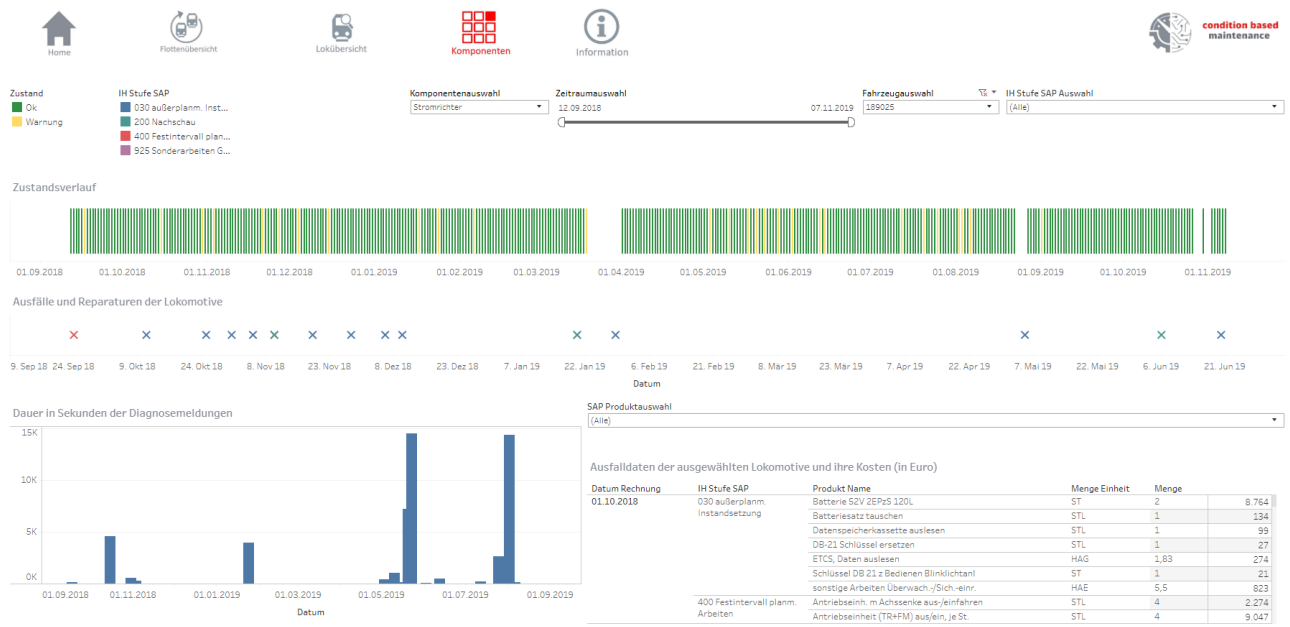


Figure 6: Component view - power converter

For the traction motor the dashboard has the same visual elements and informations as shown in Figure 6.

In total there are following six components which have the same dashboard type as in Figure 6:

- power converter
- traction motor
- outside illumination
- main air compressor
- control technology
- current transformer

For 10 temperature sensors, from whom 6 are situated in the two auxiliary converters, 2 in the power converter and 2 within the two current transformer circles, a visualization like in Figure 7 exists.

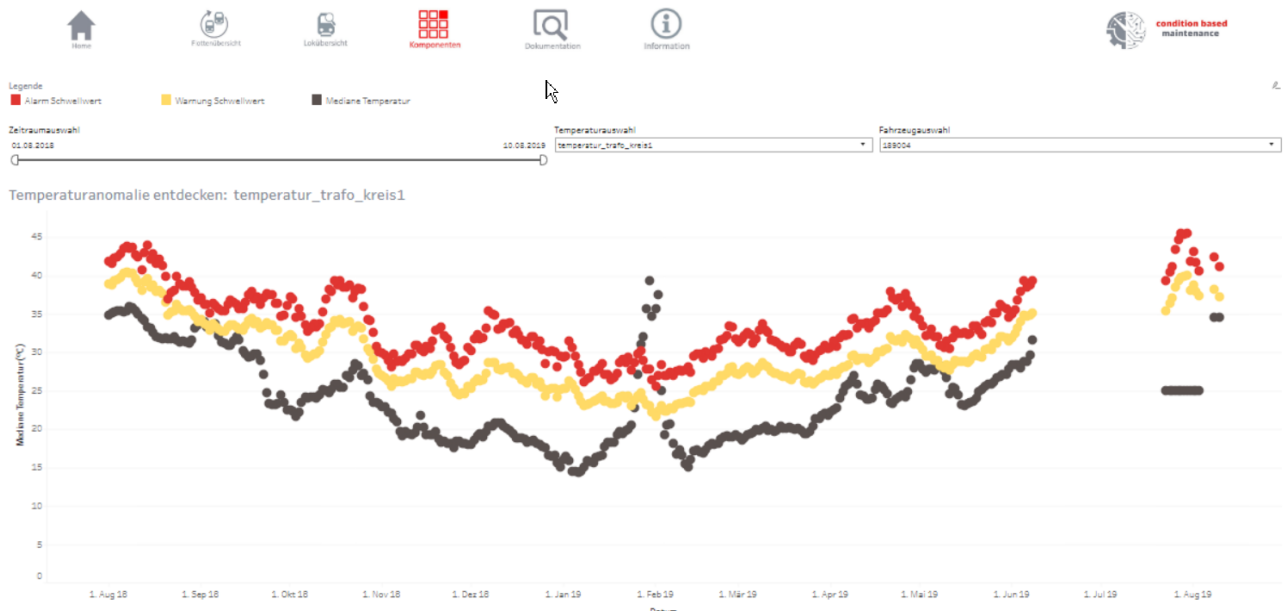


Figure 7: Component view - temperature monitoring

It is the target of this dashboard to save money by initiating actions if temperature values are above defined thresholds. The current experience says, that components with temperatures above the defined thresholds are very likely to have a technical problem. With this knowledge a supply of the locomotive including a root cause analysis at the affected component can be planed and a loss of the component can be avoided.

In Figure 7 the median temperature of a current transformer circle (black), the warning temperature (yellow) and the alarm temperature (red) is illustrated for every day. The calculation of the median temperature at one day is done with the temperature values of this sensor within the 15 days

before. The alarm and warning values of that day are calculated with further statistical functions out of the 75 percentiles of all values of all locomotives of the same category within the last 15 days before.

Whenever the median value (black) is the lowest in the graph, the status is “OK”. If it is between the alarming and warning status, the status is “warning” and if it is above the alarming values, the status is “alarm”.

As a last demonstrated dashboard the Battery monitoring is mentioned (see Figure 8). Here an assessment of the age of the battery is given by consideration of voltages, time effects, KPIs and battery quality values.

Figure 8: Component view - Battery monitoring

Furthermore other detailed monitoring dashboards exist for

- converter disturbances
- rotation speed analysis
- count of operating hours of components
- count of switching operations
- battery deep discharge
- collective diagnostic messages
- optical wave guides.

For all dashboards a documentation with an explanation of the visualized graphs and KPIs exist. So the user can learn on his own about how to read all dashboards and their common uses.

3. SUMMARY

This report gives a short insight to the monitoring dashboards of several locomotive components like the power converter, traction motor, outside illumination and so on is given. With these the user gets an overview of the condition of the fleets, locomotives and their components, which are calculated out of algorithms based on locomotive data within the CBM project.

Single values are compared with a threshold value calculated out of those of the rest of the fleet. Traffic light colours give the user an idea if maintenance action might be necessary or a deeper look would be reasonable.

Monetary benefits can be generated as corrective maintenance and all its additional costs will be avoided and preventive maintenance actions can be ordered. In previous undertakings the experience of all the available vehicle data had been validated to be sure, that an excess of defined thresholds will most likely lead to a soon failure.

For monitoring the relevant asset information and their trends the BI platform of Tableau was chosen. A specification for the required data and calculation parameters, the definition of usable and available data sources has been done and a scalable monitoring of the locomotives and their components has been developed to ensure a performance-based monitoring. With this condition monitoring a fleet control and component and system behavior was built for several use cases. Prioritized components and sub-components have been identified and their current condition has been visualized due to certain variables in these dashboards. As well the determination of the threshold of these variables has been done to be able to decide if a maintenance task is required.

With these dashboards a condition monitoring of main components of locomotives had been implemented. Persons responsible for ECM 3 are able to order maintenance actions previously if a higher failure risks exists due to the visualized values in the dashboards.

After first experiences and a monitoring of the development of further corrective failures, in a certain time an automatization of the ordering process of maintenance action can be developed to close the automation loop from data generating to actions in workshops.