Remote Locomotive

Telemetry System

TCAV i4.0

1. Introduction

This technical document is issued by Avantgarde, with the aim to give a description of the remote locomotive telemetry system TCAV i4.0, as an onboard unit for the data transfer and analysis used to support fleet management and in particular of locomotive operational.

The system provides the geo-location of all the vehicles and monitoring in real time the performances and individuate eventual failures of the locomotive.
The information collected will help for a journey analyses to organize preventive interventions for a better management of the maintenance plan of the locomotive.

From the experience and know-how of Avantgarde in the design and implementation of advanced tools to be installed on track machines, its assured that all products and services comply with its quality management system in accordance with UNI EN ISO 9001:2015 and ISO 14001: 2015 Standards certified by R.I.N.A S.p.A. and latest standards in railway applications.

To help the CUSTOMER to understand more about the TCAV i4.0, Avantgarde can provide a weblink to show in real time a dashboard of a locomotive in operational in Italy, on which the system is installed.

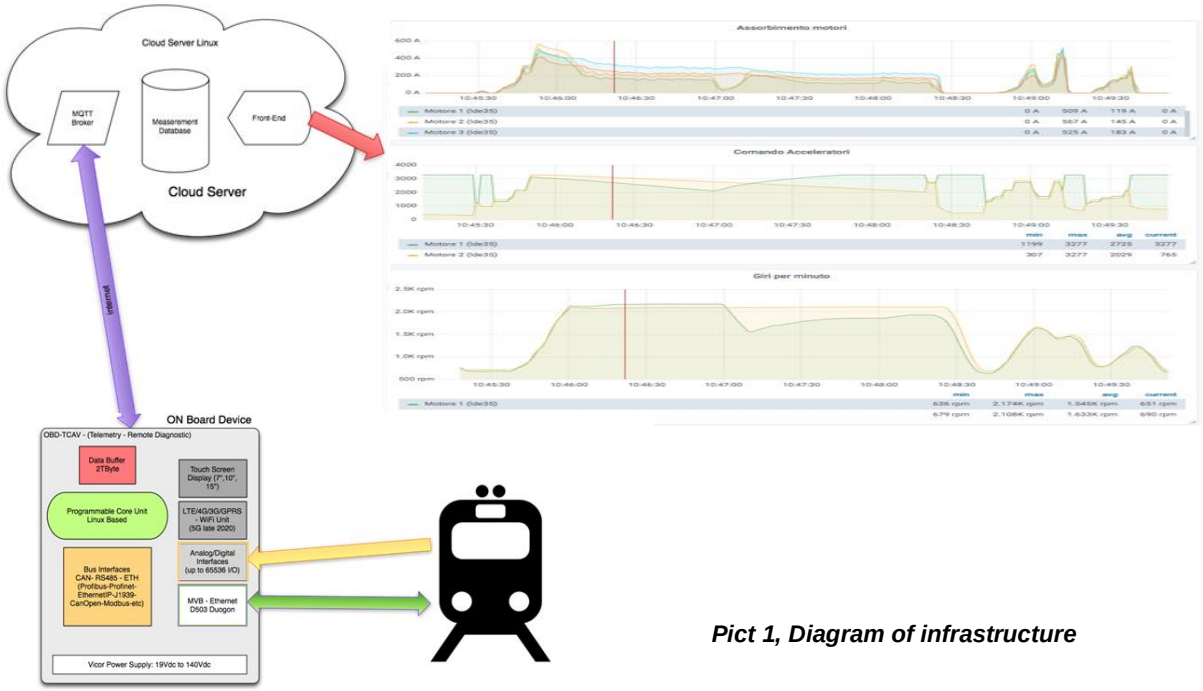
Avantgarde can also provide a demo system to be installed directly on CUSTOMER's locomotive, as a trial to show all characteristics and benefits.

2. Telemetry, Location and diagnostic system

The remote locomotive telemetry system TCAV i4.0 is a product that suites monitoring of railway fleets and in particular of Diesel Electric Locomotives.
Since 2004 we have started installing a localization system on railway machinery and among the years the system has been implemented by adding I/O interface capable of measuring the most important variables of the locomotive.
The implementations have been integrated by a safety features for alarming the telemetry system by using a telemetry Server and a On-board device.

2.1 Telemetry Server

By using the latest technologies in the industry, the IT infrastructure will acquire and record all data, coming from the locomotive during its operational, for on- condition analysis.
All the data will be stored with geospatial references and for relevant data analysis. The data storage could be made on Customers servers or Avantgarde owned server.
The Customer will receive, credential for access through password to a web page interface, showing a virtual dashboard, with the graphs and indicators relating to the measurements made during locomotive operational and will allow also to consult the status of the various inputs and historical trends.
The dashboard can be customized upon request, integrated with other data analysis tools and can include an application of intelligent algorithms to adjust the maintenance intervals in order to increase the reliability of the locomotive itself.



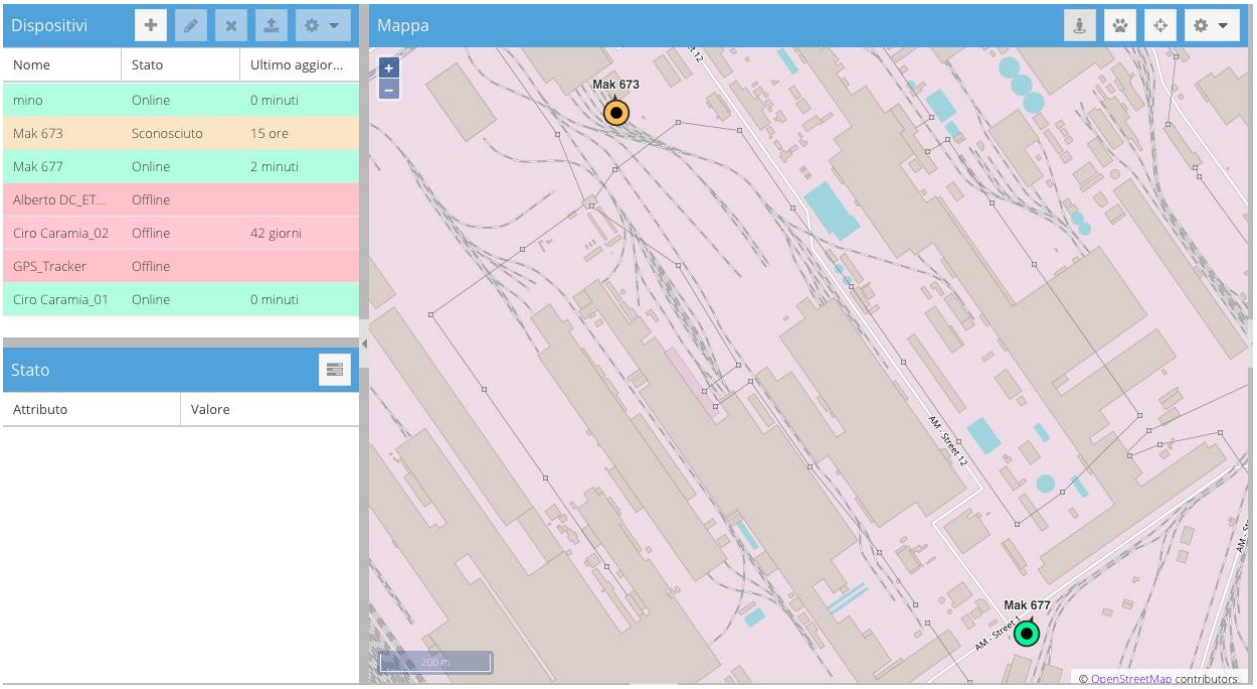
Pict 1, Diagram of infrastructure

2.2 Event analysis module (MEAM):

The MEAM module provides an overview of occurrences of known events and statistics based on historical event data.
End users can select the events to be analyzed, the relative time intervals, aggregate functions to be applied on the virtual dashboard.
This module allows to easily recognize correlations between the events, any abnormal behaviors or long-term trends and all alarm can be sent to the user transmitted via Telegram or email.

2.3 Signal Analysis Module (MSAM):

The MSAM module offers an effective way to select, combine and analyze analog and digital signals recorded by TCAV i4.0.
Data analysis can be saved and shared using customizable templates.

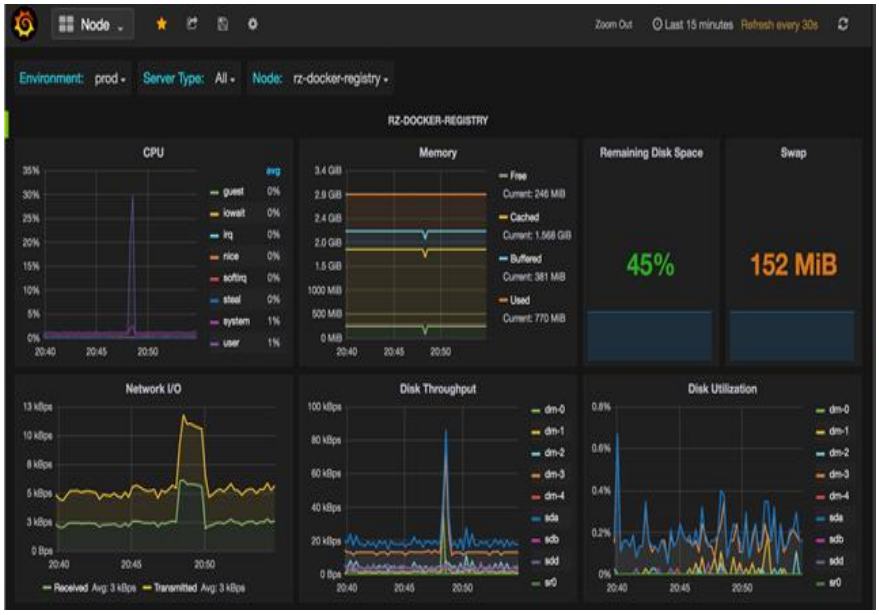


Pic 2, Fleet location map

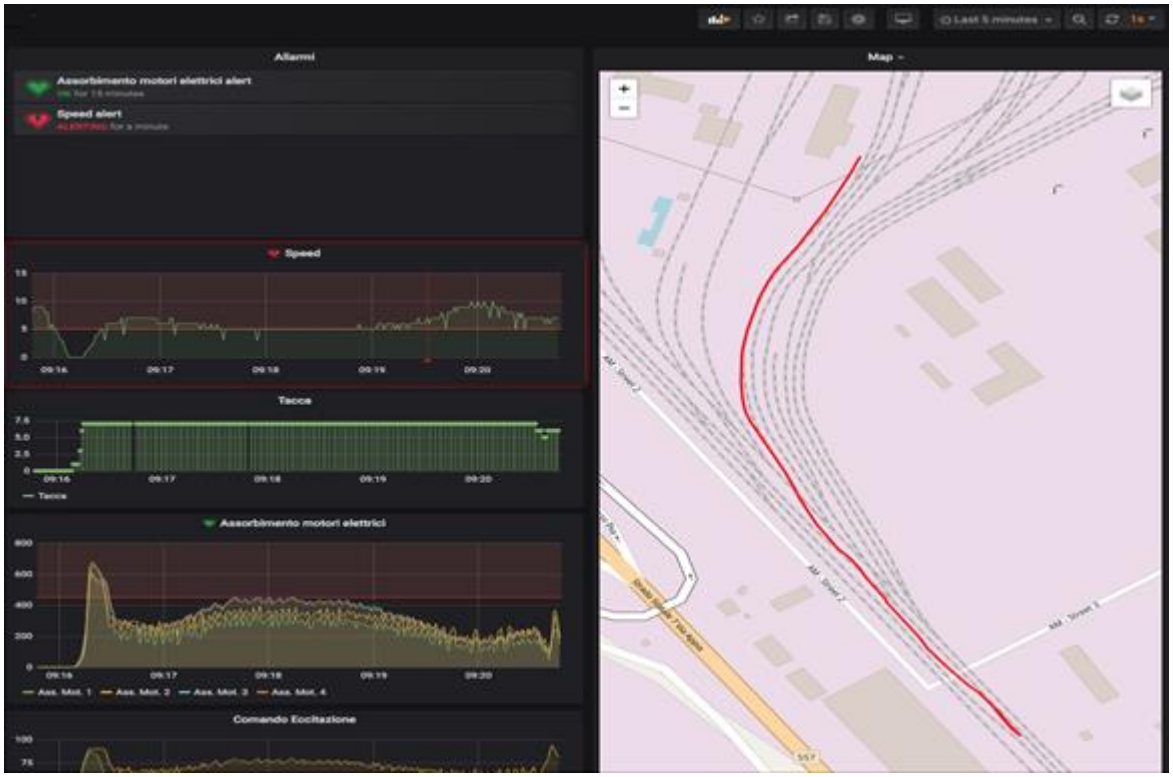
2.4 Journey Report (MJR)

The MJR module allows instantaneous display of the locomotive position, analysis of routes, stops, speeds, and other data based on Customer request.

The function "Follow" allows an instant updating of the locomotive position by moving the map.



Pic 3, Advanced sensor data analysis



Pic 4, User customizable dashboard

2.5 On Board Device (OBD i4.0)

The on-board device i4.0 consists of:

a) One (1) diagnostic control unit.
b) One (1) communication unit on LTE/3G/GPRS network and WiFi apparatus.
c) One (1) GPS positioning device.

The diagnostic control unit is a programmable logic unit (PLC), for analogue and digital inputs and is configurable for working with different supply voltages and can interface with any kind of sensors. It has large capacity of data storage, up to 2TByte and can be used also as a black box function.
The OBD i4.0 is always connected to the server, acquiring and transmitting data with frequency up to 1Hz.

The OBD i4.0 specifications:

a. WiFi
b. GPS - 3 GNSS (GPS, Galileo, GLONASS, BeiDou)
a. LTE/3G/GPRS Router
b. Local data recording GM/RT2472 standard
c. Storage unit for video recording (as optional).
d. Configurable I/O interface
e. On board Interfaces: CAN, RS485, Ethernet, RS232, LoRa, Bluetooth.
f. Extended list of Protocols available: Ethernet IP, Modbus TCP/RTU, Profinet, Ethercat, MQTT, J1939, CANOpen (other Protocols can be provided upon request).
g. Engine ECM Interfaces : Caterpillar, Volvo, MTU, IVECO, Deutz, Mercedes, J1939 compliant.
h. Backup Battery with auto shut-off system.
i. Power supply DC-DC converter 140VDC-19VDC

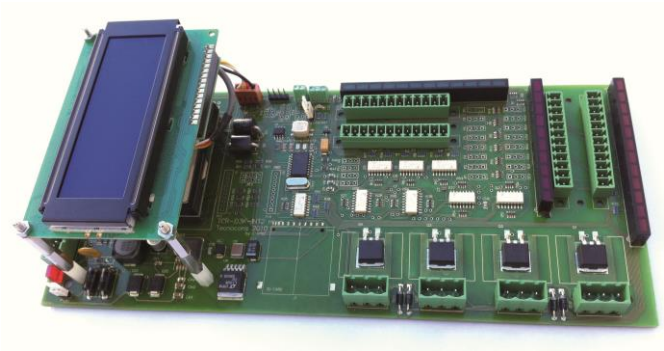
List of the basic measurements provided for a Diesel Electric Locomotive

a. Traction motor currents (1 TA sensor for each axle)
b. Main Generator voltage
c. Traction status (neutral, forward, reverse)
d. Notch
e. Battery voltage
f. Battery current drain
g. Diesel RPMs

h. Diesel oil pressure
i. ECM alarm
j. Cooling water temperature
k. Fuel level
l. Air reservoir pressure
m. Direct Brake Pressure
n. Brake pressure
o. Speed
p. GPS position
q. Altitude
r. Other variables according to Customer's request.

2.6 Samples of hardware designed by Avantgarde

Custom made electronic board



On-board device OBD i4.0

Virtual remote dashboard

Switcher equipped with remote telemetry system TCAVi4.0